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Monetary and Economic Department

FINANCIAL STRUCTURE AND THE MONETARY POLICY TRANSMISSION MECHANISM

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INTRODUCTION

In recent years increasing attention has been paid to the process of internationalisation and globalisation of financial markets. As deregulation and financial innovation have gathered momentum, the causes and implications of the process have come under close scrutiny. While this is both natural and justified, the almost exclusive focus on the forces that work for uniformity is not without risk. It fosters the impression that remaining differences in national financial structures are minor or of little interest for most policy issues. Moreover, it may tend to overstate the pressures towards, and hence the speed of, convergence.

That this risk is real was confirmed by events during the ERM turbulence in the autumn of 1992. The episode pointed to apparent major differences across countries in respect of the speed, intensity and reach of the transmission of changes in policy interest rates to other interest rates in the economy. By interacting with balance-sheet configurations, such differences influenced the economic as well as political costs of interest rate decisions designed to defend exchange rate parities. More generally, they could be expected to affect the characteristics of the response of economic activity to monetary policy impulses, that is, the contours of the "transmission mechanism".

The episode raised a number of questions. It was clear that differences existed, but just how large were they? Subsequent preliminary fact-finding exercises revealed a surprising dearth of information about some of the aspects of financial structure highlighted at the time; the extent to which interest rates on outstanding contracts are fixed or adjustable is one notable example. Similarly, would it not be worth examining other aspects of financial structure that could in principle affect the transmission mechanism? A broadening of the focus could help in understanding whether the overall impact and incidence of changes in monetary policy were likely to differ systematically across countries. Finally, could empirical evidence be brought to bear on the significance of such potential effects?

Against this background, the objective of the present volume is threefold. First, it is to document in some detail cross-country differences in financial structure that may be relevant for the transmission mechanism. Second, it is to consider whether it is possible to identify empirically significant differences in national transmission mechanisms. Finally, and to the extent that the answer to the second question is affirmative, it is to begin to assess whether such differences can be traced back to financial structure.

The papers presented here are by no means exhaustive of the range of linkages between financial structure and the transmission mechanism. To mention just one example, the financing of the public sector is not examined directly; its influence is only assessed as one element contributing to the overall shape of the balance sheets of private non-financial agents. Taken together, however, the papers cover a comparatively broad spectrum of characteristics and rely on a variety of statistical techniques to assess the sensitivity of the findings to the methodology adopted.

The starting-point of the exercise was a questionnaire on financial structure sent to the fourteen central banks contributing to the volume (those of the Group of Ten countries, Australia, Austria and Spain). The questions related to the composition of the balance sheet of financial and non-financial agents and to the characteristics of financial contracts, including both interest and non-interest terms. The information requested was generally limited to two years, 1983 and 1993.[1] The replies then served as the initial input for the two descriptive papers that document differences in financial structure. The remaining contributions to the volume rely on econometric techniques to identify regularities in the pattern of responses of both financial and real variables to monetary policy impulses.

1 The exceptions were series for net and gross interest payments of households and businesses.

Before outlining briefly the main findings of the papers, it is useful to step back and ask more specifically why and how financial structure should be expected to influence the transmission mechanism. In a world of perfectly competitive markets and perfect information financial structure would play no role. Indeed, the view that financial structure should have only a modest influence on the impact of policy has often been predicated on the assumption that the theoretical paradigm can be a useful guide to actual behaviour, at least as a first approximation.

As conditions progressively depart from those of the ideal, benchmark world, the influence of financial structure can begin to be felt. In fact, only then is it meaningful to talk about monetary policy at all; for only then do notions of "liquidity" and "money" come into their own rather than being artificial constructs devoid of a useful function. The characteristics of financial contracts, institutions and balance-sheet configurations all become relevant. It is considerations such as these, for instance, that have rekindled academic interest in the link between capital market imperfections and the business cycle. Imperfect information between suppliers and users of funds is seen as the basis for limited substitutability between internal and external financing sources and between different forms of external finance, such as intermediated and non-intermediated credit. The relevance of these factors was highlighted during the recent business cycle. The weakness of the balance sheets of lenders and borrowers in several countries generated concerns about a potential "credit crunch", a situation in which lenders' reduced willingness to extend credit makes economic activity less responsive to monetary easing.

A stylised characterisation of the transmission mechanism can help to identify the potential impact of financial structure. According to this, the central bank gears its instruments to influencing quite closely very short-term interest rates. Changes in such "policy-controlled" rates ultimately affect economic activity through four main channels. First, they induce changes in interest rates and yields on new financing and portfolio investments (marginal rates), thereby affecting the opportunity cost of real expenditure decisions (e.g. through the cost of capital). Second, they lead to changes in average rates on outstanding contracts, modifying incomes and cash flows and hence constraints on spending. Third, they affect asset values, impinging not only on wealth perceptions but also on the ability to borrow and willingness to lend. Finally, they have an impact on the exchange rate, and hence on the relative price of assets and goods and services denominated in different currencies.

Financial structure can have a bearing on these channels of transmission in at least two ways. First, it can affect the speed, size and compass of interest rate changes. For instance, the degree of competition in various market segments and the scope for arbitrage across markets can influence the responsiveness of interest rates on new loan contracts. Similarly, through specific balance-sheet configurations, the structure can shape the constellation and intensity of valuation effects. The level, composition and distribution of wealth and indebtedness are especially relevant in this context. Through both of these mechanisms, the structure can alter the overall strength of monetary impulses to the economy, the relative importance of the channels of transmission and the incidence of policy across sectors, notably as between households and businesses.

The paper by Kneeshaw documents the balance-sheet structure of households and businesses. It is suggested that countries can be divided into two broad groups. The first comprises the United States, the United Kingdom, Canada and Australia ("English-speaking" countries) as well as Japan and Sweden. The second includes most continental European countries. Certain characteristics of the balance-sheet configurations indicate that valuation, income and cash-flow effects may typically be more powerful in the first group. In particular, households in these countries are more heavily indebted and/or hold a larger proportion of their wealth in the form of assets whose price is highly interest rate sensitive and subject to large fluctuations, such as equity and real estate.

The study finds little evidence of convergence over time between the two groups with respect to the above characteristics. By contrast, on the basis of certain measures some convergence appears to have taken place in the capital gearing of the business sector. In particular, since the early 1980s gearing has tended to grow faster in most English-speaking countries, where it was comparatively low; it has actually fallen in parts of continental Europe. The convergence in indicators of gearing has not been accompanied by fundamental changes in the nature of corporate control mechanisms; the relationship between suppliers and users of external funds remains more at arm's length in English-speaking countries. As a result, companies there cannot benefit from greater reliance on one set of financial arrangements that typically helps to limit the effects of indebtedness on the vulnerability to a monetary policy tightening.

The paper by Borio examines in more detail the characteristics of credit to the non-government sector, including both interest and non-interest terms. Three findings merit particular attention. First, the share of securities in total credit is comparatively high in English-speaking countries. Second, most English-speaking countries are characterised by a relatively high share of adjustable rate credit, defined as credit which is either short-term (up to one year original maturity) or medium and long-term but at rates that move in line with short-term rates. This is due primarily to the widespread use of adjustable rate mortgages by households. Outside the English-speaking group, the main exception is Italy; inside it, the United States.[2] Third, the share of loans backed by real estate collateral is comparatively high in most English-speaking countries. Elsewhere, it is very high in Sweden and Switzerland. There are also indications that the share is relatively high in Japan.

To varying degrees, the above characteristics tend to strengthen the impact of monetary policy. Typically, compared with loan ("customer") markets, in securities ("auction") markets interest rates adjust faster and investors are less willing to temporarily insulate borrowers from adverse changes in economic conditions. More importantly, the higher the share of adjustable rate debt, the larger the income and cash-flow effects associated with changes in policy-controlled interest rates. Finally, given the interest rate sensitivity of real estate prices, a comparatively high share of loans backed by real estate collateral increases the responsiveness of the willingness to lend and ability to borrow to monetary policy impulses. It may also lead to periods of self-reinforcing pressures between asset prices and credit availability.[3]

Since the early 1980s there is little evidence of convergence between country groups in terms of the highlighted characteristics. By and large, the share of securities has tended to grow faster in countries where it was already high; Japan and France are two notable exceptions. A similar pattern applies to real estate collateral, its share in total loans rising most in English-speaking countries, Sweden and Japan. These were also the countries experiencing some of the largest asset price cycles or where the interaction between credit and asset prices caused greatest concern during the last business cycle. Information on the share of adjustable rate credit is too limited to form an overall view. However, one key component, the part in the form of short-term credit, has generally changed remarkably little since the early 1980s.

The paper by Borio and Fritz investigates the response of interest rates on short-term bank loans to changes in policy rates. The authors find that after one month the adjustment is faster in English-speaking countries, taken as a group, than elsewhere. Systematic differences largely disappear after one year; by then the loan rate has typically reflected the initial increase in the policy rate in full. At one end of the spectrum, adjustment is full and immediate in the United Kingdom. It is considerably slower in Germany and France. This broad picture does not appear to have changed substantially over time. Admittedly, the heterogeneity of the loan market complicates international comparisons. For instance, rates charged to large companies generally respond faster than those

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2 In the United States, however, a large component of medium and long-term fixed rate debt can be repaid early and refinanced at current rates with little or no penalty; this flexibility is exceptional in comparison with experience elsewhere, especially in continental Europe and Japan. Moreover, the active use of derivatives to alter interest rate exposures clouds the picture somewhat.

3 Of course, a positive interaction between credit availability and asset values does not require that the assets are used as collateral. It may also arise, for instance, when share prices are taken as a direct indication of the future prospects of the companies. Ceteris paribus, this mechanism is likely to be more important where share markets are more developed.

applicable to small businesses or individuals. However, careful assessment of the rates chosen in the study appears to indicate that the broad pattern is not misleading. The authors suggest that one significant factor explaining cross-country differences may be varying responsiveness of average funding costs to market rates.

The paper by Tsatsaronis attempts to cast further light on the role of bank loans in the transmission mechanism. The author examines the question of whether the behaviour of loans following a policy tightening is consistent with the existence of a contraction in their supply that cannot be offset with other sources of external funding (a "bank loan channel"). In the context of the Romer-Romer methodology applied in the study, this is tested by comparing the behaviour of credit, money and output following independently identified policy tightenings and attempting to extract information from the temporal pattern of responses. The exercise covers four countries: the United States, Japan, Germany and the United Kingdom.

The results are not clear-cut, probably reflecting the shortcomings of the methodology. Nevertheless, on balance the evidence of a bank loan channel is comparatively strong in Japan, mixed in the United States and the United Kingdom and very weak in Germany. German banks appear to have had both the incentive (because of close ties with non-financial companies) and the balance-sheet flexibility to temporarily insulate borrowers from a policy tightening. Despite similar close ties, no such flexibility seems to have been available to Japanese banks, as the monetary authorities have successfully relied on direct controls on lending for much of the period.

In order to establish whether it is possible to identify systematic cross-country differences in the response of economic activity to changes in monetary policy, Gerlach and Smets apply structural vector autoregressions (SVARs) to the Group of Seven countries. Their model includes three variables: a three-month money market rate (the "policy" rate), real GDP and prices. The influence of changes in monetary policy is identified through a mixture of short and long-run restrictions on the implied behavioural relationships. Specifically, it is assumed that (unexpected) changes in policy have neither instantaneous (within one quarter) nor long-run effects on output, viz. that their impact is only temporary and felt with a lag.

The resulting estimates provide little evidence of large cross-country differences in the impact of monetary policy on economic activity, especially once confidence bands are taken into account. The point-estimates of the effects on output of a standardised monetary tightening are very similar in Canada, Germany and the United States, somewhat lower in France and Italy, with the United Kingdom and Japan somewhere in between.

The rest of the volume is devoted to a description of the simulations with central bank models, summarised in the paper by Smets. The exercises trace the responses of real and nominal variables to a 100 basis point increase in policy-controlled rates maintained for two years, under both fixed and flexible exchange rates. The simulations are carried out using two sets of models. One set comprises national central bank models for their own economies; their structures differ significantly. The second is the Multi-Country Model (MCM) of the Federal Reserve, which imposes the same basic structure on all Group of Seven countries. The results depend crucially on the set used.

In the case of the MCM, there is little evidence of substantial cross-country differences. Indeed, if anything, the point-estimates are closer than those found with the SVARs. The exception is the United Kingdom, for which the output response is relatively large.

In the case of national central bank models, by contrast, a broad pattern emerges. The impact of the tightening on economic activity tends to be comparatively strong in English-speaking countries and Japan, with Italy exhibiting a larger response than other continental European countries. After roughly two years, the effects are especially large in the United Kingdom. The results hold regardless of which measure of aggregate economic activity is used, such as GDP or domestic demand. They also hold irrespective of whether the exchange rate channel is allowed to operate. This channel, however, is typically very important and outweighs the domestic channels of transmission in the case of small open economies.

We now have information about certain key elements of financial structure, a set of conjectures about their relevance and a sample of econometric results. For an assessment of the impact of structure on the transmission mechanism one ingredient is still missing: an informed judgement about the a priori classification of countries in terms of the likely strength of the response of economic activity to changes in policy-controlled rates. Without a weighing scheme permitting a comparison of the relative importance of the various characteristics, any such classification is necessarily very rough. But the clustering of the various features across countries does provide some clear pointers.

On balance, at one end of the scale the impact of monetary policy might be expected to be stronger in the United Kingdom, Canada and, to a lesser extent perhaps, Australia. In these countries the structure is such as to speed up the adjustment of interest rates and amplify income/cash-flow and valuation effects. The United States could also belong to the same group, with question marks owing to the different degree of adjustability of rates on existing contracts. Outside this group, the impact might be expected to be comparatively high in Japan, reflecting mainly gross indebtedness levels and potential valuation effects. The position of Sweden appears to be similar. At the other end of the spectrum, most other continental European countries should rank comparatively low. Because of the exceptionally high share of adjustable rate debt, however, the response of economic activity could be stronger in Italy.

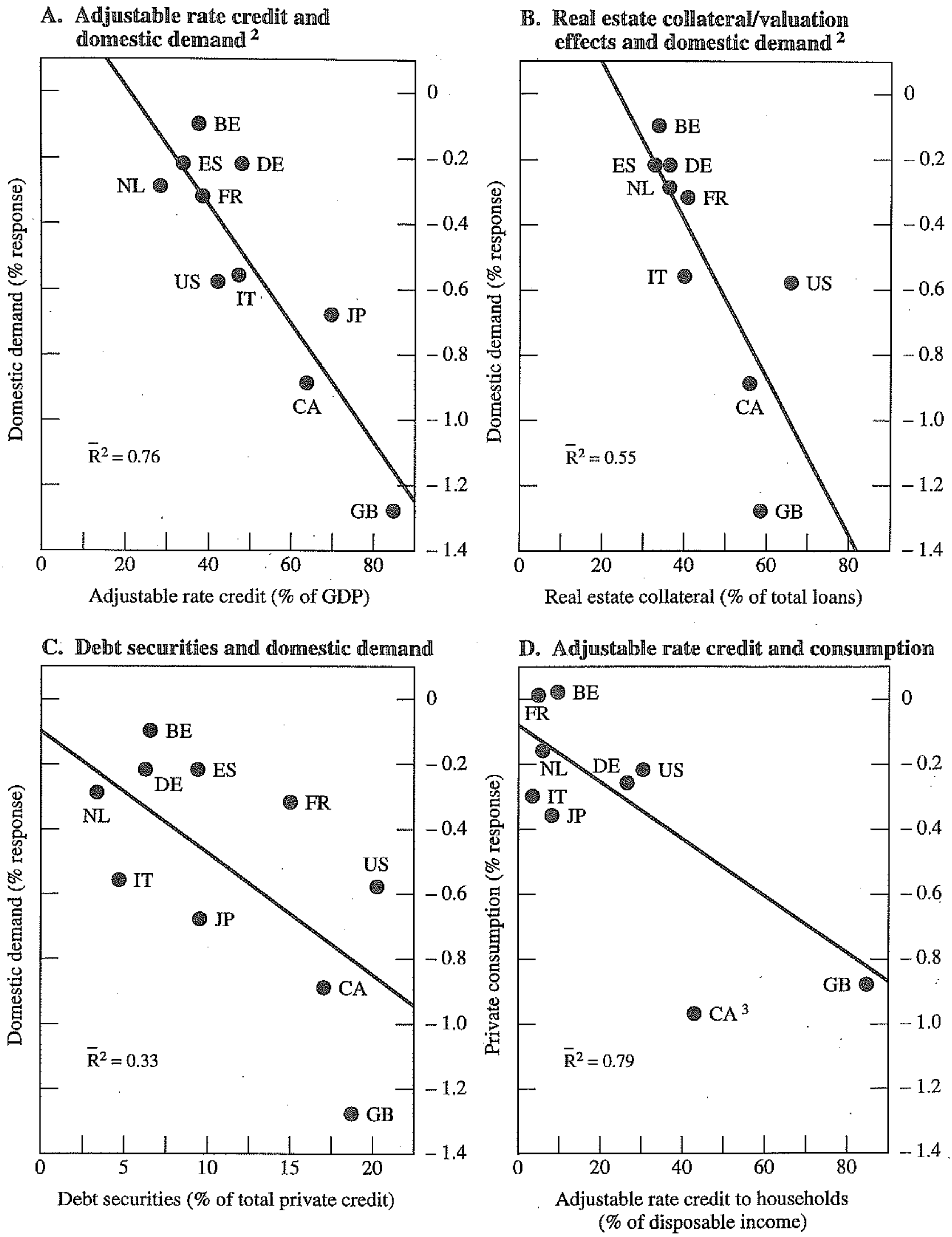
This set of presumptions finds no confirmation in either the SVAR or MCM results. By contrast, it is broadly validated by the outcome of the simulations of the national central bank models.[4] This general correspondence is further supported by some simple statistical exercises (see the graph overleaf). The reductions in economic activity following the standardised tightening are larger in countries where adjustable rate debt is more important and where the share of lending backed by real estate collateral (in part a proxy for valuation effects) is higher. A weaker but positive relationship can also be detected with respect to the share of debt securities in total private sector credit. At the sectoral level, adjustable rate debt also helps to account for differences in the response of consumption.

Looking further into the properties of the models casts additional light on these findings. Admittedly, the way in which financial structure is accounted for is rather crude. Levels of indebtedness of households and businesses do not generally appear in the equations; the related income flows are typically limited to the interest payments from the government to the household sector. Similarly, wealth effects are only partially modelled. For instance, equity prices are only included in four countries (the United States, Japan, the Netherlands and Belgium) and house prices in only two of these (the Netherlands and Belgium). As a result, the main domestic channels of transmission operate through the effects of changes in marginal real interest rates on investment and consumption. Any impact of the financial factors not explicitly captured in the equations can only be felt indirectly, through their correlation over the estimation period with variables included in the relationships. The correlation between asset prices and real interest rates is one notable example; that between these rates and cash flows is another. For instance, if asset prices are high and balance-sheet positions strong when interest rates are low, some of the estimated impact attributed to the interest rates will reflect the influence of wealth and availability of credit effects. On the other hand, the models do incorporate one key feature of financial structure: short-term rates have been selected for inclusion where adjustable rate debt is predominant, most notably in the United Kingdom, Canada and Italy.

The contrast between the results based on national econometric models, on the one hand, and SVAR and the MCM, on the other, raises the question of their comparative reliability. No doubt, econometric exercises such as SVAR, based on relatively weak a priori restrictions on economic relationships, have the advantage of limiting any potential "biases" that model builders may introduce. The risk of such biases is particularly significant when common and strong restrictions are applied across countries, as in the case of the MCM. Nevertheless, for present purposes, the results of the

4 No simulations could be executed for either Sweden or Australia.

Financial structure and economic activity [1]



[1] Percentage point deviations from baseline in domestic demand and private consumption according to the simulations of national central bank models. (100 basis point increase in policy rates maintained for two years). The deviations are measured in the second year following the tightening. For domestic demand, domestic channels only; the results are similar if real GDP or total domestic demand are used. [2] Adjustable rate credit (% of GDP) and real estate collateral (% of total loans) jointly "explain" 86% of the cross-country variation in domestic demand. [3] A dummy is added for Canada: consumption also includes residential construction and inventories.

simulations of national central bank models probably provide the most useful benchmark. The models reflect a greater familiarity with individual economies, better capture the specificities of national financial structures and need to fit experience quite closely so as to be of use in the policy process.

The above findings hardly represent conclusive evidence of the significance of differences in financial structure for the overall impact of monetary policy on economic activity. At a minimum, however, they strongly suggest that certain often neglected aspects of financial systems, such as the mix between fixed and adjustable rate debt, merit considerably more attention than they have received hitherto.

More generally, from a policy perspective the overall picture that emerges from this volume raises at least two issues that are worthy of future analysis. One is the extent to which differences in financial structure can complicate the implementation of monetary policy internationally. Quite apart from the overall net impact on economic activity, there is ample evidence that financial structure affects the channels of transmission and hence the incidence of policy across sectors. It thereby influences the economic and political costs of alternative policy actions. As vividly illustrated by the ERM turbulence in 1992, this can make it harder to pursue common interest rate policies across countries. A second issue relates to the ultimate determinants of the relevant characteristics of financial structure. The studies in the volume do not tackle this question in much detail. There is some evidence that the inflation record helps to determine contract maturities and the mix between fixed and adjustable rates. This indicates that the financial structure is affected, directly or indirectly, by the course of monetary policy itself. But clearly other factors are at work. A better understanding of the underlying forces would cast light on the extent to which the various features are likely to persist over time or to change with the economic, legal and regulatory environment.

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Switzerland:	Mr. Erich Spörndli Mr. Franz Ettlin
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United States:	Mr. Paul Bennett (New York) Mr. David Stockton (Washington) Mr. Peter Hooper (Washington)
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BIS:	Mr. Horst Bockelmann (Chairman) Mr. Renato Filosa Mr. William White Mr. Joseph Bisignano Mr. John Bispham Mr. John Kneeshaw

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Analysis of answers to the questionnaire on financial structures

Non-financial sector balance sheets in the monetary policy transmission mechanism

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I. INTRODUCTION[1]

While a broad consensus has been reached on how monetary policy is implemented and on what it can or should be expected to achieve in the longer run, the transmission process is not well understood. In varying degrees, the impact of policy on the economy seems to have changed in recent years as a result of financial liberalisation, asset price inflation and changes in sectoral balance-sheet positions. Some of the developments have potentially increased the sensitivity of expenditure to changes in interest rates. Other may have reduced it. While the overall effect is difficult to quantify and may change over time, policy has been adapted in various ways to take account of balance-sheet positions. For example, the European exchange market crisis in 1992-93 highlighted cross-country differences in European monetary policy transmission mechanisms which seemed to substantially affect the cost of pursuing exchange rate based policies.

These developments have drawn attention to cross-country differences in the responses to changes in policy controlled interest rates of other interest rates and in the balance-sheet positions of banks, governments, households and enterprises. In particular, they suggest country differences in the strength of wealth, income and cash-flow effects of changes in interest rates, which may depend on the composition of the balance sheets of the private non-financial sectors. Changes in the interaction of wealth and cash-flow effects over the business cycle as asset price expectations change imply that these effects are not always easy to identify empirically and make the impact of monetary policy less certain. The impact may be strengthened, at least temporarily, when financial positions come under stress and may at times constrain policy.

Our knowledge of cross-country differences in balance-sheet positions of the household and business sectors has been improved by the responses of fourteen central banks to a BIS questionnaire on financial structure. The answers contained information on balance-sheet positions a decade earlier, as well as on developments in interest payments and receipts by the household and non-financial enterprise sectors. The results of the survey are summarised in this note. In combination with the country differences in the response of rates applied by financial institutions to changes in official rates, which are discussed in detail in another BIS note,[2] it suggests various ways in which the monetary policy transmission mechanism may differ significantly from country to country. Some divergences seem actually to have widened during the last decade. The question arises whether the changes are likely to prove lasting or form part of a cyclical process which could be repeated. To facilitate comparison of the developments over the period, time series broadly corresponding to the

1 The author gratefully acknowledges helpful comments from Horst Bockelmann, Bill White, Joseph Bisignano, Elmar Koch and Stephan Arthur, who prepared graphs. Errors of fact or interpretation are the author's own. My thanks go to Gerhard Randecker for very helpful statistical assistance.

2 See Claudio Borio (1994), *The structure of credit to the non-government sector and the transmission mechanism of monetary policy: a cross-country comparison*, this volume.

data for two dates supplied in answers to the BIS questionnaire have been collected, for as many of the countries as possible, from other central bank or official sources.[3]

Developments in sectoral balance-sheet positions have been extensively analysed by several central banks and some of the salient differences between major countries are fairly well known. Data on a number of countries is considered here but for many it is only annual or covers only a short time-span and is thus not suitable for rigorous analysis. Notwithstanding some adjustment, its comparability between countries remains open to question in certain respects. Hence the discussion is preliminary, tentative and informal. It aims only at drawing attention to apparent differences in countries' situations and experiences and suggesting possible implications for the monetary policy transmission mechanism. The impact of changes in balance-sheet positions of financial institutions and the government sector is not considered.

A section placed directly after the introductory section provides a tentative overview of the results. After that are two sections which review the available information on balance-sheet positions and interest payments of the household and enterprise sectors in turn. In each case the discussion begins with a comparison of the key components of the sector's present balance-sheet position and of the position at an earlier reference date, as revealed mainly by questionnaire responses. This is followed by a consideration of the possible implications for the transmission mechanism of developments in balance-sheet structures as reflected in capital gearing, net interest-bearing asset and debt ratios and the composition of indebtedness. Next the data available on interest payments and receipts by the household and enterprise sectors are reviewed, a rough distinction being drawn between the direct effects of monetary policy on average interest rates paid and received and effects coming about through induced changes in balance-sheet positions. Finally, some hypotheses are put forward as to how cross-country differences in financial positions may help to account for differences in the behaviour of particular components of aggregate expenditure, though no attempt is made to test these hypotheses empirically.

II. THE MONETARY POLICY TRANSMISSION MECHANISM AND BALANCE-SHEET POSITIONS

Much attention has been paid to analysing intertemporal substitution effects induced by changes in monetary policy, which essentially entails consideration of the incentives of potential borrowers and lenders to bring forward or delay expenditure. Balance-sheet structures and current income flows may affect agents' capacity to take advantage of such incentives, for instance by recourse to increased borrowing, as well as influencing consumption through standard wealth/permanent income channels. Balance-sheet positions may also reflect the operation of liquidity and credit-rationing effects.

It is generally assumed that following deregulation the transmission of monetary policy impulses to expenditure has become increasingly dependent on effects operating through interest rates, asset prices and exchange rates. A question often raised is whether a weakening of credit-rationing effects could imply that large changes in interest rates are now necessary to have a given effect on private expenditure.[4] However, where changes in financial structures have augmented wealth, income or cash-flow effects which operate quickly, the impact of given changes in interest rates on aggregate demand may actually have increased. At high debt levels, cash constrained debtors may have a stronger tendency to respond to rises in interest rates than creditors. The possibility that credit institutions could be more inclined to ration credit might enhance the effects of interest rate increases. The wealth effect of declines in asset prices, greater importance of the housing stock in

3 Differences of detail are largely determined by data availability.

4 Some commentators have also contended that an increase in the demand for short-lived services relative to the demand for more durable products may have reduced the interest elasticity of aggregate demand.

personal wealth and increased consumer borrowing against higher market values of housing all potentially increase the effectiveness of interest rate increases. Some commentators have noted that, particularly where levels of short-term government debt[5] are high, changes in interest rates may bring about a counteracting fiscal shock. However, the government may respond by action to offset the change in the budget deficit. There is also a question of whether private economic agents perceive changes in the budget deficit as implying changes in potential future tax burdens. Some wealth and cash-flow effects of monetary policy may be non-linear. Certain asset price effects depend on the proportionate change in interest rates, implying that a given change in rates is most powerful when their level is low.[6] Certain cash-flow effects are stronger at high levels of nominal interest rates, even to the extent that interest rate levels reflect inflation expectations.

The role of wealth, income and cash-flow effects clearly differs between countries and has changed over time in ways which are difficult to identify and their importance in particular situations has often been controversial. The effects are potentially strongest when policy changes unexpectedly. Much depends on whether the changes on policy or in other influences on asset prices are expected to prove lasting. Relevant distributions of positions among individual enterprises and households are often not fully revealed by aggregate data. Developments in balance-sheet positions ultimately reflect desired adjustments to perceived income and profit prospects and risks. The implications for the impact of monetary policy on aggregate expenditure of leverage, long/short or fixed/variable interest rate positions cannot always be interpreted unambiguously. For instance, leverage increases the wealth effect of changes in asset prices which are expected to continue, even if cash-flow positions are being squeezed, until the cash-flow effect begins to dominate. When asset prices are not expected to rise cash-flow effects may come into operation quickly. Sectoral balance sheets indicate vulnerability to changes in interest rates. Market participants' perceptions of vulnerability change in the light of experience and balance-sheet positions can be adjusted accordingly. However, the process usually takes time and usually has effects on output.

Recent experience has highlighted several concrete problems associated with the interest rate transmission process as conditioned by sectoral balance-sheet positions. On the one hand, long-term interest rates and the prices of some assets, such as real estate, typically respond only slowly to the moderate changes in policy rates which have been characteristic of the gradualist counter-cyclical monetary policy course normally followed in some large countries. In principle, policy can be adjusted more if necessary, but the risk of exploding an existing asset price bubble may at times have constituted a constraint. It has proved particularly difficult to influence asset prices once speculative bubbles or an implosion have developed. Monetary ease has also operated slowly in counteracting the interest rate, cash-flow or balance-sheet effects of non-monetary disturbances. On the other hand, relatively large changes in policy controlled interest rates have continued to be necessary at times for countering exchange market pressures, even in countries with flexible exchange rates. The sensitivity of sectoral wealth positions and cash flows can intensify the dilemmas faced in these situations.

More generally, the response of long-term interest rates and asset prices to changes in monetary policy is not always predictable, given the important role of expectations. Moreover, the complicated and changing effects of balance-sheet positions has made the direct effect of monetary policy on aggregate expenditure less certain, at least in the short run. This is certainly not the sole criterion for evaluating the effectiveness of policy. The view that policy will have the most favourable effects on investment and growth if it succeeds in reducing and controlling inflation expectations implies that to the extent that increases in short-term interest rates are effective in lowering inflation expectations smaller adverse effects on output may be needed to achieve an inflation objective. Yet uncertainties about the effect of monetary policy on aggregate demand may complicate the task of steering policy towards the achievement of ultimate objectives.

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5 Which is akin to "outside wealth".

6 See E. Mauskopf (1994), "The transmission channels of monetary policy: how have they changed?", *Federal Reserve Bulletin*, pp. 985-1008.

III. TENTATIVE CONCLUSIONS AND OPEN QUESTIONS

With economic recovery in the industrial countries now on a firmer footing attention is turning to the question of the impact of rises in interest rates. Whether the impact is likely to be faster and stronger than in the past or much the same as in previous cycles can be expected to depend on sectoral balance-sheet positions and underlying factors, which differ significantly between countries.

At the risk of oversimplification, it seems possible to identify two groups of countries. The distinction depends less on recent experience than on underlying differences in tastes, such as preferences for home ownership, which have in many cases been reinforced by the tax treatment of interest payments and receipts.

One group of countries includes the United States, Japan, the United Kingdom, Canada, Australia and Sweden. In most of these countries, the value of household housing and/or share assets is high, and large recent changes in values remain imprinted on household memories (Table 1). Except in Japan, home ownership is widespread. Housing wealth is relatively large in the United Kingdom and Australia and household share portfolios are substantial in Canada and the United States. In these circumstances wealth effects operating through changes in asset prices are likely to be important. The operation of wealth effects depends on asset price expectations but capital leverage is relatively high in all of these countries except Australia, where it is now rising. Asset prices and household cash flows are clearly vulnerable to a tightening of monetary policy as the economic recovery advances. Households' direct holdings of interest-bearing assets, net of their indebtedness, have fallen to low levels or have become negative in the United Kingdom and Sweden but are large in Japan and, to a lesser extent, Canada and (if implied debt asset holdings through unit trusts are included) the United States. The impact of changes in policy rates on average rates payable by households on existing debt seems relatively large and fast in most of these countries. This is clearly not the case in Sweden, however, and it is difficult to judge how much of an apparent sluggishness of the responses to money market rates of interest rates applied by financial institutions in the United States in recent years reflects only unusual rate setting behaviour of financial institutions in recession.

The other group includes most continental European countries. In many of them home ownership is less widespread, household financial wealth largely takes the form of debt claims and capital gearing ratios are low. Wealth effects and cash-flow constraints may therefore remain limited. That the household sector's net holdings of interest-bearing assets are comparatively large and net interest receipts high may suggest that traditional income effects of monetary policy on household spending could act as significant counter-forces to intertemporal substitution effects. However, the substantial long-term component of both assets and liabilities with interest rates which adjust slowly implies that the impact of policy may be comparatively small in the short run. Relatively weak reactions of household interest receipts and payments, as well as of average rates received and paid, tend to support this. Qualifications to this stylised description are called for in the case of individual countries. In Italy, for instance, interest rates paid and received by the household sector seem comparatively flexible and, as in France, the value of household share portfolios is now high. Household indebtedness seems substantial in Switzerland. However, the overall structure of household balance sheets suggests that these factors are unlikely to become major influences on the transmission mechanism.

The extent to which the remaining cross-country differences in transmission mechanisms are attributable to regulatory influences has not been investigated. In most cases rises in household capital leverage experienced during the last decade were encouraged by *changes* in regulations affecting the attractiveness of home-ownership. Housing and mortgage markets remain subject to strong government influence which could undergo further change in the future. There may also be some question as to whether the spread of innovations such as money market funds or home equity loans could bring about large changes in household balance sheets - and hence in policy transmission mechanisms - in countries where they have to date shown a relatively stable development. There may

Table 1

Household summary data[1]

(as a percentage of personal disposable income)[2]

Items		JP	US	CA	AU	UK	DE	FR	IT	ES	BE	NL	CH	SE
1. Total net assets	1993	720	480	440	480	530	420	450	600					200
	1983	540	480	290		430	380	390						190
2. Tangible assets	1993	480	210	210	350	280	280	270	370					
	1983	390	230	150		250	280	300						
3. Share assets	1993	35	85	115	45	55	10	90	65	40				35
	1983	..	45	45		35	10	25	50	20				40
4. Indebtedness	1993	95	90	85	80	95	80	50	25	50	40	65	130	100
	1983	65	70	55	70	60	70	40	20	40	25	50	110	100
5. Debt/total assets (%)	1992	12	16	15	14	19	15	12	2					32
	1982	10	13	13	..	15	16	12	2					34
6. Net debt assets (incl. pension claims)	1992	185	120	120	..	155	125	90	150	70				0
	1982	125	95	100	..	130	95	65	100	65				5
7. Net debt assets (excl. pension claims)	1992	110	15	35	10	5	65	55	130	55				- 20
	1982	95	35	50	..	30	50	55	85	65				- 10
8. Gross interest received[3]	1992	10.4	14.8	[16.8]	12.4	[15.8]	9.6	5.8	16.0	10.1	9.9	17.0		8.0
	1982	11.6	16.3	[18.0]	10.3	[13.3]	7.7	6.3	13.0	..	9.3	..		8.7
9. Gross interest paid[3]	1992	6.2	7.5	8.8	10.3	[10.6]	5.5	5.6	4.7	5.9	3.8	6.9		13.5
	1982	5.3	6.8	8.6	8.1	[7.7]	5.4	4.1	3.9	..	3.9	..		12.2
10. Net interest received[3]	1992	4.2	7.3	[8.0]	2.1	[5.2]	4.2	0.2	11.4	4.2	6.1	10.1		- 5.5
	1982	6.4	9.5	[9.5]	2.2	[5.7]	2.3	2.1	9.1	..	5.4	..		- 3.5

[1] Items1-4, as in Table 3; items 5-10, as in graphs. (Shares include mutual funds.) For items 7, 8, 9 and 10 for the United Kingdom, 1984 and 1992. [2] Except item 5. Items 1 and 2 are rounded to the nearest 10; items 4, 6 and 7 to the nearest 5. [3] For the United Kingdom, including dividends; for Canada, receipts and net payments include dividends received.

be little need to take wealth effects explicitly into account in monetary policy in countries where asset price movements have been moderate and where increases in wealth have largely taken the form of longer-term quasi-fixed interest rate claims. However, increases in wealth in these forms could have increased the sensitivity of household spending to bond market disturbances stemming from abroad.

Large cross-country differences in the response of borrowing by non-financial enterprises (Table 2) to changes in asset values could imply continuing differences between countries in the impact on investment of changes in interest rates and asset prices. Increases in leveraging in the 1980s in the United States, Japan, the United Kingdom, Canada and Australia seem to have reflected a breakdown of the traditional reluctance of enterprises to rely heavily on external financing but they were influenced in some cases by changes in the taxation of interest and dividends or other tax changes. The subsequent restructuring of overstretched balance sheets was facilitated by monetary ease. In Japan, where enterprises' holdings of real and financial assets rose even more than financial liabilities during the asset price boom, they have remained much higher, on balance, than in earlier years. A renewed rise in leverage from a higher base in this group of countries could increase the sensitivity of corporate cash flows to interest rates.

Capital gearing ratios of non-financial enterprises in several European countries, including Germany, were relatively high at the beginning of the 1980s. Various explanations have been advanced as to how the large bank lending component may have made higher leveraging acceptable. In many continental European countries enterprises took advantage of improvements in profitability during the 1980s to reduce recourse to external financing. Cash flows were subsequently eroded by recession but interest gearing ratios typically remained relatively low. In France, Italy and Belgium, where these ratios seem high in comparison with some other countries, they are much lower than they were in the early 1980s. Presumably reflecting the relatively large influence of long-term interest rates, the responses of enterprises' interest burdens to changes in short-term market interest rates seems relatively low in many cases. In France, and possibly also Germany and Spain, the sensitivity of interest rates received to short-term market rates seems to have increased, perhaps indicating more active portfolio management by non-financial firms.

Questions of the broader implications for economic efficiency of differing balance-sheet structures and, in particular, differing proportions of equity and short or long-term debt financing of the enterprise sector are beyond the scope of this paper. In contrast to the historically atypical substitution of debt for equity by the US corporate sector in the 1980s, the traditional heavy reliance of firms in many continental European countries on cash flow and external debt finance may partly reflect a traditional reluctance of many firms to rely on equity financing. In many cases financing structures are still influenced by earlier official steps taken to promote the supply of long-term debt financing. Differences in corporate financing structures may also reflect more basic differences in the structure of corporate ownership, creditor enterprise relations and the market for corporate control.[7] To the extent that such factors are decisive, the prospects for convergence of the financial positions of non-financial corporations in Europe and North America may be limited. However, the scope for equity, bond and short-term market debt financing in domestic and international markets has increased in recent years, though these typically remain modest sources of funding for many European firms. It may be asked whether increases in the availability of market financing or the search for low funding costs and pressures stemming from international competition could contribute to substantially reducing cross-country differences in enterprise financing structures and thus in the monetary policy transmission mechanism.

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7 See Borio, C.E.V. (1990): "Leverage and financing of non-financial companies: an international perspective", *BIS Economic Paper*, No. 27, Basle, May, and Prowse, S. (1994): "Corporate governance in international perspective: a survey of corporate control mechanisms among large firms in the United States, the United Kingdom, Japan and Germany", *BIS Economic Paper*, No. 41, Basle, July.

Table 2

Non-financial enterprise sector summary data[1]

Items	Year	JP	US	CA	AU	UK	DE	FR	IT	ES	BE	NL	CH	SE
1. Tangible assets/GDP (%)	1993	240	130	80	100	120	150	140						
	1983	200	200	90		110	150	160						
2. Debt liabilities/GDP (%)	1993	135	60	45	65	50	75	70	45	60	45	60	50	105
	1983	90	60	45		20	50	55		70	45	45	40	65
3. Shares on issue/GDP (%)	1993		115	105	80	120	30	215	50	35	30			60
	1983		105	65		50	20	50		20	10			35
4. Debt/total assets[2]	1992	0.48	0.45	0.61	0.46	0.46	0.51	0.39						
	1982	0.37	0.28	0.59	..	0.25	0.45	0.29						
5. Debt/equity[3]	1992	..	0.51	..	0.92	0.49	2.71	0.41	1.47	2.10				1.74
	1982	..	0.80	..	..	0.42	3.20	1.41	1.47	2.97				..
6. Net debt/operating surplus	1992	7.30	3.10	4.50	3.60	3.20	1.80	5.10	3.70	1.90				10.20
	1982	3.70	1.80	2.60	2.80	0.50	2.00	6.80	3.50	..				8.80
7. Operating surplus/GDP	1992	0.13	0.07	0.05	0.14	0.10	0.21	0.09	0.09	0.20		0.15		0.06
	1982	0.15	0.08	0.11	0.12	0.15	0.17	0.05	0.07	..		..		0.05
8. Long/short-term debt	1992	..	1.80	2.10		0.60	2.60	1.60	0.60		1.20	2.90	0.70	
	1982	..	1.60	1.70		0.10	2.40	1.70	0.90		1.30	..	0.70	
9. Gross interest paid/ operating surplus	1992	0.79	0.64	1.00	0.43	[0.43]	0.42	0.63	0.73	0.40		0.51		0.96
	1982	0.64	0.77	0.66	0.33	..	0.52	1.03	1.21	..		..		0.83
10. Net interest paid/ operating surplus (%)	1992	0.54	0.29	0.68	0.30	[0.42]	0.29	0.51	0.58	0.32		0.32		..
	1982	0.49	0.35	0.45	0.21	..	0.44	0.86	0.94	..		..		..

[1] Items1-3, as in Table 5; items 5-10, as in graphs (for Japan, shares on issue are at book value). Item 1 is rounded to the nearest 10; items 2 and 3 to the nearest 5; items 6 and 8 to the first decimal place. [2] Excluding share holdings by non-financial enterprises (Japan, Germany, France and the United Kingdom). [3] Equity at market value; for the United States, non-farm non-financial corporate enterprises only.

IV. THE HOUSEHOLD SECTOR

1. Cross-country differences in balance-sheet positions

Table 3, based mainly on central bank answers to question 10 of the BIS questionnaire, provides summary data (typically for 1993) for household assets and liabilities set in relation to personal disposable income for a recent date and for a reference year, normally 1983. Some adjustments have been made to facilitate cross-country comparisons.[8] The nature of the data and the changes over time preclude firm conclusions about the strength of particular monetary policy transmission mechanisms but it may provide insights into cross-country differences in the potential importance of different channels.

In many of the countries shown the ratio of recorded household wealth (total gross real and financial assets minus financial liabilities) to disposable income appears to fall within a fairly narrow range of 420 to 530%. The ratio is relatively low in Sweden, where high marginal income taxes were previously combined with liberal tax deductibility for interest payments, but it is substantially larger in Japan and relatively high also in Italy, where large government budget deficits have long gone hand in hand with high personal savings ratios. Of course, this raises a question of how far government debt should be counted as wealth. Clearly many items which may enter into household calculations of desired wealth positions, not least human wealth, are not taken into account in this data. On the one hand, the accumulation of these typically large-scale holdings of net tangible and financial wealth might have made household spending less sensitive to current income, credit and liquidity restraint and even perhaps to interest rates. On the other hand, household spending might also have become more sensitive to changes in asset values and to interest rate incentives to delay spending. The extent to which such changes have been significant in practice evidently differs considerably from country to country.[9]

Assets differ in liquidity and price sensitivity. Significant cash-flow, income and even wealth effects of monetary policy depend on the *composition* of household portfolios, which are influenced by institutional constraints as well as preferences and display substantial cross-country differences. The possibility that the sign or magnitude of the impact on spending of different components of household wealth may differ has generally been neglected in econometric investigation of wealth effects, in particular.

Housing, which dominates tangible assets and forms a large component of total assets, constitutes a potentially important channel for wealth effects on expenditure, though complex distributional influences may be entailed. In particular, impacts of changes in house prices on the expenditure of house-owners may be counteracted by those on the affordability of housing for first-time buyers. Moreover, house prices have not always responded quickly to changes in short-term interest rates. Differences in land values account for much of the difference in the relationship of household tangible assets to disposable income in Japan and North America, but an unknown amount of tangible assets of unincorporated businesses is included in the estimate shown for Japan. Though countries' statistical valuation procedures differ, relatively high estimates of housing wealth in some European countries (where occupier-ownership is much lower than in North America) reflect relatively high land prices and building costs. In some cases personal sector housing wealth includes substantial investment in accommodation for letting.

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8 The dates to which the figures shown relate and information about BIS adjustments is contained in the footnotes to the table. Nevertheless, allowance needs to be made for differences in coverage of items other than those drawn from the balance sheets of domestic credit institutions and for obvious differences in the methods used to value items expressed at market prices.

9 Evidence suggesting a decline in the relative importance of transitory income relative to permanent income or wealth in explaining consumption in a number of countries which had undergone financial innovation was reported in A. Blundell-Wignall, *OECD Working Paper*, No. 77, April 1990.

By contrast, in many continental European countries households' total gross holdings of financial assets (including shares and pension assets) are lower in relation to disposable income than in the United States, Canada, Japan and the United Kingdom. Moreover, notwithstanding relatively high levels of indebtedness, in the latter four countries households' total net financial asset/income ratios are higher than in most continental European countries. Financial asset holdings are also relatively high on both a gross and net basis in Italy and strikingly low in Sweden.[10]

Share prices can be viewed as a potentially significant, if tenuous monetary policy transmission channel. The direction of any influence of short-term interest rates on the rates at which expected returns on shares are discounted is clear, though the influence of changes in monetary policy on expected nominal and real returns is less predictable. Wealth effects stemming from changes in the market value of household financial assets have long been a central element in the Federal Reserve's model of the US economy where, as in Canada, household portfolios of shares remain relatively high in relation to disposable income when indirect holdings through bond and share mutual funds are included. In relation to disposable income household holdings of marketable shares are lower in Australia and the United Kingdom, even smaller in Sweden, Spain and Japan and strikingly small in Germany and Switzerland. The high figures shown in the table for France and Italy in part reflect a spreading of share ownership and comparatively strong rises in share prices in recent years. That for France includes substantial amounts of non-marketable equity claims at values which have been adjusted upwards in line with rises in the prices of quoted shares.[11] There may be a question as to whether household perceptions of wealth in these forms adjust as quickly as this implies. Elsewhere such claims are largely left out of account or included at conservative book values.

In relation to income, household pension and insurance claims are particularly large in the United Kingdom and are also substantial in Japan, the United States, Canada and Australia. The smaller ratios in many continental European countries in part reflect a wide coverage of unfunded government pension schemes. Typically national accounting procedures impute claim values and interest income to the household sector on the basis of the funded reserves of pension and insurance institutions. How closely the evaluations made by households correspond to this procedure is an open question. Pension claims are relatively illiquid and, like housing assets, they do not contribute to household cash flow but may serve as collateral for borrowing.

More light may be thrown on the potential for income effects of changes in interest rates by comparing only direct household positions in debt claims such as deposits, bonds and credit. Yet the elasticity of expenditure to interest income may be smaller than that of other elements of disposable income. Movements in interest income may also influence saving for retirement or the decumulation of lifetime savings in retirement. However, changes in interest rates which simply match developments in inflation expectations may have only limited effects (though changes in inflation expectations could directly affect expenditure). The income effect of changes in household interest receipts may be partly offset by income effects of interest payments by debtors in other private domestic sectors. Questions may also be raised about the extent to which interest receipts on government debt, which are relatively high in countries such as Italy and Belgium, are viewed as a net addition to private incomes or are offset by expected future debt servicing costs. Even so significant effects of changes in interest income have persistently been found in some countries.

Household sector direct holdings of debt claims are relatively large in Japan, Italy, Germany, France and Spain, where they far exceed household indebtedness. Holdings of debt claims are also fairly large in relation to disposable income and household indebtedness in Canada and, if indirect holdings through mutual funds are added, in the United States. By contrast, it would seem that, allowing for the fact that currency and non-interest-bearing sight deposits are included in the debt

10 That the figure for France is higher than that for Germany largely reflects differing valuation practices for equity claims, as explained below.

11 To permit more comparability with other countries, holdings of short-term mutual claims by French households, listed with equity in national financial statistics, are included under debt claims in Table 1. In 1993 the amount was equivalent to nearly 20% of disposable income.

Table 3

Household sector balance sheet[1]

(as a percentage of annual personal disposable income)

Items	AU	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]												
Total net assets	**481.6**		**438.9**	**454.4**	**420.3**	**597.9**	**722.7**			**200.7**		**532.6**	**484.0**
Assets:													
Tangible, total[3]	353.9	..	212.6	267.9	280.4	366.5	484.9					278.1	210.4
Housing[4]	318.1	168.1	167.5	209.5		..			n.a.	143.0		250.3	150.7
Financial, total	206.9		311.9	237.5	217.8	262.8	333.5		168.7	158.0		356.5	365.6
Debt claims	76.3	..	115.9	109.7	144.0	165.7	223.5	67.3	108.2	78.7	..	101.0	99.2
of which: Long-term[5]	*6.7*		*48.2*	*12.2*	*73.4*	*50.2*	*192.5*	*6.7*	*5.7*	*14.2*			*26.2*
Shares[6]	46.5		95.6	74.0	11.7	56.3	20.7		20.4	25.0		45.6	63.6
Mutual funds[7]	n.a.		17.9	17.4	n.a.	9.4	12.4		20.7	10.6		7.4	22.8
Insurance/pension claims	83.4		82.5	36.5	62.2	23.8	76.9		17.5	22.4		192.0	111.7
Liabilities:													
Financial, total[8]	79.2	41.5	85.6	51.0	77.9	31.4	95.7	64.9	58.0	100.3	130.3	102.0	92.0
Debt claims	79.2	41.5	85.6	51.0	77.7	24.7	95.7	64.9	51.1	100.3	130.3	95.7	89.9
of which: Long-term[8,9]	*44.9*	*23.5*	*82.6*	*43.9*	*72.4*	*14.7*	*38.7*	*59.0*		*57.3*	*115.6*	*77.6*	*67.9*
	1983[11]												
Total net assets	**440.3**		**288.6**	**392.0**	**382.5**	**523.2**	**536.0**			**187.4**		**427.2**	**481.0**
Assets:													
Tangible, total[3]	325.5		149.1	299.7	282.1	331.7	385.0					254.1	227.5
Housing[4]	329.6	172.1	107.2	207.2				n.a.	n.a.	135.6		209.5	166.5
Financial, total	185.0		196.1	133.5	172.3	219.2	214.8		133.5	154.2		240.2	324.5
Debt claims	83.1	..	98.4	97.9	120.5	145.3	179.5	63.9	107.0	94.8	..	92.8	109.8
of which: Long-term[5]	*12.4*		*30.0*	*11.4*	*65.8*	*37.2*	*153.2*	*13.3*	*6.3*	*20.2*		..	*23.5*
Shares[6]	34.4		44.0	19.6	7.6	44.0	3.7		17.9	38.4		31.7	42.9
Mutual funds[7]	n.a.		2.0	5.2	n.a.	5.4	n.a.		0.1	n.a.		3.2	3.5
Insurance/pension claims	65.9		51.7	10.9	44.3	18.2	31.6		2.5	n.a.		105.8	69.8
Liabilities:													
Financial, total[8]	70.2	25.2	56.6	41.2	71.9	27.7	63.8	51.7	44.3	102.4	111.8	67.1	71.0
Debt claims	70.2	25.2	56.6	41.2	70.1	22.4	63.8	51.7	38.9	102.4	111.7	58.9	69.0
of which: Long-term[8,9]	*29.1*	*20.5*	*55.2*	*36.8*	*63.8*	*12.8*	*26.6*	*46.2*		*40.5*	*96.4*	*44.6*	*47.0*

Footnotes to Table 3

[1] For Australia, Belgium, France, Italy, Japan, Spain, Sweden and the United Kingdom, including unincorporated enterprises. However, identified trade credit assets and liabilities and tangible assets of individual enterprises (normally the items most dominated by this sector) have been excluded from debt items and the totals (n.a. for Australia).

[2] For Belgium, September 1993; for Japan, Sweden and Switzerland, end-1992. Total net assets include tangible assets for the dates given in footnote 3 below.

[3] Including durable goods. For Australia, June 1993; for France, Germany, Italy and the United Kingdom, end-1992; for Japan, total fixed capital and land.

[4] At market value. Housing includes the estimated value of land, except for France.

[5] In general, deposits at one year or more and bonds; for Canada, partly estimated on the basis of the maturities of the public debt - includes two-thirds of time deposits; for Japan, includes all time deposits, most of which are at over one year; for Spain and Sweden, bonds only; for the United Kingdom, the relatively small holdings of medium and long-term debt are included in short-term debt or company securities; for the Netherlands, only bank deposits; for the United States, bonds, government securities and mortgages.

[6] At market value. For Germany, BIS estimate; for the United Kingdom, all company securities; for France, Italy, Spain and Sweden, including substantial amounts of equity claims other than quoted shares; for the United States, excluding equity in unincorporated business (equivalent to 47% of personal disposable income in 1993).

[7] For most countries, all funds. For France and the United States, bond and share funds (money market funds are included with short-term debt assets (for France, holdings of such funds amounted to 19.5% of disposable income in 1993)). In most cases where holdings of fund shares are not available separately they are included in shares.

[8] For Belgium, liabilities to credit institutions only; for Japan, housing credit (instalment repayments); for the Netherlands, liabilities to banks, insurance and pension organisations only; for Switzerland, liabilities to banks only; for Germany, including an estimated 80% of the debt of the housing sector (which is included with enterprises in the National Financial accounts).

[9] In principle, claims of one year or more. For Australia and the United Kingdom, housing credit granted by major lenders; for Sweden, all loans other than from banks; for Switzerland, mortgage and fixed-term loans; for the United States, mortgages and bonds.

[10] For Australia and the United Kingdom, estimated as a residual respectively of total liabilities and total credit.

[11] For Australia, December 1988 (except tangible assets, June 1989); for Italy, December 1989; for Japan and Sweden, December 1982.

N.B.: Financial asset and liability items may not add to the total as in most cases there are small residual items which are not shown.

assets shown in the table, total personal sector direct holdings of interest-bearing claims may be smaller than household interest-bearing liabilities in Sweden and the United Kingdom. This could imply large cross-country differences in the magnitude of any conventional current income or cash-flow effects associated with changes in gross interest receipts. To the extent that changes in net interest receipts are relevant, the income effects, usually assumed to be clearly positive, could now be negative in some countries.

The scale of income and cash-flow effects and the speed with which they operate depends on the response of interest rates on household assets and liabilities to changes in monetary policy. The national financial ("flow of funds") accounts contain no information on fixed-variable interest rate mixes and the maturity breakdown differs conceptually from country to country. The long-term asset component is clearly substantial in Japan, Germany, Canada and, to a lesser extent, the United States. Data not fully classifiable by sector suggest that households' long-term debt claims are substantial also in Austria, Belgium, the Netherlands and Switzerland. To the extent that the long-term instruments bear interest at fixed rates related to longer-term market rates the response of average interest rates received to monetary policy may be slow and uncertain. Some more direct evidence on this is reported below. Moreover, to the extent that long-term rates follow changes in policy controlled rates, positive income effects could be counteracted by a negative wealth effect associated with changes in the market price of existing portfolios of fixed interest rate securities. Household holdings of long-term fixed interest rate bonds are relatively high in relation to disposable income in the United States, Canada, Japan and Germany. However, in many European countries households hold a substantial proportion of their long-term interest-bearing assets in the form of non-marketable claims, such as medium-term time deposits and bank debentures issued on tap. Interest rates on new issues are typically related to market yields of comparable maturities but households probably do not perceive the value of existing claims as changing when the interest rates on new issues change.

In all countries the household sector holds substantial amounts of short-term interest-bearing assets. The nature of the predominant types of claims (savings deposits, short-term time deposits, Treasury bills, etc.) implies that the interest rates on them can in principle be adjusted following changes in short-term market interest rates. In practice, however, the response of rates on the large savings deposit balances in Germany, Switzerland, Austria and Japan is more limited than that of retail interest rates in the United States and the United Kingdom. Household holdings of money market claims through mutual funds are now particularly large in France and Spain. In short, the responsiveness of deposit to market rates has tended to increase in recent years in most countries, but in varying degrees.

If marginal propensities to consume out of income are larger for debtor than creditor households or if interest rate changes have stronger cash-flow effects on credit-constrained net debtors than on creditor households, levels of gross indebtedness may be more relevant than the aggregate net asset position of the household sector.

The household sector's total financial liabilities are relatively low in Italy, Belgium and France. The debt ratio is also comparatively low in Australia. By contrast, household indebtedness is relatively high in relation to disposable income in Sweden, the United Kingdom and, to a lesser extent, Japan, the United States and Canada. It is also quite high in Switzerland and (on the basis of an assumption in the table that 80% of housing debt is attributable to the household sector) Germany. While it may partly be due to difficulties in allocating debt between sectors, the high debt ratio in Switzerland, where the owner occupancy rate is very low, may reflect an incentive to "leveraged investment in rental accommodation" stemming from relatively low real interest rates and the availability of non-amortised mortgages. In comparing debt ratios, allowance has to be made for the inclusion in this sector in some countries of unincorporated enterprises whose borrowings are probably larger than their financial asset holdings.

Household indebtedness everywhere includes substantial amounts of mortgage and other long-term debt.[12] However, taking into account the differing proportions of variable interest rate debt, it can readily be seen why a relatively high level of indebtedness in relation to personal disposable income should expose the UK household sector to stronger cash-flow effects than only moderately lower levels of indebtedness in the United States and some continental countries where fixed interest rate financing predominates. The vulnerability of households to changes in debt servicing obligations may be mitigated if, when interest rates change, mortgage lenders make offsetting adjustments in debt amortisation instalments payable by borrowers, thus effectively adjusting the duration of the loan, as is common in Australia and for some floating rate mortgages in Canada. In the United States the maturity of some lending to the personal sector seems to have been increased temporarily when inflation rates rose in the early 1980s. Such practices do not appear to be common elsewhere.

2. Proportion of assets and liabilities with banks

Table 4, based on the questionnaire answers and national financial accounts, shows that in European countries including the United Kingdom, the bulk of household indebtedness is to the banking sector broadly conceived.[13] The concept used here covers all deposit-taking and other institutions covered by the national monetary statistics.[14] It includes long-term lending institutions, which in some countries provide a significant share of mortgage lending, but not insurance companies and pension funds, which bulk relatively large in lending to households in the Netherlands.

Table 4

Households

(share of total debt assets and liabilities with banks[1])

Items	AU	CA	FR	DE	IT	NL	ES	SE	UK	US
Assets:										
1993[2]	83.5	50.7	68.9	68.1	58.9		96.6	..	78.5	60.6
1983[3]	62.6	40.4	85.0	69.9			95.6	..	69.5	71.3
Liabilities:										
1993[2]	73.2	53.7	82.2	100.0	94.6	75.8	88.3	90.2	97.5	39.2
1983[3]	61.9	41.3	77.3	99.2	.	75.7	90.8	83.2	93.3	32.9

[1] For Australia and Canada, commercial banks; for France, Germany, Italy and Spain, credit system; for Sweden, financial sector; for the United Kingdom, banks and thrift institutions. Debt assets as defined in Table 3. [2] See footnote 2 to Table 3. [3] See footnote 11 to Table 3.

In the case of Australia and Canada the banking sector is narrowly defined. The shares in lending to households of banks and other deposit-taking institutions, considered together, is relatively large. In the United States, on the other hand, a substantial proportion of household mortgage loans are held by Federal Government-related mortgage pools and by government-sponsored enterprises active in promoting the securitisation of mortgages, which has made a significant contribution to the availability of long-term fixed interest rate housing credit. A comparison with the sources of mortgage financing elsewhere would have to take into account the significant amounts of long-term fixed rate financing of universal banks and specialised long-term credit banks in many European countries and

12 A concept of long-term debt which unavoidably differs in some cases from that used in the BIS analysis of answers to other parts of the questionnaire.

13 All household positions vis-à-vis non-residents identified in the financial accounts data are relatively small. They are not analysed in this section.

14 In the case of Germany, building and loan associations are excluded. Lending by finance companies is in principle included but is typically relatively small.

Canada, contrasting with the heavier reliance on deposit financing in the United Kingdom and Australia.

Only to a limited extent are such differences revealed by proportions of household debt claims held with "banks" which, except in Germany, include long-term non-deposit placements with credit institutions. To a considerable extent cross-country differences in the proportion reflect relatively high shares in household portfolios of securities in the United States, Canada, Germany and Italy and of money market funds in France. Such differences have important implications for the availability and terms of different types of credit to households but an analysis of this aspect of the transmission mechanism is beyond the scope of this paper.

3. Change in balance-sheet positions since 1982

A comparison of the data for the two dates shown in Table 3 reveals that in relation to disposable income the value of household tangible assets has risen strongly, on balance, in Japan, Canada and the United Kingdom, has changed little in Germany and France and has apparently fallen in the United States. Of course, the huge measurement problems in this area must be borne in mind. Financial asset holdings have risen strongly in relation to disposable income in all countries except Sweden. In Germany, France, Spain and especially Italy, the rise in household indebtedness has been modest and net financial assets have risen considerably. In Japan and, to a lesser extent, the United Kingdom and Canada, large rises in housing values and debt have been accompanied by less well documented but substantial rises in financial asset holdings. As in the United States, where financial assets and liabilities have both risen strongly, net financial assets have risen in relation to disposable income.

In many cases the net movement in balance-sheet positions over the decade masks sharp divergences during the period. This can be clearly seen in the graphs which complement Table 3 by showing balance-sheet ratios based on the available time series for household balance-sheet positions.[15]

Ratios of household total net assets to disposable income (Graph 1) for which, it has been argued, households may have targets, show strong cyclical movements in the United States, with some tendency to revert to a level or slightly rising trend. In Japan, the United Kingdom and Sweden the ratios reflect strong rises in the late 1980s, partly reversed subsequently, in the value of household non-financial assets, which remains much higher than in the early 1980s. In Germany, France and Italy the ratios also seem to have moved upwards over time mainly as a result of increases in households' financial wealth. However, in Germany the ratio has been remarkably stable since about 1983. The observed upward trend in Japan is plausible but the ratio has remained remarkably high. In Sweden it has returned to a strikingly low level.

Notwithstanding strong rises in the value of housing assets, ratios of household debt to total assets, a conventional indicator of household capital gearing[16] and of constraints on spending, displayed strong rises during the 1980s in the United Kingdom, Sweden and, reversing a fall lasting until 1984, Canada. This ratio also rose strongly in the United States.

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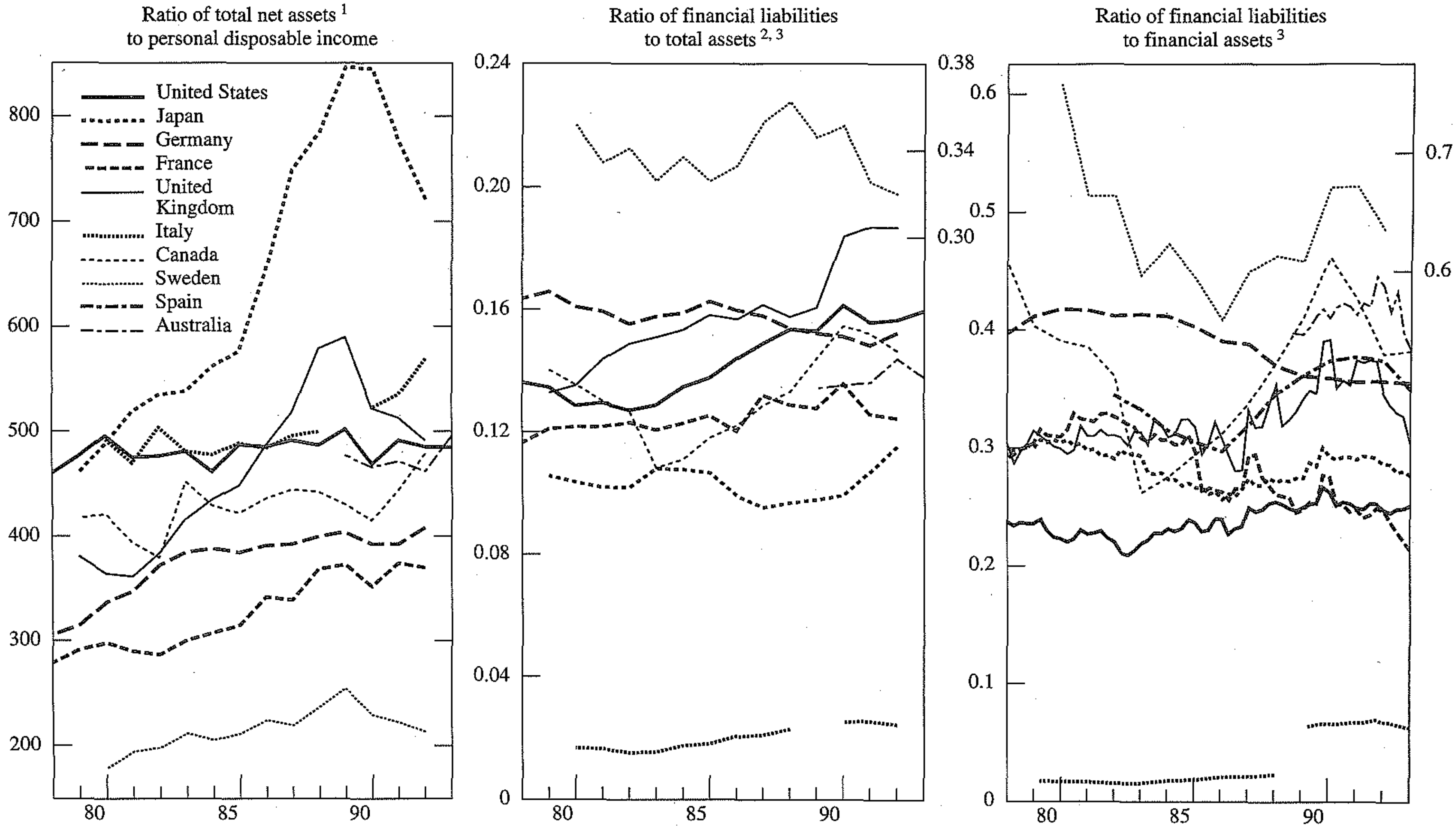
15 Graphs showing developments in the underlying series, set in relation to personal disposable income measured at annual rates (so as to facilitate cross-country comparisons), are shown in Annex 1. Annex 2 contains notes on the content of individual country series. It should be noted, in particular, that in contrast to the data in the tables unincorporated enterprises are included in the enterprise sector in the graphs for Italy. For Canada household assets in the graphs include assets of unincorporated enterprises.

16 Ratios of debt to net assets, a related measure sometimes used, show similar patterns.

Graph 1

Household sector: total net asset and capital gearing ratios



[1] For France, Italy, Japan and Sweden, real housing assets only. [2] Financial plus non-financial assets. [3] For Sweden, right-hand scale.

In several countries, large rises in household debt during the 1980s followed the removal of long-standing credit ceilings which had borne most heavily on household borrowing. However, demographic factors and the interaction of inflation with differing income tax treatment of interest payments also played a role in most cases. In the United States the removal by 1986 of the Regulation Q ceilings on which credit restraint had traditionally relied substantially changed the interest rate transmission mechanism. However, other regulatory changes which increased the availability of variable interest rate mortgages and facilitated the securitisation of mortgage lending under the aegis of Federal Government agencies had a more immediate effect in increasing the growth of mortgage credit. As in other countries where a strong expansion of household indebtedness took place, government intervention affecting the mortgage and housing markets designed to foster home ownership changed its form but remained extensive and could be changed further in future.

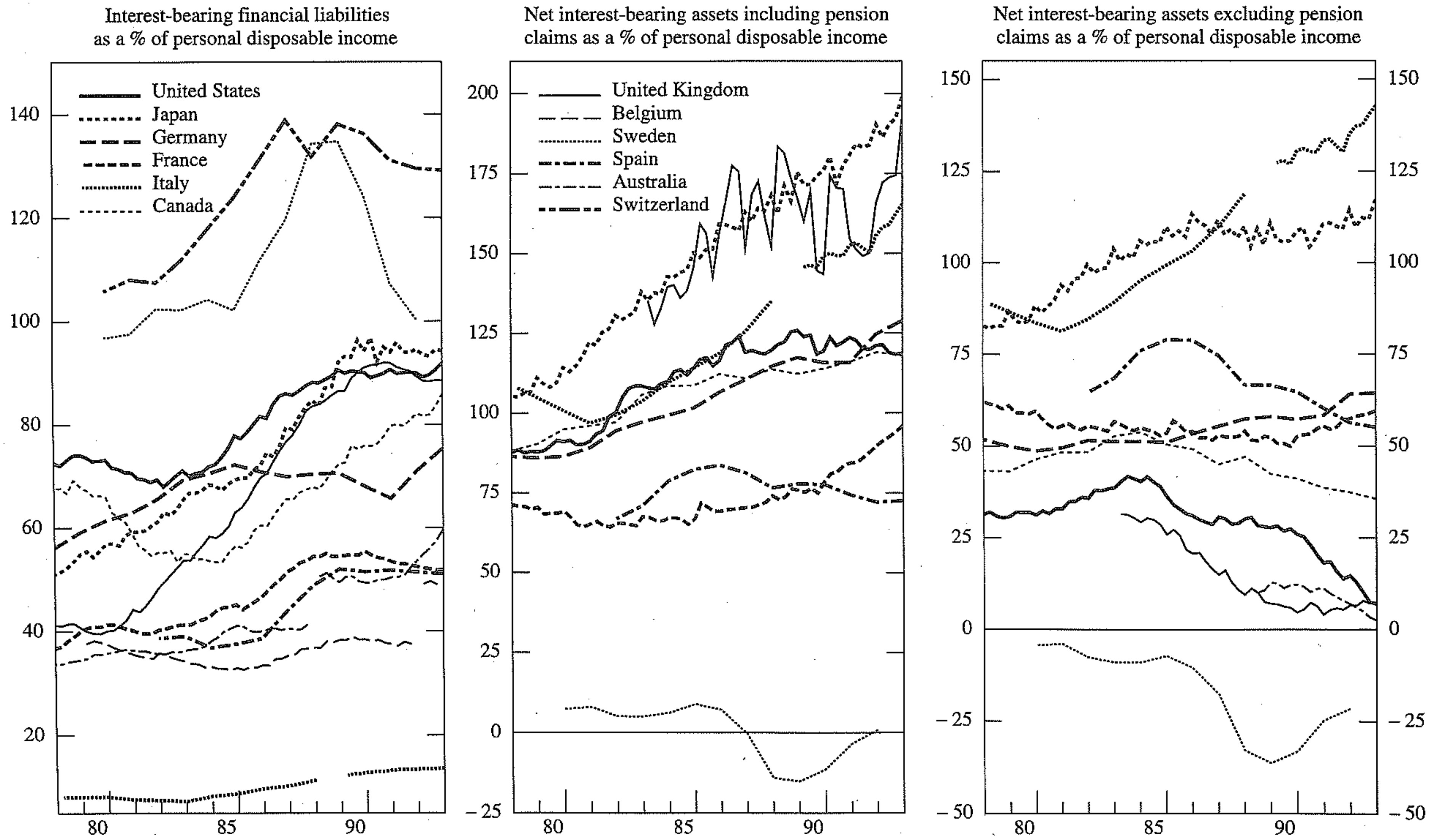
No reduction in the household debt/asset ratio in the United Kingdom took place in the early 1990s, when household cash flow benefited from lower interest rates. Continuing falls in asset prices help to explain this but, as in the United States, the economic recovery began with a higher debt/asset ratio than in previous cycles. In Japan, with rises in asset values continuing to exceed increases in debt, the debt/asset ratio fell on balance until 1990. It rose when asset prices fell but, save Italy, remains lower than in the other countries shown. In Germany the ratio seemed to be on a declining trend prior to the inclusion of east German households in 1992. In Sweden it fell as from 1987 but remains relatively high.

Ratios of household debt to financial asset holdings quickly reflect the portfolio impacts of current monetary conditions but in some cases are also quite sensitive to movements in share prices. In the United Kingdom, Australia, Canada, Sweden and also Spain, they rose strongly in the 1980s but fell in the early 1990s when balance-sheet restructuring was in process. Similar tendencies were also evident in the United States and Japan but the changes remained within narrow bounds. These ratios suggest a persistent trend towards a strengthening of household financial positions in Germany and in France. In France (as in Japan until 1989) strong rises in the value of equity holdings help to explain the fall in the ratio to a low level. In Italy both the total and financial gearing ratios remain remarkably low.

The increases in gross debt/income ratios (Graph 2) suggest that the impact of rises in household indebtedness during the 1980s on the monetary policy transmission may prove substantial in some countries. In the United Kingdom the rise was remarkably sustained. In relation to disposable income it even exceeded that in Japan. By contrast, the rises in France and Spain were quite modest, though no doubt structural. In North America the movements in debt ratios appear more cyclical, particularly if a longer period is considered. Financial retrenchment resulted in a stabilisation of debt ratios as from 1990 in the United States, the United Kingdom and Japan, but the ratio did not fall significantly except in Sweden, where by 1992 it was back to the levels recorded in the early 1980s. Renewed rises have been underway since 1991 in Canada and Australia and since 1993 in the United States. The rise in Germany since 1990 reflects not only the strength of new housing construction but also temporary tax incentives to borrowing to finance acquisition of existing houses.

Graph 2

Household sector: interest-bearing liabilities and net interest-bearing assets



In all ten countries for which data is available much of the rise in household financial asset holdings over the past decade has taken the form of pension and insurance claims, which displayed particularly fast growth in France, Spain, the United Kingdom and the United States. Households' direct holdings of debt claims plus pension and insurance claims net of household debt, sometimes used as a broad measure of the sector's net interest-bearing assets,[17] remained on a strongly expansionary course in Japan and (when money market funds are included, as in the graph) France. In the United Kingdom they surged back up to the longer-term trend in 1991-93, apparently as a result of increases in the valuation of the equity component of the pension and insurance institutions' portfolios. Even by this broad measure[18] households' net "interest-bearing" assets became negative in the late 1980s and early 1990s in Sweden,[19] but elsewhere the measure is clearly positive.

The situation appears quite different, however, when pension claims are excluded. The resulting ratio for net direct positions in interest-bearing debt claims[20] has shown little increase since the mid-1980s in Japan and has fallen progressively in the United States and Australia to a level which, as in the United Kingdom, appears barely positive. In Canada it seems also to have been on a declining trend. In Sweden it rebounded as from 1990 but remained substantially negative in 1992. Certainly the ratio does not reflect large increases in household holdings of liquid assets through mutual funds recorded in recent years in the United States and Spain in particular. In Germany, France and Italy the ratio has continued to rise in recent years, but a substantial proportion of the rise has taken the form of longer-term placements.

In general, the share of long-term debt in total household debt (as here defined) has remained fairly stable in recent years, most notably in Germany. It has displayed some tendency to rise progressively in the Netherlands and to fall gradually in France. A rise recorded in the United States reflects an expansion in the share of mortgage financing, encouraged by the phasing out of tax exemptions for household interest payments on consumer credit and facilitated by the development of home equity loans, which increased the liquidity of existing housing wealth. Although the lion's share of mortgage financing is still at fixed interest rates, the ability to negotiate refinancing at lower interest charges permitted downward adjustment of interest rates payable by households in the 1990-93 period.[21] Efforts to develop instruments permitting a reallocation of the resulting risks faced by providers of mortgage finance were a major force driving innovation in instruments for securitising mortgage loans. Securitisation has contributed to a reduction in spreads between interest rates on mortgage loans and governments bonds and to faster adjustments in rates on new mortgage loans.

4. Household sector interest receipts and payments

Gross and net interest flows in relation to personal disposable income

In principle, the strength and speed of the interest rate pass-through may be seen more directly in data on interest receipts and payments of the household sector as supplied by central banks or taken from the national accounts (Graph 3) but here, too, allowance must be made for cross-country differences in coverage and compilation procedures.

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17 Of course, this measure does not capture unfunded pension claims.

18 Which does not, however, include bonds (and, in some countries, short-term debt assets held indirectly through unit trusts).

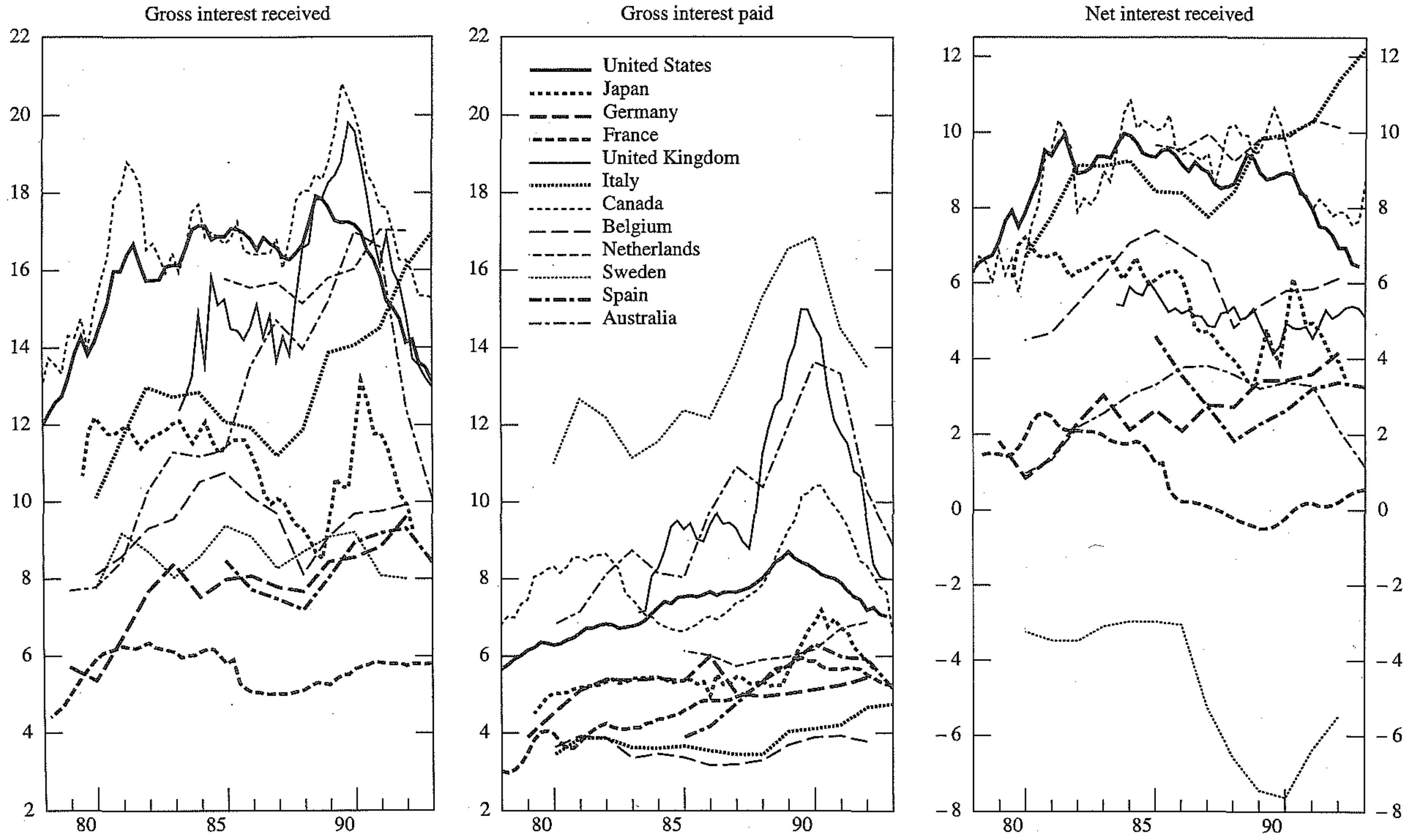
19 It must be borne in mind that, as in some other countries, unincorporated enterprises are included in the sector, though recorded trade credit granted and received is excluded from the measure shown.

20 As no attempt has been made to exclude currency or non-interest-bearing sight deposits the measure presumably overstates non-interest-bearing claims to some extent. In the case of Australia "debt assets" include only deposits with bank and non-bank building societies.

21 Refinancing was extensively used earlier, under different market conditions, to increase the size of mortgage loans in order to extract equity in housing, to finance house improvements or to repay other debt.

Graph 3

Household sector interest receipts and expenditure: as a percentage of personal disposable income



Two cycles are visible in aggregate household interest receipts since 1978, set in relation to household disposable income. In the United States, Japan, the United Kingdom and Australia, money market rates reached higher peaks in the early 1980s than in the late 1980s but the imprint of the latter rise is much more evident. This partly reflects the build-up in the stock of household assets including pension claims during the period. In combination with it, however, came the impact of interest rate deregulation in the first two and of financial innovation in all four above countries in making short-term placements bearing interest rates which respond quickly to money market rates available to the household sector. No such development can be seen in the data for France (which presumably exclude dividends paid by mutual funds). Little change during the period is evident in Canada, where the absence of interest rate controls permitted a flexible response in the early 1980s. For most continental European countries annual data suggest slow and muted responses of household interest rate receipts to changes in money market rates. An exception is Italy, where the sharp rise in average rates in 1991 and 1992, attributable to the tightening of monetary policy in defending the lira within the ERM, increased returns on household portfolios of short-term and variable rate government securities.

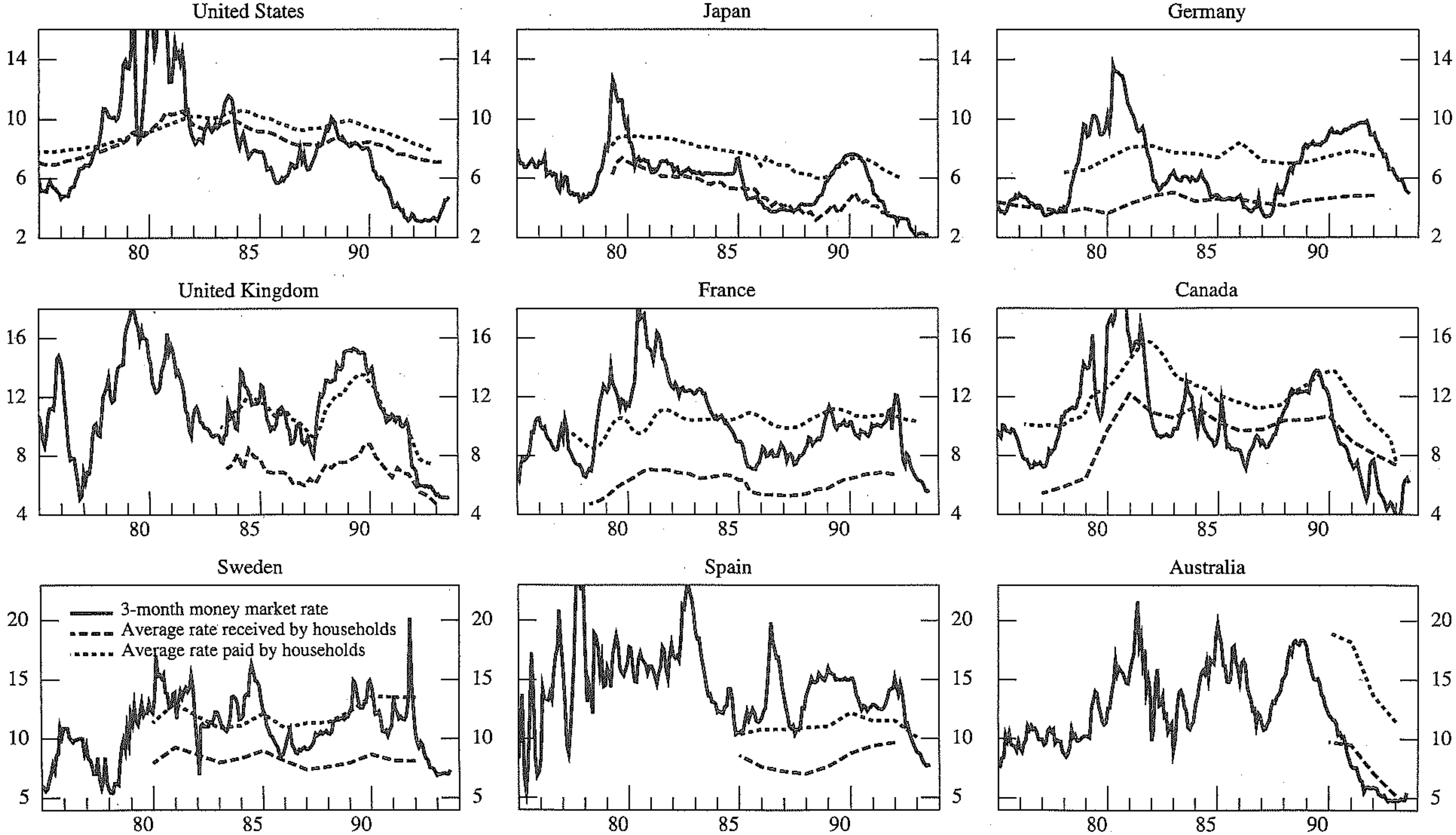
Typically gross household interest payments have displayed less volatility than receipts. This reflects to some extent the long-term fixed interest component of indebtedness. Notable exceptions can be seen in the case of the United Kingdom and Australia, where adjustable rate mortgage loans predominate and where, as in Japan, Sweden and Canada, the stock of long-term debt has undergone large changes. In most countries net interest payments, while mirroring the fluctuations in gross interest receipts, have remained within a narrower range. In making cross-country comparisons of these ratios it must be borne in mind that interest receipts generally include imputed interest on pension and insurance claims, which, as indicated above, are particularly large in the United Kingdom. Here and in Canada dividends received are included in the measure of "interest receipts".

Average rates of interest received and paid

While changes in stocks of assets and debt are influenced by monetary policy and form part of income effects in the transmission mechanism, substitution and wealth effects depend more on the direct impact of monetary policy on average interest *rates* paid or received by the sector. The calculation of average rates can also be viewed as means for helping to distinguish the sensitivity of total interest receipts and payment/income ratios to direct interest rate effects from the impact of changes in income and in asset or debt/income ratios. An approximation of the average rates may be estimated by dividing sectoral interest receipts and payments by the relevant stock of sectoral assets and liabilities. Graph 4 compares average rates so estimated with representative three-month money market rates, assumed to be indicative of the thrust of monetary policy. The graph highlights relatively strong and quick responses of average interest rates received and paid by the household sector to movements in money market rates in the United Kingdom, Australia and, to a lesser extent, Canada and Japan. The reactions appear remarkably limited in continental European countries, including France, for which quarterly series are available. The responses to money market rates of both average rates received and paid in the United States, particularly since 1990, also seem very small. During the recent period of monetary easing concerns about slow reactions of bond yields and of interest rates applied by financial institutions were widely expressed. A progressive rise in the average interest rate received in relation to money market rates, evident in France, Sweden and Japan, presumably reflects liberalisation and increasing competition in the financial markets.

Graph 4

Average interest rates received and paid by households:* relationship to money market rates



* Total volume of household interest receipts and payments divided by the amount of debt assets or liabilities of the household sector.

5. Household financial positions and expenditure

To the extent that changes in short-term interest rates affect the attractiveness of investment in real assets, the impact of monetary policy may be felt mainly on housing and consumer durable expenditures. The strength of substitution effects, and the speed with which they operate will depend on the response of long-term rates to money market rates and the availability of variable interest rate contracts. The introduction of variable interest rate mortgages in the United States could, for example, have increased the sensitivity of the demand for new mortgage loans to changes in short-term rates through various channels. In particular, the variable mortgage rate has generally been below the fixed rate and there is evidence that many borrowers take the lower current rate.[22] Recently the traditionally interest-sensitive housing component of aggregate expenditure has again been a major element in the economic recovery in the United States, Australia, the United Kingdom and Japan. Indeed, in some cases the strength of the rebound in housing has already led to expressions of concern that an unsustainable upswing could again be developing in this sector.

To the extent that monetary policy operates through its effects on income, net wealth or the debt servicing burdens of existing house owners, policy might influence many types of consumption expenditure. Traditionally, household spending on consumer goods other than durables has not seemed particularly interest-sensitive, though increases in interest sensitivity have been identified in recent years in some countries, including the United Kingdom. Given the large swings in balance-sheet positions over the past decade it is perhaps not surprising that stable effects are difficult to identify. There is also some question as to whether such effects as have been found are likely to prove stable in future. Similar considerations apply to attempts to identify a separate role for movements in balance-sheet variables, such as debt, which are related to spending in different ways at different stages of asset price cycles. In some countries ratios of household consumption to income rose to unusually high levels in the late 1980s, when rising prices of residential real estate boosted wealth and borrowing capacity, but then fell sharply as balance-sheet positions were consolidated. Striking cross-country correlations have been found between increases in household debt ratios in the 1980s and the extent of the subsequent shortfall in the growth of household consumption relative to its trend.[23] Particularly strong effects have been seen in the United Kingdom and Sweden. Though the adjustment may now be complete, households may remain vulnerable to interest rate pressures to the extent that increased competition has led to lasting easing of lending criteria such as loan-value or loan-to-income ratios. It has been suggested that although household debt ratios in Sweden have been restored, the erosion of net wealth could exert a depressing effect on consumption for some years.[24] On the other hand the rise in household asset holdings may help to explain the less pronounced effect on consumption of increases in debt ratios in Canada and Japan.[25] Longer-term, the impact on the transmission mechanism of rises in household net wealth may also be stronger than that of past rises in debt in other countries. However, renewed increases in debt ratios as recovery proceeds cannot be precluded and the vulnerability of households could increase if lending standards weaken once more.

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22 There is strong evidence that the share of adjustable rate mortgages in new US mortgage loans has fluctuated closely in line with the spread between rates on fixed and adjustable rate mortgages. Rates on fixed interest rate mortgages may include term premia and/or premia for interest rate risk (which is borne by the borrower in the case of variable rate loans) and for prepayment risk, which US financial institutions have found particularly difficult to manage. It would seem that, in practice, the terms of variable rate loans, which have often entailed deeply discounted rates for the first year or two, have not always included appropriate allowance for the credit risks entailed. Lending practices in the 1980s generally permitted a household to borrow more with an adjustable than with a fixed rate instrument. However, ability to have recourse to financing, in effect at short-term interest rates, could have reduced the interest rate sensitivity of the timing of expenditures.

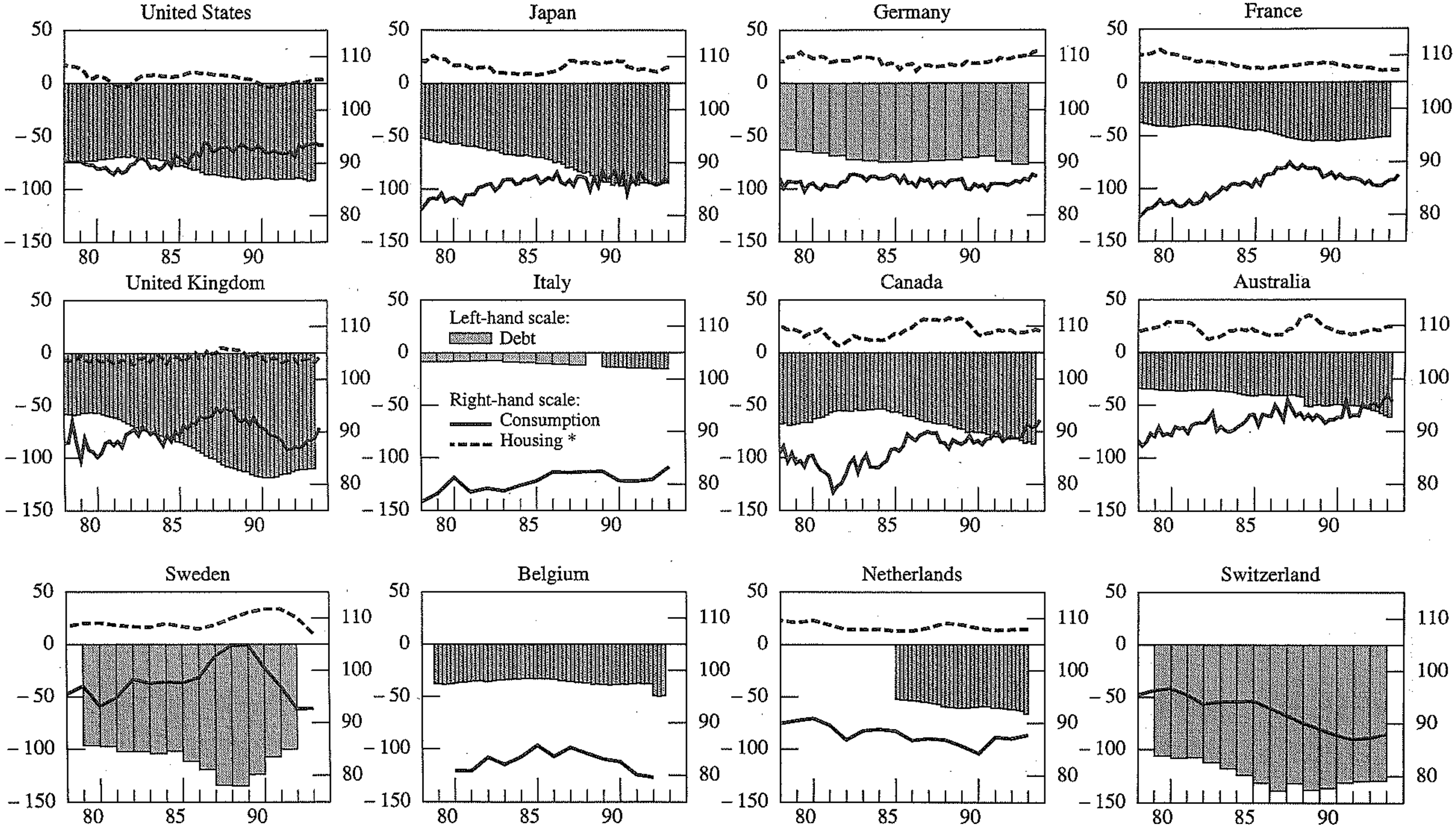
23 Mervyn King, Presidential Lecture delivered to the European Economic Association, August 1993.

24 Daniel Barr and Kurt Gustavsson, "Debt consolidation in progress", *Sveriges Riksbank Quarterly Review*, 1993:4.

25 Bank of Japan, *Annual Review*, 1994, p. 36.

Graph 5

Household debt, consumption and housing expenditure: as percentages of personal disposable income



* As a percentage of GDP, plus 100.

V. THE ENTERPRISE SECTOR

The deterioration in the balance sheets of non-financial enterprises, particularly in the United States, Japan and Australia, during the 1980s and the subsequent balance-sheet correction which delayed economic recovery, have posed a challenge to the presumption, common in the 1980s, that the impact of financing structures on investment could largely be ignored. This is reflected in the revival of central bank interest in the roles that credit and asset market disturbances may play in the monetary policy transmission mechanism and in magnifying swings in economic activity. It has been acknowledged that tax and bankruptcy costs do have a significant impact on investment decisions in practice. This has paved the way for a resurgence of the belief that, as a result of market imperfections which limit enterprises' ability to obtain external funding and raise its cost, cash flows can be a significant independent influence on investment. Wider acceptance of this position has been encouraged by analysis relating to information asymmetries and "principal-agent" problems associated with differences in owner and manager incentives. Over the business cycle these factors may change in ways which affect the supply of credit and the willingness of firms to invest.

Recent experience in a number of countries has demonstrated that increases in corporate leverage can amplify the effects on aggregate demand of interest rates and asset price movements. Uncertainty about future interest rates, cash flows or relative prices can have strong impacts on firms' willingness to invest and on their incentive to accumulate liquidity and to reduce indebtedness. Credit-rationing can exert a strong influence on the monetary policy transmission process, even in a liberalised and competitive financial environment, particularly if balance-sheet positions of credit institutions come under strain. The impact of changes in interest rates on the cash flow, liquidity, net worth and solvency of enterprises can affect output both directly and via impacts on the value of assets usable by enterprises as collateral. Monetary policy can influence the availability and cost of credit through these channels both directly and through its effect on output.

1. Cross-country differences in balance-sheet positions

The basic data on the balance sheets of non-financial enterprises, scaled by GDP, in Table 5, have largely been obtained from central bank answers to the BIS questionnaire.[26] The table reveals the imprint of country differences in enterprise internal financing capacity and in the use made of various types of external finance. These reflect differences in the cost of equity, short and long-term debt financing, as influenced by institutional and regulatory structures, and convention. Balance-sheet structures, in turn, affect the impact of the short-term risk-free rates of interest on the costs of internal and alternative external financing sources as perceived by non-financial enterprises, on enterprise cash flows and hence on investment. It is conceivable that as a result of the increasing use made by enterprises of derivative products some balance-sheet items may have become less informative over time. However, in practice, cross-country differences in the coverage of positions vis-à-vis non-residents are probably a more important problem.

26 It should be noted that data for Australia, Canada, France, Italy, Japan, Spain, Sweden and the United Kingdom exclude some or all private unincorporated enterprises and that public sector enterprises are not included in Canada, Japan or the United Kingdom.

Values of tangible assets embody histories of cyclical and longer-term movements in investment in fixed capital and stocks. However, some of the largest cross-country differences seem to reflect values of non-reproducible assets which affect collateral available for borrowing. In particular, land prices help to explain the relatively high value of tangible corporate assets in Japan. Land is excluded from the data for Australia and Germany. Similarly, large cross-country differences in ratios of total financial assets (other than trade credit receivable) to GDP are strongly influenced by the value of enterprises' holdings of equity claims in other firms. Exchange-traded equity holdings include claims on other non-financial corporations at market values on a gross basis for all countries other than the United States and Australia.[27] Debt asset/GDP ratios (which generally mainly reflect claims on domestic financial institutions) show much less diversity between countries. They are relatively high in Japan and, to a lesser extent, Germany and Sweden but seem relatively low in Australia, Canada, France, Italy and Spain. The proportion identified as long-term is relatively small, even in Germany and the Netherlands, the notable exception being Japan, where holdings of longer-term time deposits are substantial.

Enterprise indebtedness (other than trade credit) is comparatively high in relation to GDP in Japan, Sweden and Germany. Elsewhere the relation falls within a fairly narrow range, but it is particularly small in Italy. The component identified as longer term in this data[28] is relatively large in Germany and the Netherlands but also fairly high in France, Canada and the United States. As might be expected, the value of equity on issue is considerably higher in the United States, Canada, the United Kingdom and Australia than in the continental European countries (other than France). The identified trade credit items excluded from debt and financial asset totals, but shown as memorandum items, are relatively high for Japan, France and Spain and low for Germany and Italy.[29]

2. Proportion of assets and liabilities with banks and non-residents

Table 6 summarises the data available from the questionnaire and published sectorial financial accounts on the shares of non-financial enterprises' positions vis-à-vis domestic banks and non-residents in 1993 and the reference year.

In the continental European countries 78-90% of non-financial enterprises' total recorded debt liabilities consist in credits from banks, broadly conceived as credit institutions covered by the monetary statistics. In Germany the share of bank indebtedness has declined since the early 1980s but in Spain it has risen. In all these countries a very high proportion of debt assets are held with banks, though in Germany and Spain the proportion has fallen since the early 1980s. By contrast, only about one-third to one-half of debt liabilities in the Anglo-Saxon countries are to "banks". In the United Kingdom and, to a lesser extent, Canada and the United States, the proportion has fallen during the last decade, as a result of recourse by non-financial enterprises to bond issues. Certainly the concept of "banks" in Australia and Canada covers only commercial banks, but even if liabilities to other deposit-taking institutions were included the proportion in the total would remain much lower than in the continental European countries. The share of enterprise debt claims held with "banks" is strikingly high in the United Kingdom but relatively low in Australia and the United States.

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27 For Japan, equities on the liability side of the balance sheet are recorded at book value. For Germany, market values of equity for 1993 are BIS estimates. Equity in unincorporated enterprises is included in other liabilities at book values.

28 As noted above for the household sector, the definition of longer-term used here differs in some cases from that given in central bank answers to other parts of the BIS questionnaire. For details see footnotes to Table 5.

29 Although the exclusion of trade credit may in principle be less justified than in the case of the personal sector when the focus is on the financial viability of individual enterprises, it would seem appropriate when the cadre of interest is the structure of debt claims vis-à-vis financial institutions. As pointed out above, country differences in the coverage and degree of consolidation of inter-enterprise claims probably preclude reliable international comparisons.

Table 5[1]

Non-financial enterprise sector balance sheet

(as a percentage of annual GDP)

Items	AU	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
							1993[2]						
Assets:													
Tangible, total[3]	99.1		78.8	137.6	145.2		240.9					123.7	128.8
Fixed capital[4]			61.3	83.3	125.7		107.6					47.8	71.6
Inventories			17.5	21.1	19.5		14.9					17.5	17.8
Financial, total[5]	34.5		43.5	189.3	69.2	35.7	86.0		39.0	91.2		61.6	34.1
Debt claims	16.6	..	11.5	18.3	33.4	10.5	53.3	26.5	22.5	41.8	..	15.2	13.9
of which: Long-term[6]	*0.2*		*3.9*	*1.6*	*7.2*	*3.5*	*40.1*	*1.7*	*2.6*	*16.6*		..	*2.2*
Equity[7]	0.2		22.6	169.7	18.1	15.3	19.4		10.8	34.0		19.0	0.2
Liabilities:													
Financial, total[5, 8]	73.1	78.6	74.3	67.9	93.9	59.4	144.0		65.1	135.6		81.5	71.2
Debt claims[9]	64.4	45.9	44.9	67.9	73.2	45.6	136.2	59.7	58.2	103.6	50.4	49.3	58.2
of which: Long-term[6, 10]	*n.a.*	*27.6*	*30.7*	*41.8*	*55.9*	*20.2*	*17.5*	*44.5*	*4.5*	*4.8*	*38.8*	*21.4*	*37.6*
Memorandum items:													
Equity[4, 7]	*78.7*	*29.7*	*104.5*	*215.2*	*29.8*	*48.1*	*14.2*		*32.5*	*58.7*		*121.9*	*115.0*
Trade credit granted	*n.a.*		*19.3*	*49.3*	*5.7*		*50.8*		*32.1*	*18.1*		*14.7*	*15.8*
Trade credit received	*n.a.*		*21.1*	*39.4*	*3.5*	*2.3*	*39.0*		*20.8*	*17.3*		*15.5*	*12.8*
							1983[11]						
Assets:													
Tangible, total[3]	98.9		85.7	156.6	150.3		199.0					107.9	200.1
Fixed capital[4]			61.1	89.9	125.3		94.3					39.0	95.2
Inventories			24.6	27.5	25.0		22.0					21.7	24.3
Financial, total[5]	43.2		33.2	48.4	46.4	32.1	44.2		29.5	44.4		43.9	32.2
Debt claims	19.4	..	11.0	8.3	24.8	11.9	41.3	15.0	16.4	25.5	..	12.7	14.6
of which: Long-term[6]	*0.2*		*4.0*	*1.2*	*2.4*	*4.0*	*25.8*	*1.1*	*1.7*	*9.3*		..	*2.3*
Equity[7]	0.4		16.5	34.0	13.2	12.9	2.9		7.0	16.1		8.3	0.1
Liabilities:													
Financial, total[5,8]	88.4	62.9	68.4	53.1	77.0	51.0	91.1		73.6	85.2		41.1	67.6
Debt claims	78.6	47.1	44.6	53.1	52.7	39.8	91.1	45.1	69.2	66.8	38.5	21.8	58.4
of which: Long-term[6, 10]	*n.a.*	*24.4*	*30.4*	*34.9*	*37.6*	*16.9*	*6.1*	*29.9*	*6.8*	*5.9*	*27.9*	*1.6*	*36.0*
Memorandum items:													
Equity[4, 7]	*56.3*	*9.1*	*63.9*	*48.7*	*20.4*	*46.2*	*7.4*		*22.6*	*35.7*		*50.6*	*106.5*
Trade credit granted	*n.a.*		*20.4*	*42.4*	*7.5*	..	*64.4*		*40.1*	*22.0*		*19.4*	*17.5*
Trade credit received	*n.a.*		*22.5*	*40.2*	*4.6*	*2.5*	*52.1*		*30.6*	*19.2*		*20.3*	*14.2*

Footnotes to Table 5

[1] For Australia, Belgium, France, Italy, Japan, Spain, Sweden and the United Kingdom, excluding unincorporated enterprises. Excluding identified trade credit assets (n.a. for Australia and Italy) and liabilities (n.a. for Australia) and, in the case of Sweden, loans between affiliates.

[2] For Belgium, September 1993; for Japan, Sweden and Switzerland, end-1992.

[3] For Australia, June 1993; for France and the United Kingdom, 1992; for Germany and for inventories only, end-1991. For Australia, excluding land.

[4] Excluding residential buildings and land.

[5] For Italy, shares and debt claims include domestic assets and liabilities only; for the Netherlands, only bank deposits.

[6] In general, deposits at one year or more and bonds; for Japan, including all time deposits, most of which are at over one year; for Spain, including all credit granted other than trade credit; for the United Kingdom, the relatively small holdings of medium and long-term debt are included in short-term debt; for the United States, bonds and government securities.

[7] At market values, except for Japan (book values). For Germany, BIS estimate; for the United Kingdom, assets: all company securities, liabilities: all company securities minus debenture and loan stock issued; for France, Italy, Spain and Sweden, including substantial amounts of equity claims other than quoted shares. For the United States, including equity in unincorporated business at book value (equivalent to 35% of GNP in 1993).

[8] For Belgium, liabilities to credit institutions and bonds only; for Germany, including an estimated 20% of the debt of the housing sector (which is all included with enterprises in the national financial accounts).

[9] For the Netherlands, liabilities to banks, insurance and pension organisations only; for Switzerland, liabilities to banks only.

[10] In principle, claims of one year or more. For Canada, mortgages and a share of other credit based on a maturity breakdown for bank credit; for Japan, Spain and Sweden, bonds only; for Switzerland, mortgage and fixed-term loans; for the United States, mortgages and bonds; for the United Kingdom, debenture and loan stock issued.

[11] For Australia, December 1988 (except tangible assets, June 1989); for Italy, December 1989; for Japan and Sweden, December 1982.

N.B.: Financial asset and liability items need not add to the totals as in most cases there are substantial residual items including, in particular, claims on and liabilities to non-residents.

Table 6

Non-financial enterprises: shares of assets and liabilities with banks and the rest of the world

Items	AU	BE	CA	FR	DE	IT	JP	NL	ES	SE	UK	US
	Share of total debt assets and liabilities with banks[1]											
Assets:												
1993[2]	61.0			81.8	79.5	63.6			77.3		94.5	47.2
1983[3]	40.4			84.3	88.7				93.9		85.3	42.8
Liabilities:												
1993[2]	29.5	89.9	32.8	80.2	85.1	94.6		78.6	77.3	80.9	49.4	32.4
1983[3]	19.7	95.4	43.3	88.7	91.3			71.3	81.2		77.6	39.5
	Share of foreign assets and liabilities[4] in total assets and liabilities											
Assets:												
1993[2]	37.0					24.1	15.5		11.6	13.0	40.1	33.6
1983[3]	29.4					19.3			7.6		39.0	41.3
Liabilities:												
1993[2]	28.5	30.2	7.8			5.0	9.6		23.1	7.0	8.0	10.3
1983[3]	31.1	22.8	8.2			5.8			17.3		11.9	6.1

[1] For Australia and Canada, commercial banks; for Belgium, France, Germany, Italy and Spain, credit system; for Sweden, financial sector; for the United Kingdom, banks and building societies; for the United States, banks and thrift institutions. Debt assets as defined in Table 5. [2] See footnote 2 to Table 5. [3] See footnote 11 to Table 5. [4] For Belgium, total liabilities of the household enterprise sector to the rest of the world; for Canada, non-resident holdings of corporate claims, foreign currency loans to residents and commercial paper in foreign currency; for Italy and Spain, debt claims and equity; for Japan and the United Kingdom, securities and foreign direct investment; for Sweden, debt claims and shares at book value; for the United States, direct investment, foreign deposits (assets), bonds and loans (liabilities).

The proportion of cross-border assets and liabilities of non-financial enterprises in the total is not easy to compare. In Canada it includes only debt liabilities; in Japan, the United Kingdom and the United States, a large proportion consists in foreign direct investment. In Spain and Italy equity constitutes a substantial portion. Except in the case of Canada, the identified foreign component has increased significantly since the early 1980s,[30] as might well have been expected. This points to a large and growing weakness of the national financial accounts data – its poor coverage and identification of cross-border operations and positions.

3. Change in balance-sheet positions since 1983

Holdings of tangible assets by non-financial enterprises have on balance risen considerably over the last ten years in Japan and the United Kingdom but have fallen in relation to GDP in Canada, France, Germany and, particularly, the United States. For US non-farm incorporated enterprises alone the decline has been somewhat less pronounced. The ratio for fixed reproducible capital has fallen in the United States and France, changed little in Germany and Canada and risen in the United Kingdom. Graph 6, which shows movements over the last 15 years,[31] highlights the contrast between the almost continuous decline in the United States since 1982 and the huge rise in Japan between 1986 and 1990, followed by an equally steep fall in the following two years when collateral values were eroded. The huge increase in Japan helps to explain why the Bank of Japan has pointed to over-investment in physical capital in the economic expansion period of the late 1980s and the difficulties subsequently experienced by companies in making adjustments in the stock of tangible assets as a major recessionary force. Substantial rises in tangible assets in the United Kingdom and Australia in the late 1980s were also partly reversed subsequently as enterprises sought to redress balance-sheet positions which had come to be viewed as overextended by curtailing investment. By comparison, the ratios for France and Germany remained remarkably stable throughout the period. Reflecting structural as well as cyclical influences, stock ratios have been pruned in all the countries, a development which has no doubt reduced the interest sensitivity of expenditures on stocks.

Large rises in the value of financial assets held by non-financial enterprises have been recorded in Japan and (largely equity values) France. Substantial increases, in part reflecting accumulation of debt claims, have also taken place elsewhere, most notably in the European countries (other than Spain).[32] Except in Japan most of the rise in holdings of debt claims has been in short-term forms.[33] Over the decade as a whole gross debt/GDP ratios (excluding trade credit) have risen substantially in Japan and Sweden. Considerable increases have also taken place in many other continental European countries. The rise in the value of shares on issue has been relatively large in the United Kingdom, Canada, France, Belgium and Sweden but relatively small in Germany and the Netherlands.

Though the trade credit data excluded from the debt totals is probably not comparable across countries, a decline in the amounts outstanding over time, as is evident for Japan, Spain, Sweden and the United Kingdom, may indicate a reduction in the role of restrictions on credit-granting by financial intermediaries which typically provided an incentive to the use of trade credit. Of course, the decline is probably in part cyclical and may also reflect efforts of companies to cut back on such claims with a low direct interest yield.

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30 For Australia and Italy, data for reference year relate to the late 1980s.

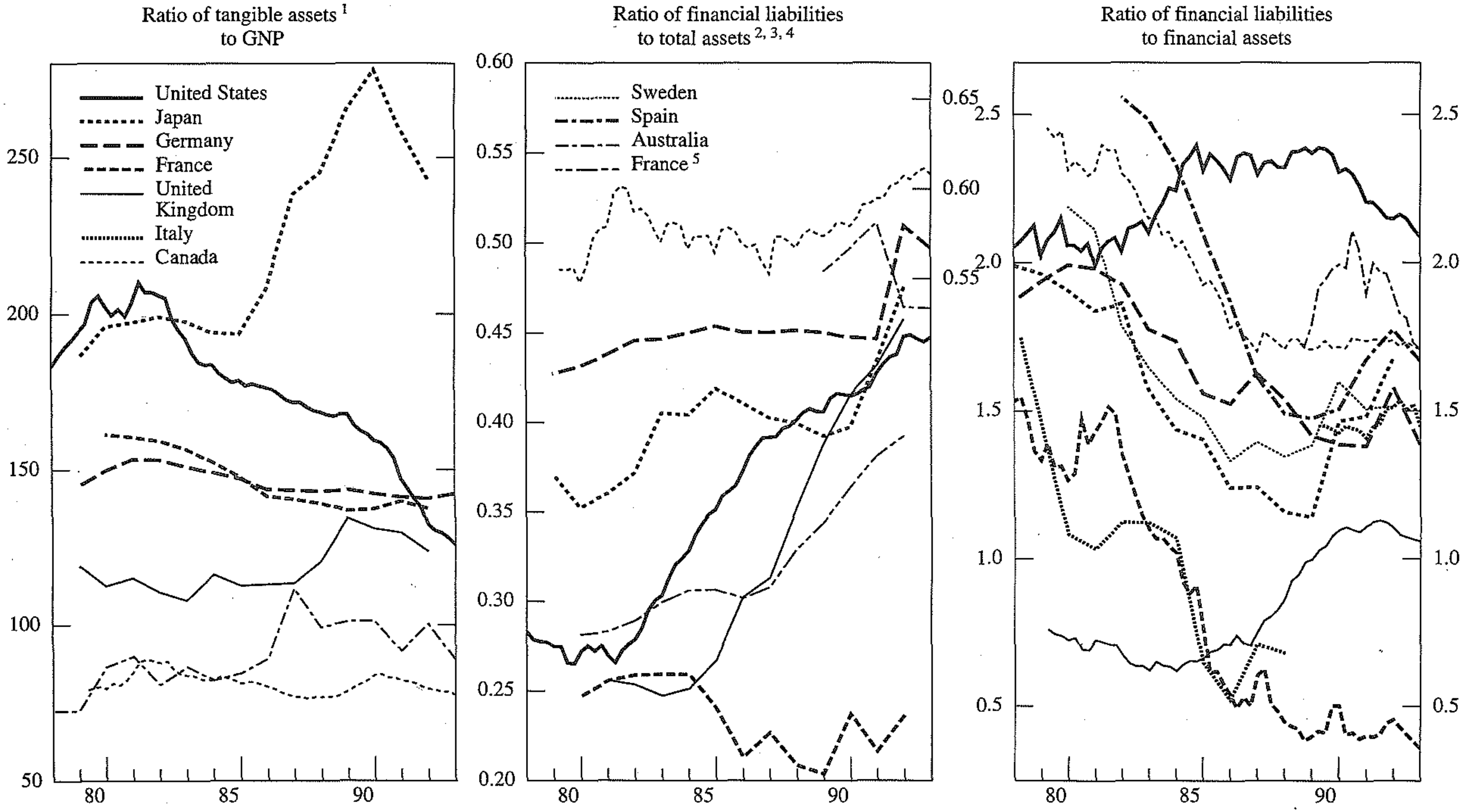
31 See footnote 15. For the United States, the graphs, like the table, relate to all non-financial business except where expressly indicated. For Australia, the data underlying the graphs relate to private corporations only.

32 For Australia, a fall is shown but the reference year is 1989. For Italy, where a fall in debt claims is shown, the base year is 1988.

33 For the United States, certainly, equity in unincorporated enterprises is included at book value.

Graph 6

Non-financial enterprise sector: tangible asset and capital gearing ratios



[1] For Japan and Germany, excludes housing assets. [2] Excludes identified trade credit. For Japan and Germany, excludes all share assets; for the United Kingdom, excludes domestic share assets. [3] Financial plus non-financial assets. [4] For Canada, right-hand scale. [5] Excluding domestic share assets.

In the United States the ratio of other enterprise debt to total assets, real and financial, which had risen steeply in the 1983-87 period when leveraged buyout and debt financed merger activity contributed to major changes in balance-sheet structures, rose further in 1990-92 when the recorded value of land holdings fell sharply. In Japan, notwithstanding a huge debt-financed expansion of firms' balance sheets, the ratio edged down until 1989-90 as asset prices boomed, but turned up when the bubble burst. Marked rises in capital gearing were recorded in Australia in the early 1980s, in a climate of strong profit expectations and rising share prices following the relaxation of credit and interest rate controls, and in the United Kingdom in the late 1980s when merger and takeover activity expanded. The overall ratio declined in France in the mid-1980s as a result of a strong rise in the value of enterprises' equity claims and remained at a very low level.

It may be argued that the inclusion of intra-sectoral share claims on a gross basis for the sector as a whole entails an element of double-counting in countries where cross-shareholding is large. Only a very small amount of equity claims on other sectors is included in enterprise assets in the United States. Exclusion of domestic shares makes the largest difference in the case of France – where an alternative capital gearing measure so calculated shows a substantial rise after 1968, though it remains below the levels for the other countries. Domestic or all shares are excluded from the measures shown for Japan, Germany and the United Kingdom. Even after this undoubtedly excessive adjustment[34] the ratio for all non-financial enterprises in the United States almost rises by 1989 to that in Germany, where the apparent rise in 1992 largely reflects the addition of heavily indebted enterprises in eastern Germany and the inclusion of the Treuhand agency in the non-financial enterprise sector. Much higher ratios which have at times been calculated for Germany result from attributing the entire housing debt of the country to the enterprise sector as is done in the national financial statistics. In the case of Japan the data cover only the narrower corporate sector. Data for the (more comparable) US corporate sector yield a gearing ratio rising even further above that for Japan in the late 1980s. In Japan, corporate asset holdings, as well as corporate indebtedness, have traditionally been high in relation to GDP and underwent a strong expansion in the 1980s.

Ratios of total financial liabilities to total financial assets (other than trade credit) highlight the deterioration in the liquidity of US non-financial enterprises in the early and mid-1980s when debt was substituted for equity on a large scale. This development, which was encouraged by tax changes and the development of junk bonds, weakened established linkages between the growth of indebtedness and current spending but, at the same time, made firms more vulnerable to future increases in interest rates. By contrast, rises in the financial asset holdings of the non-financial enterprises far exceeded increases in indebtedness until about 1987 in all of the other countries except the United Kingdom. In most European countries and Canada financial gearing is now considerably lower than in the United States. Certainly in some countries, increases in the recorded value of enterprises' equity asset holdings had made a substantial contribution to the fall in the ratio. In Japan rising company indebtedness, much of it in equity-related instruments such as convertible bonds, was accompanied by an expansion of financial assets in part induced by the high returns offered on deposit instruments by banks seeking to increase their market shares in a phase of incomplete interest rate liberalisation. Such a build-up of liquid assets may reduce the sensitivity of enterprise cash flows to monetary policy, but it may also suggest increasing sensitivity to rates of return on financial assets. Financial gearing rose strongly in the United Kingdom as from 1987, Australia as from 1988 and Japan as from 1989. By this time efforts of companies to redress balance sheets by building up financial asset positions and cutting back borrowing were already in process in the United States and were beginning to appear in other countries. In Canada and most continental European countries the investment cycle made less impact on the balance sheets of non-financial enterprises and the lower ratios of liabilities to financial assets achieved in the 1980s were largely maintained.

Strong rises in the credit market indebtedness of non-financial enterprises in the United States and the United Kingdom were generally not reflected in large movements in ratios of debt to

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34 Holdings of domestic and foreign shares are not distinguished in the data for Japan and Germany. Holdings of share claims on other domestic sectors (such as financial institutions) are not shown separately for any of the four countries.

equity at market values. These ratios reflect the impact of changes in share prices on the availability and cost of equity financing. Declining short-term interest rates apparently contributed to rises in share prices which facilitated balance-sheet restructuring by non-financial enterprises in the 1990-93 period. This illustrates a role share prices can play in the monetary policy transmission process. However, a tendency towards stability in debt/equity ratios observed in some countries in the 1980s seems to reflect more the impact of changing profit expectations, reflected in stock market valuations of non-financial enterprises, on the ability and willingness of enterprises to borrow. Such a relationship clearly entails a risk of over-leveraging when share prices move out of line with fundamentals. The resulting problem could be exacerbated if share prices then begin to respond to market perceptions of excess gearing. The debt/equity ratio for the US non-financial corporate sector[35] was on a generally declining trend throughout the 1980s, notwithstanding net retirements of equity up until 1987. The fall steepened when a reversal of this process began in the early 1990s. Somewhat more responsive to cyclical movements in borrowing, the ratio for companies in the United Kingdom and Australia rose in the late 1980s but fell subsequently.[36] By contrast, in the continental European countries debt/equity ratios generally fell during the 1980s. Borrowing remained modest even though share prices rose. In Germany, Sweden and Spain the ratios were already relatively high but their movements scarcely suggest a close connection between equity values and borrowing.

Net liability positions in debt instruments (Graph 7), which approximate net interest-bearing positions (liabilities minus assets), rose steeply in relation to current operating surplus[37] in the late 1980s in Sweden and Japan, as well as in the United States,[38] Canada, the United Kingdom and Australia. Except in Japan, falls have subsequently taken place but the ratios remain considerably higher than in the mid-1980s. Following declines in the 1980s moderate increases have been recorded recently in Spain, Germany and France. To some extent these ratios are sensitive to cyclical developments in operating surplus. In Spain, in particular, net interest-bearing liabilities now stand much lower in relation to GDP than a decade earlier. However, as far as can be judged from net interest-bearing positions alone, firms in Japan, Sweden, France and Italy would seem comparatively vulnerable to interest rate changes, though the exposure of firms in France is much lower than in the early 1980s.

Consistent with other evidence, ratios of long to short-term credit-market indebtedness to financial institutions are relatively high in Germany,[39] France and the Netherlands. They are also fairly high in Canada and the United States, where recent increases formed part of the balance-sheet restructuring process. The rise in Germany in 1993 was strongly influenced by debt consolidation operations of the Treuhand agency. Even so, the ratios in all these countries have long displayed strong cyclical movements which to a considerable extent reflect larger changes in short-term than in long-term indebtedness. Thus there may be scope for influencing non-financial enterprises' overall demand for credit through changes in short-term interest rates, even in countries where the proportion of long-term financing at quasi-fixed interest rates is high. In Belgium, the share of long-term credit in enterprise indebtedness apparently declined in the late 1980s. In the United Kingdom, the proportion of long-term largely fixed interest rate finance in company balance sheets has recently risen as a result of large-scale recourse to issues of debenture and loan stock accompanied by net repayment of bank loans. However, the proportion remains low in comparison to other countries.

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35 As reflected in the ratio of credit market debt to equity.

36 No comparable series can be shown for Japan as corporate equities on issue are recorded in the financial accounts only at book value.

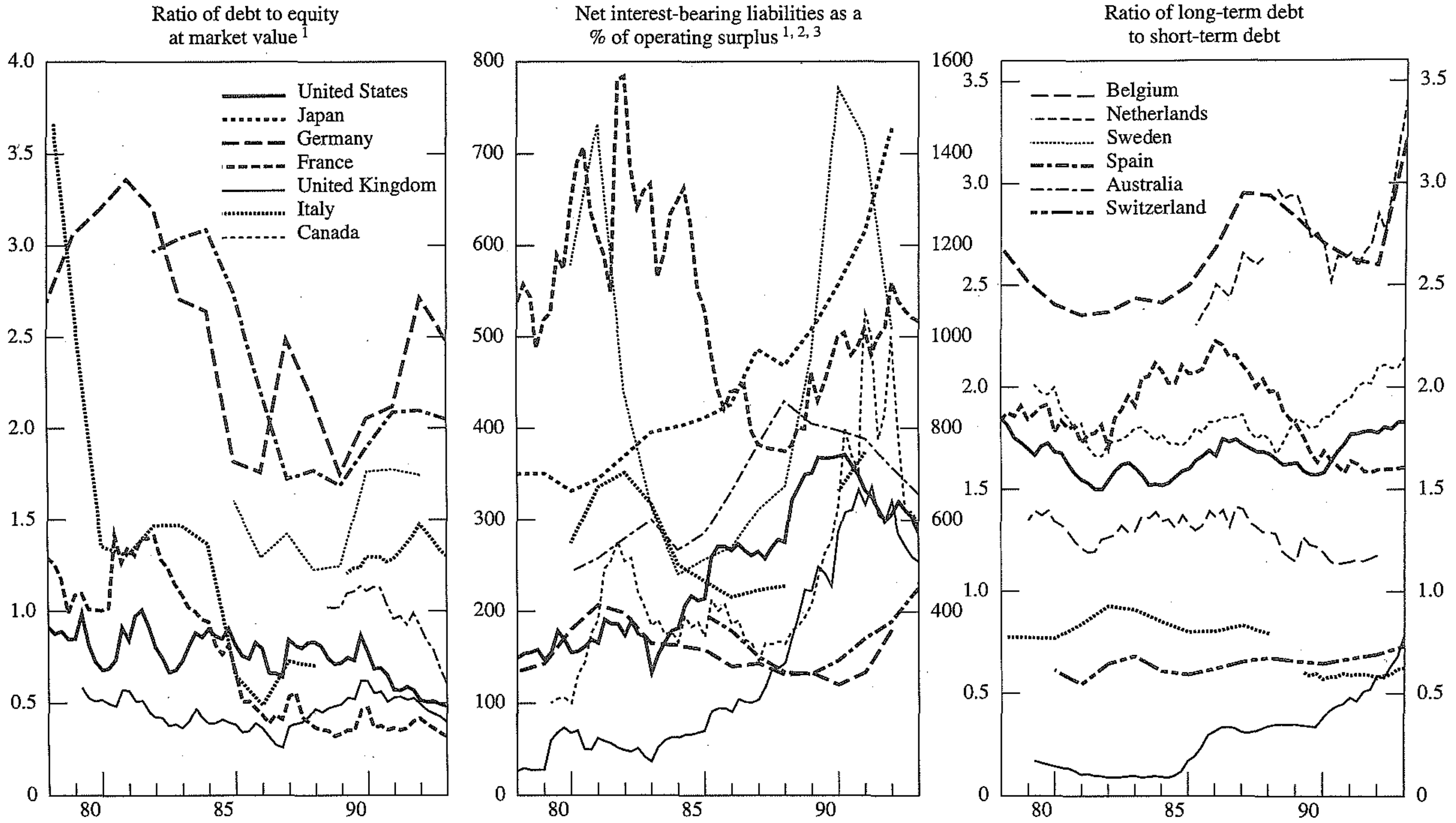
37 For countries other than Australia, Canada, France, Spain, the United Kingdom and the United States, OECD national accounts data for the "corporate and quasi-corporate sector" have been used.

38 Data shown for the United States, as for the debt equity ratio, apply to the non-farm corporate sector only. All other graphs and tables relate to all non-financial enterprises.

39 According to the breakdowns in the national financial accounts.

Graph 7

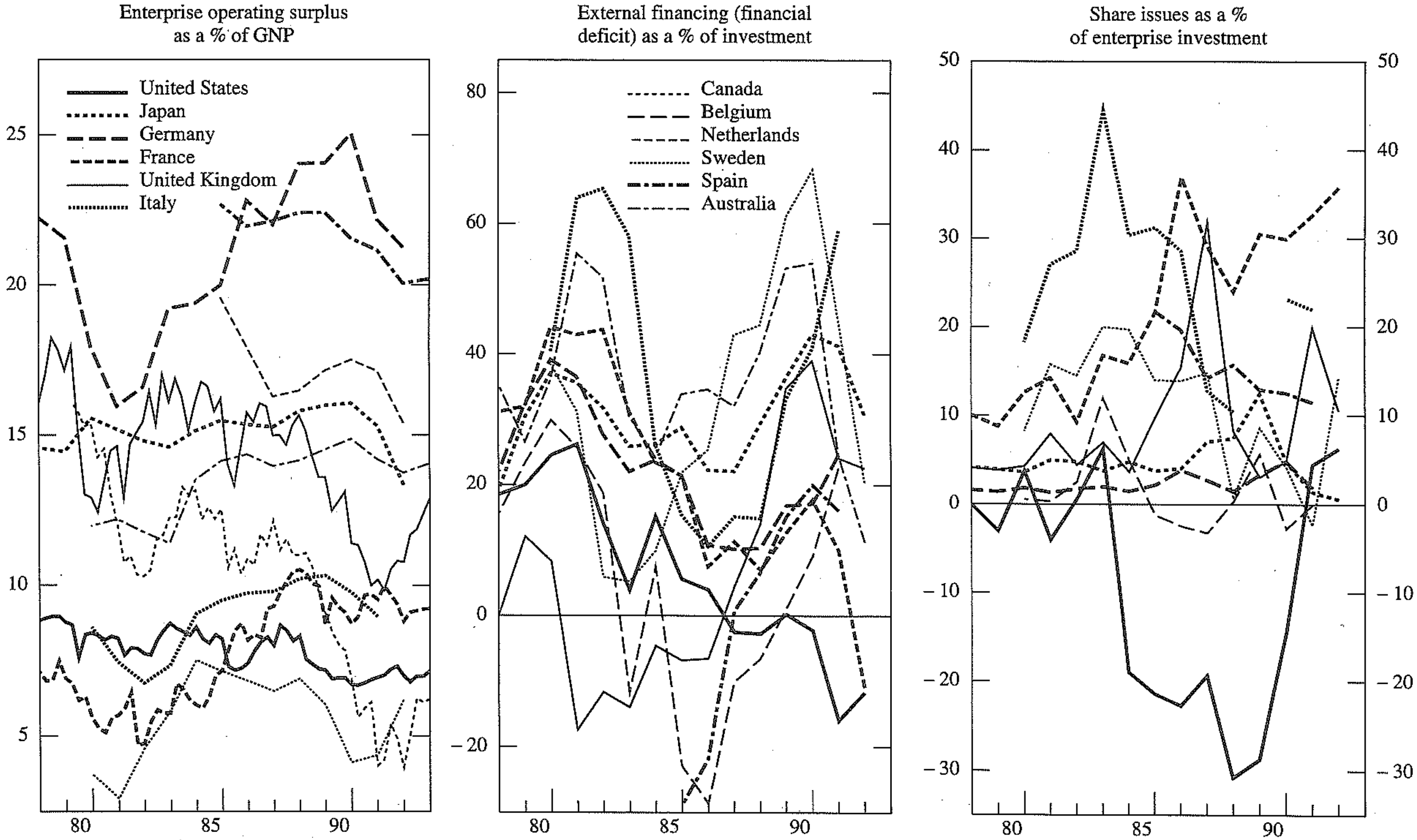
Non-financial enterprise sector: financial balance sheet ratios



[1] For the United States, corporate sector only. [2] For Australia, gross borrowing from financial institutions as a % of operating surplus. [3] For Sweden, right-hand scale.

Graph 8

Non-financial enterprise sector: financial flow ratios



The improvements in capital gearing ratios recorded in many European countries in the 1980s were largely attributable to the contribution made by wage moderation, along with steady output growth, to strengthening the profitability and internal financing capacity of non-financial enterprises. A strengthening of underlying profit positions may have brought about lasting reductions in firms' vulnerability to interest rate changes. In Germany, France, Italy and Sweden the share of the operating surplus of the non-financial enterprise sector in GDP, which may serve as an indicator of self-financing capacity, increased strongly during the 1980s (Graph 8). It fell cyclically in 1990-93 but remained higher than in the 1981-83 recession. A rise in profit shares in Australia in the 1980s also largely withstood recession, partly as a result of cost-cutting efforts by enterprises. Profit shares were also relatively high in the mid-1980s in the United Kingdom, Canada and Japan but, as in the United States, subsequently fell below the levels recorded in the early 1980s before a recovery set in. According to these indicators profit shares seem relatively high in Germany and Spain and relatively low in the United States, Canada and Sweden.

While profit shares give an indication of self-financing capacity, cyclical variations in investment ratios affect the extent to which enterprises actually make use of external financing. The enterprise sector's financial deficit[40] set in relation to its gross investment may serve as a proxy for total net recourse to external financing of investment (including decumulation in financial assets). The ratios reveal similar cyclical movements in most of the countries, falling in 1982-86, rising in 1986-90 and (except in Germany and Italy) moving back down thereafter. In Germany, France and Belgium, the second peak is lower than the earlier one, but is higher in the United Kingdom, Sweden and Japan. On average during the period use of external financing (as indicated by financial deficits) was relatively low in Belgium and Spain and relatively high in Australia, Japan, Sweden and Italy. In the last year for which this data is available (1991 or 1992) the sector remained in deficit in most countries, notwithstanding cut-backs in investment ratios, but was in substantial surplus in France. In the United States the enterprise sector moved into small surplus in the late 1980s and into much larger surplus as from 1990. External financing includes recourse by non-financial enterprises to equity issues, which can serve to reduce gearing. Scaled by GDP, equity financing reached high peaks at times in the 1980s in the United Kingdom, Canada, Japan and Italy, and has recently again risen strongly in the United Kingdom, Canada and Italy. It has risen structurally since the mid-1980s in France and has generally been comparatively high in Spain, but has remained extremely modest in Germany and Belgium. However, equity issues have on average been a minor component of external financing of investment in most of the countries and have remained very small in relation to internal financing in all cases.

4. Enterprise sector interest receipts and payments

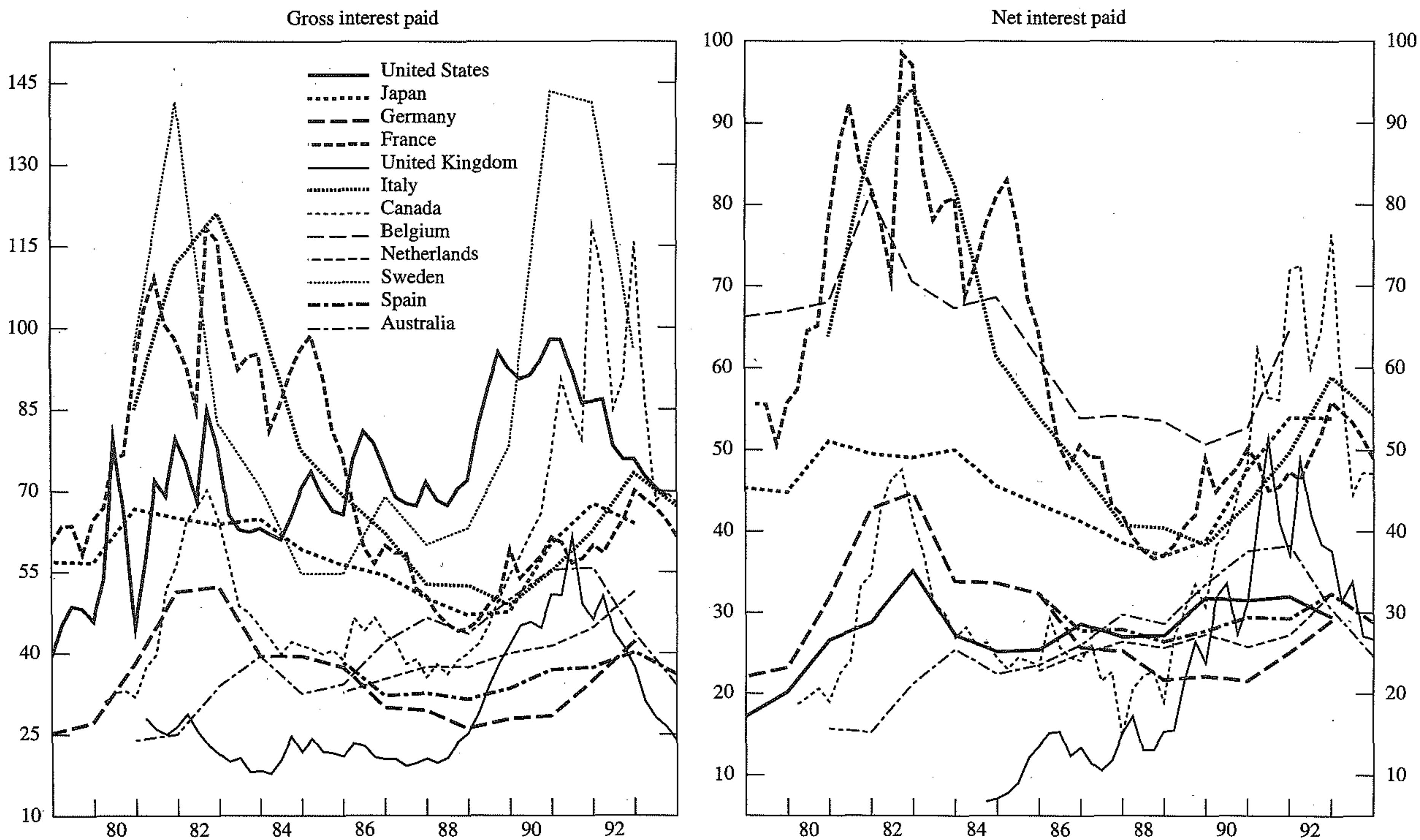
Gross and net interest payments in relation to operating surplus

Interest gearing in the non-financial enterprise sector (Graph 9) is quite sensitive to movements in profit rates and in leverage, as well as to the direct impact of interest rate changes. Developments in profitability and leverage made substantial contributions to the high peaks reached by ratios of gross and net interest payments to operating surplus in France, Italy and Sweden in the early 1980s and in Canada, Sweden, the United States, the United Kingdom, Japan and Australia in the early 1990s as well as to the recent declines in five of the latter six countries. In most cases the ratios for net payment have moved over a smaller range than gross payments.

40 Both the numerator and the denominator are based on OECD data, which differ conceptually from national data in some cases.

Graph 9

Non-financial enterprise sector interest receipts and expenditure: as a percentage of gross operating surplus



Earlier reductions in interest-bearing liabilities help to explain why the recent rise in the interest payment ratio has been relatively modest in Germany, France, Belgium, the Netherlands and Spain. In Germany, the Netherlands and Spain the level of net payments has remained quite low in recent years. In Belgium, France and Italy the level has fallen substantially since the early 1980s, on balance, but remains high in comparison with most other countries. The relatively low levels reached in the United Kingdom and Australia clearly reflect the complementary operation of de-leveraging and decline in interest rates.

Average rates of interest received and paid

To a certain extent the direct effect of interest rate changes on income gearing can be distinguished by considering developments in average interest rates paid and received (Graph 10).[41] A relatively strong response to market rates is evident in the case of interest rates paid by non-financial enterprises in the United States up until 1990. Thereafter, however, the average rate remained above the money market rate by an ever widening margin as market rates rose to levels not previously reached since in the 1960s. Delayed and unusually limited responses to money market rates of bond yields and bank prime lending rates have been cited in many accounts of the recent "credit crunch". In Japan the response of the average rate paid to declines in money market rates as from 1991 was also limited but the adjustment to the earlier rise had also been incomplete.

Average interest rates paid and received by enterprises in the United Kingdom have displayed strong, almost simultaneous, reactions to movements in money market rates. The full extent of the movement is masked by the inclusion of dividend receipts and payments in the averages. Lagged and more limited responses have been evident in France, Sweden and Italy. In Germany and Spain, as far as can be judged from the annual data available, the reaction of both averages has generally been small, the recent sharp rise in the average interest rate received in Germany, in a period of monetary restraint, evidently being an exception. Average rates paid and received in Canada, on a downward course consistent with but not closely related to that of money market rates through much of the 1980s, seem to have come down more than the corresponding US rates since 1990 when a marked decline has been evident in such interest rates in Australia.

5. Enterprise financial positions and expenditure

To the extent that differing responses to monetary policy of average rates paid by non-financial enterprises reflect cross-country differences in rate setting behaviour of the main institutional suppliers of external finance, the responses of the marginal rates applied by enterprises in making investment decisions may differ in similar ways. Where long-term quasi-fixed rate financing is available the response of long to short rates is likely to be a key factor in investment decisions. Where only variable rate financing is available short-term rates and the expected behaviour of institutions in adjusting them may enter into the calculation. Inherited balance-sheet positions may exert an influence on capital expenditure not only to the extent that cash flows are an important determinant, but also through their interaction with expectations for output, profits and asset prices, on which the influence of monetary policy may be limited, at least in the short run. That, in varying degrees, non-financial enterprises can take advantage of a wider range of financing possibilities than households has contributed to large cyclical movements in their balance sheets in some countries. However, capital expenditure normally bears some of the burden of adjustment. Moreover, enterprise balance sheets in different countries have also displayed divergent trends and still differ in ways which could affect the interest sensitivity of investment.

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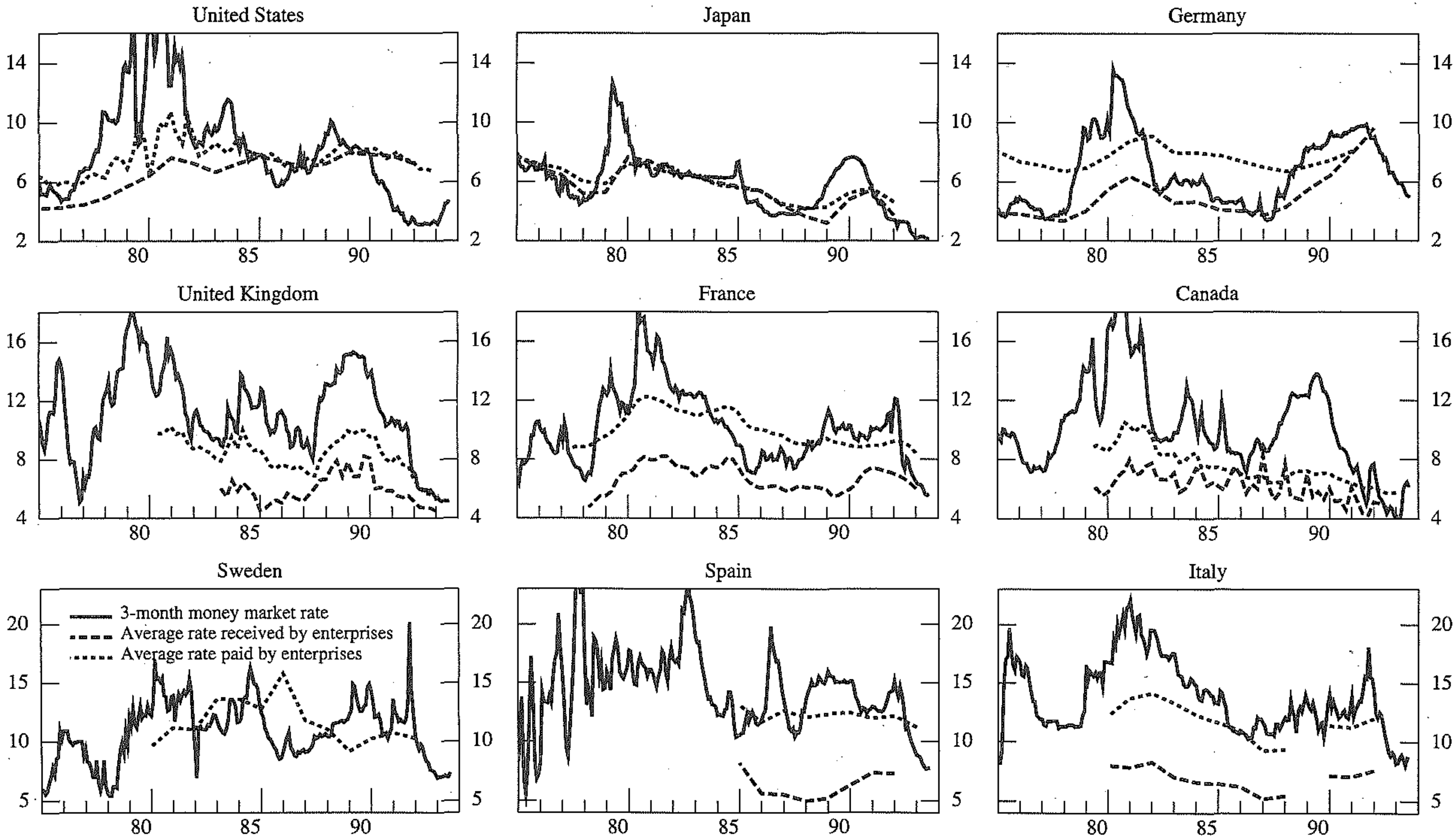
41 Calculated in the way described above for households.

Graph 10

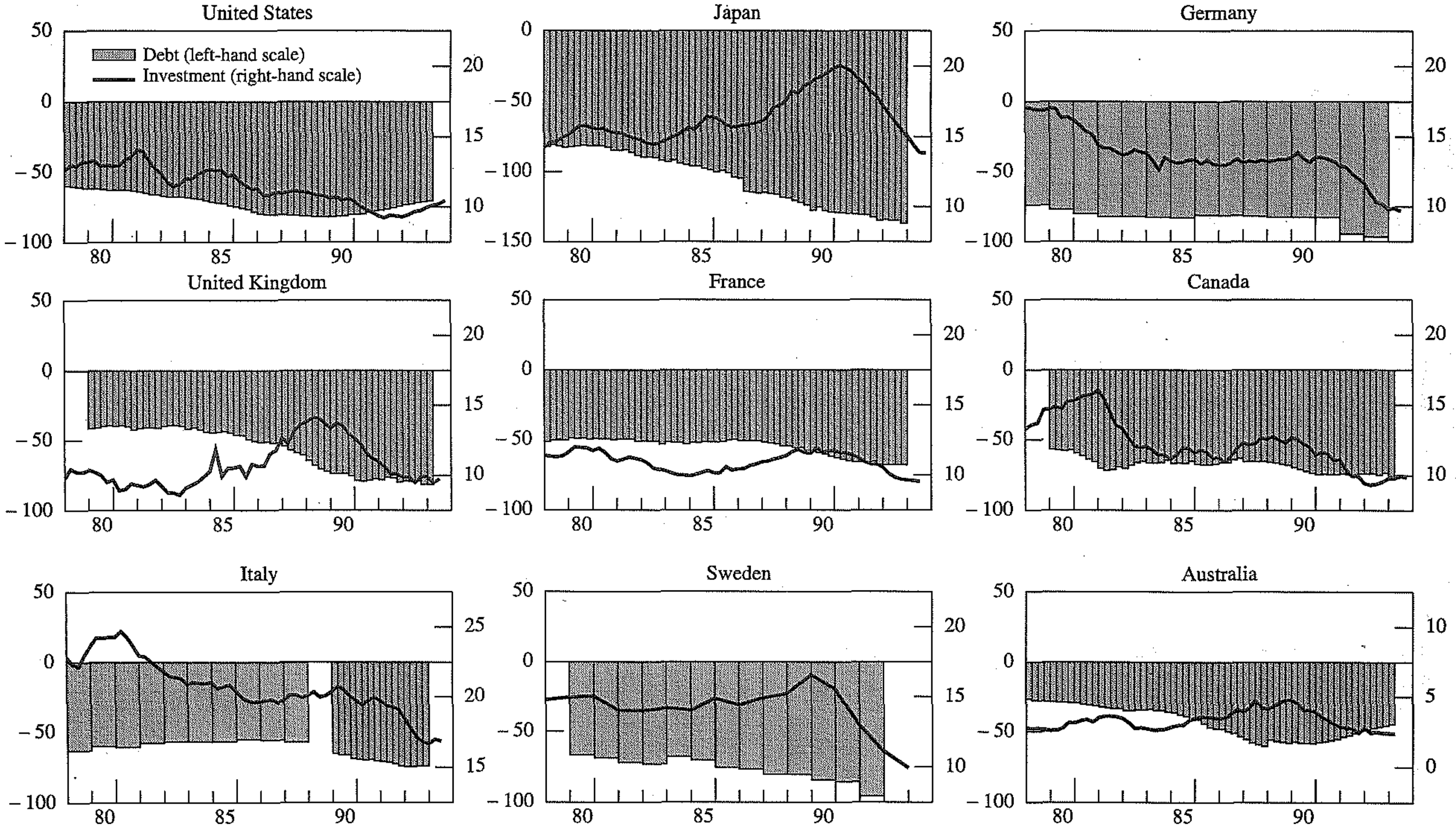
Average interest rates received and paid by non-financial enterprises:* relationship to money market rates



* Total volume of enterprise interest receipts and payments divided by the amount of debt assets or liabilities of the enterprise sector.

Graph 11

Enterprise sector debt and private non-residential fixed investment:* as percentages of GDP



* For Italy, total fixed investment; for Sweden, total non-residential fixed investment.

Non-financial enterprises were probably less directly affected by the removal of credit and interest rate controls than households, except in Australia. Yet in the 1980s balance sheets of enterprises in the United States, Japan, the United Kingdom, Canada and Australia underwent asset-price-related rises in leverage which increased exposures to increases in interest rates and declines in asset prices. The impact of asset price movements on investment has been most evident in the case of construction, which in a number of countries underwent a cycle closely related to that in prices of non-residential real estate. Other investment expenditures have undoubtedly been affected by the impact of movements in equity prices on the cost and availability of finance, particularly in Japan. In several countries de-leveraging, coupled with sluggish economic activity, clearly contributed to weakening business investment which did not until recently contribute to economic recovery. Ratios of total fixed investment to GDP had been unusually weak for some years in the United States and particularly steep falls were recorded in the early 1990s in Australia, Canada and Sweden (Graph 11). A substantial decline in the investment ratio seems also to have taken place in Italy, where non-financial enterprises' income gearing and reliance on external financing seem to have risen to comparatively high levels. In general, smaller declines were recorded in other European countries where movements in asset prices and in enterprise indebtedness have been limited. In Germany, the indicator has been distorted by the strength of personal consumption and government spending following unification of the country. In the United Kingdom, notwithstanding a substantial rise in leverage, enterprise investment seems to have been sheltered by the shallowness of the recession in output and the impact on profitability of strong growth in labour productivity in relation to the growth of wages.

Several central bank and academic studies have found evidence of the impact on investment of cash flow, leverage and other balance-sheet variables such as liquid assets, though such effects are typically difficult to disentangle from those of monetary policy operating through interest rates and output.[42] Monetary policy is only one of many influences on asset prices and balance-sheet structures. In the early 1990s in the United States, Australia and some other countries the power of interest rate reductions in counteracting recessionary influences at first seemed limited but may have increased over time. Clearly it depends on circumstances and may be felt only with a long, and perhaps variable, lag.

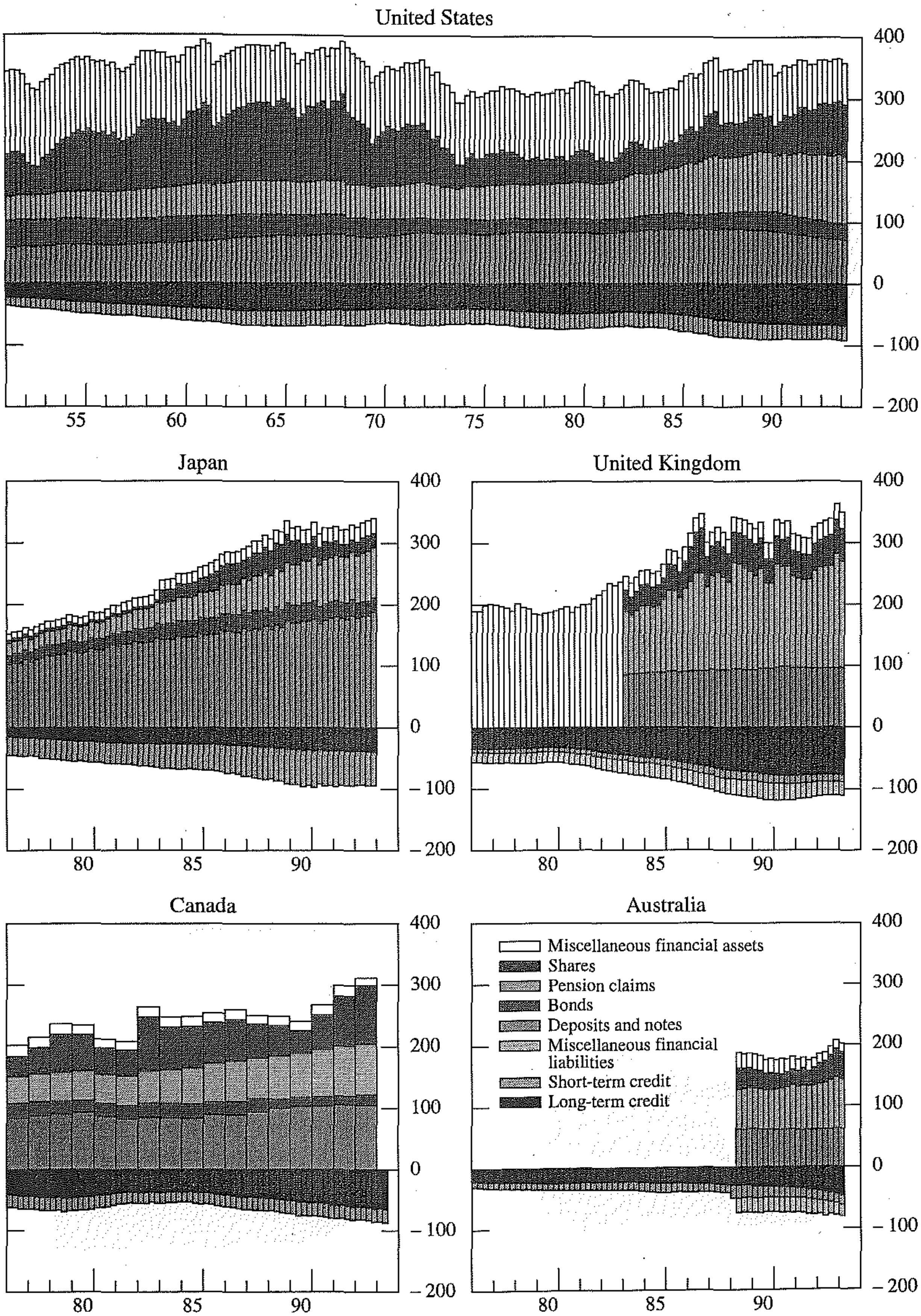
Balance-sheet restructuring has probably ceased to operate as a constraint on investment, except in Japan. To the extent that debt structures have been lengthened by long-term fixed rate financing, as in the United States and the United Kingdom, the impact of monetary policy on investment could be slower and less reliable than in the past. Exposures to influences on long-term interest rates and share prices coming from abroad may have increased. However the long-term quasi-fixed rate financing component of the indebtedness of non-financial enterprises remains higher in many European countries and in some of them firms have reduced their reliance on external financing.

With cash flows benefiting from expansion of output, investment seems to be on a strong expansionary course in many of the countries where leverage increased most during the 1980s. In some, signs of increased takeover activity may even herald renewed increases in leverage. Whether investment will as a result prove more sensitive than in the past to a tightening of monetary policy as the upswing progresses remains to be seen.

42 For instance, cash flows constitute a key determinant of investment in the Bank of France model. Some studies have found significant effects of balance-sheet variables in the United States, Canada and Australia. See e.g. Fillon, J.-F., *Bank of Canada Working Paper,* No. 94-7, August 1994, Mills et al., *Reserve Bank of Australia Research Discussion Paper,* No. 9402, May 1994, and Federal Reserve Bank of New York, articles in the *Quarterly Review*, Spring 1993, and in *Studies of Financial Changes and the Transmission Mechanism,* May 1990.

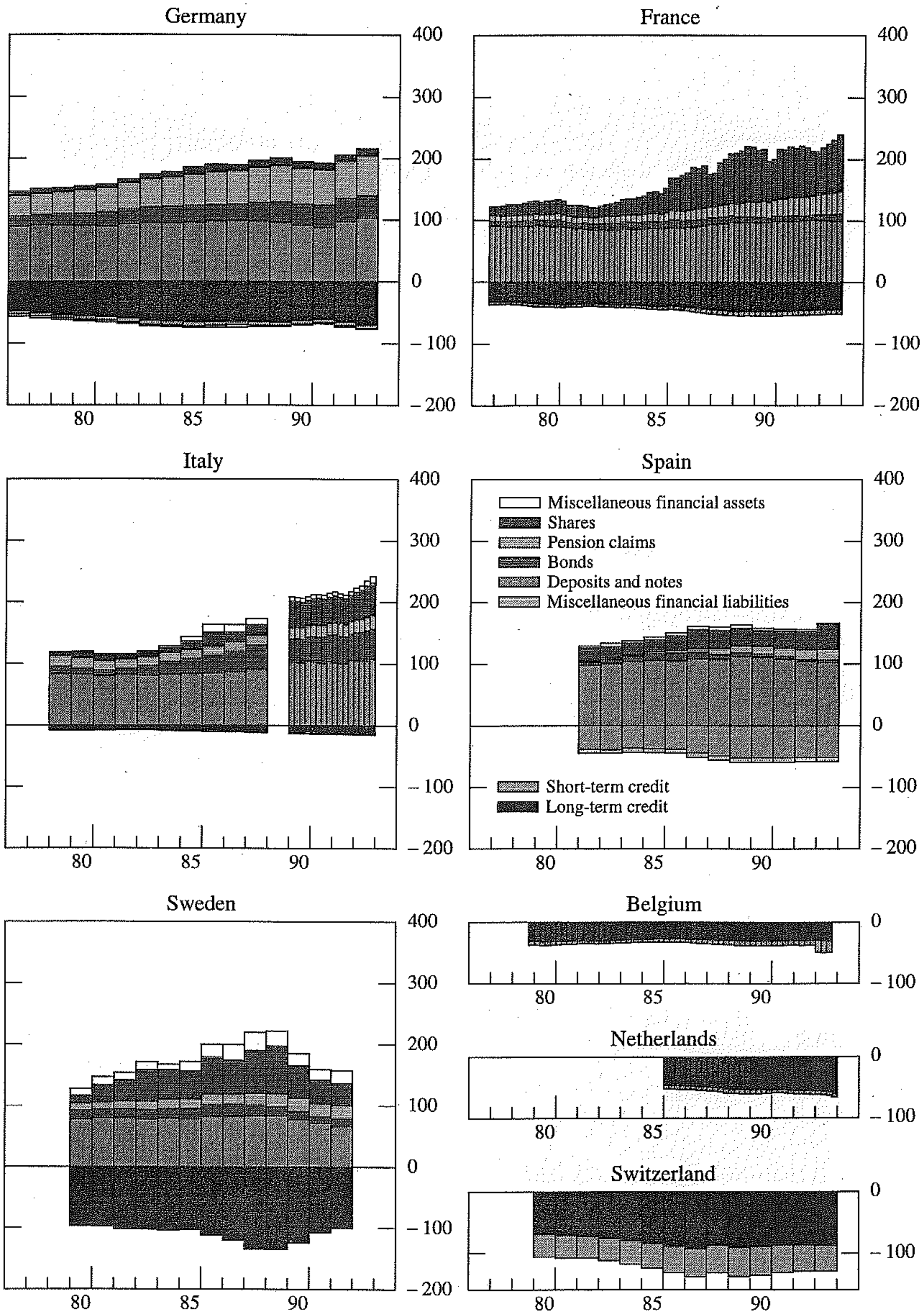
Graph A.1

Household sector balance sheet: percentages of personal disposable income



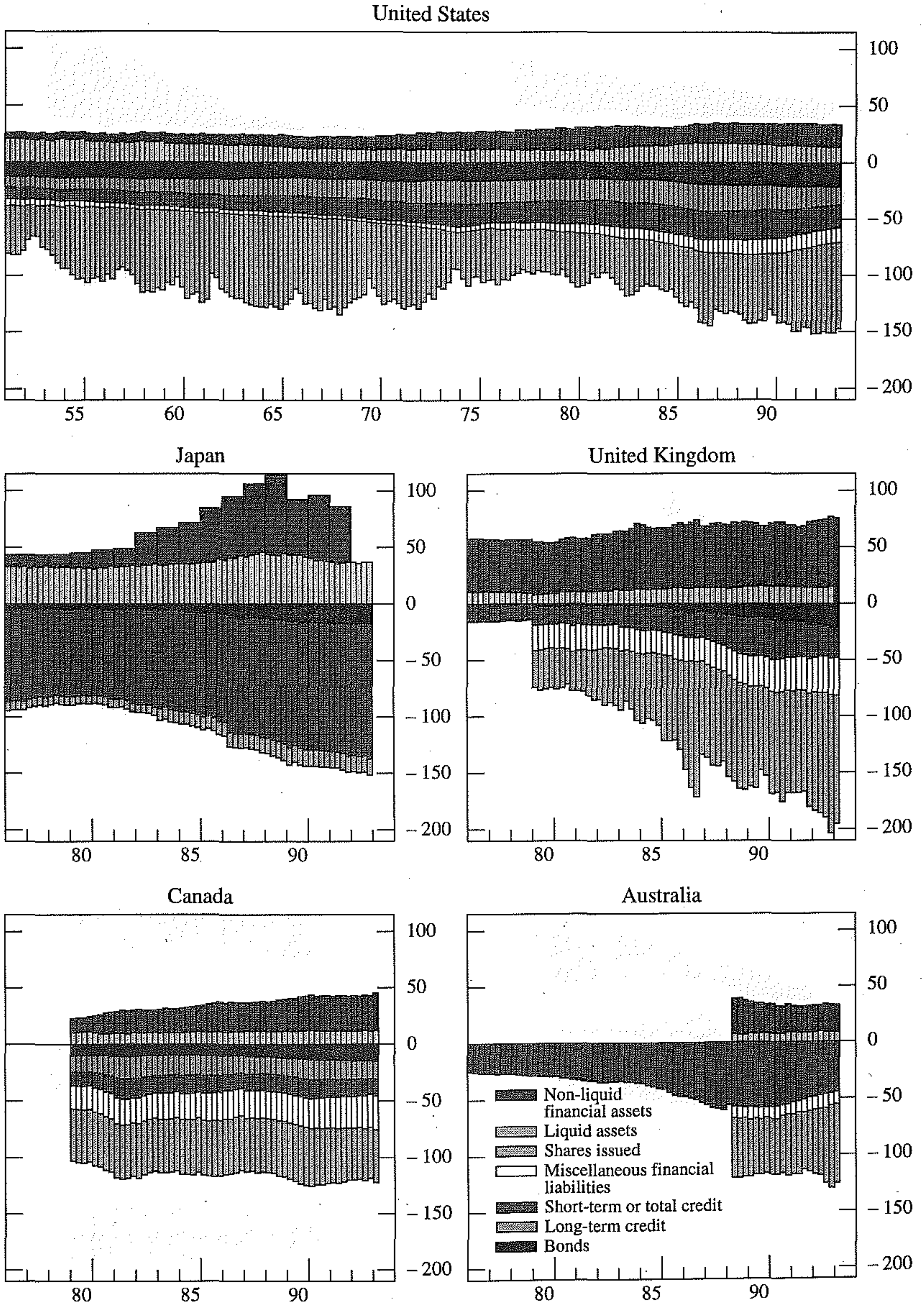
Graph A.1 (cont.)

Household sector balance sheet: percentages of personal disposable income



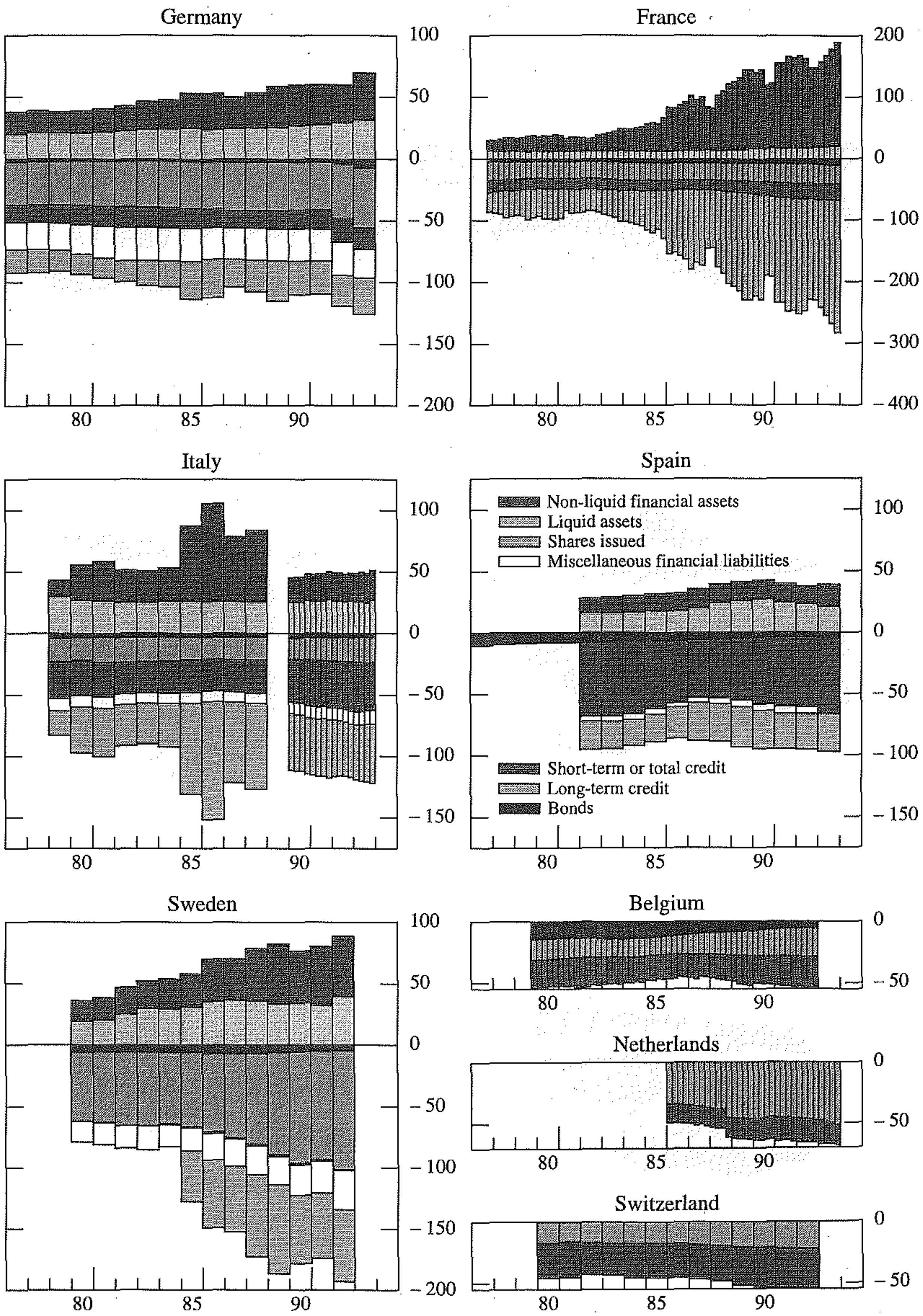
Graph A.2

Non-financial enterprise sector balance sheet items: as percentages of GDP



Graph A.2 (cont.)

Non-financial enterprise sector balance sheet items: as percentages of GDP



ANNEX 2

Notes on data sources and methods

I. HOUSEHOLD AND ENTERPRISE SECTOR BALANCE SHEETS

This annex lists data sources used in addition to data supplied in central bank answers to the BIS questionnaire on financial structures. Selective notes on the sectorisation, data coverage, BIS adjustments and differences between the data used in the tables and graphs are included.

Australia: Financial assets and liabilities for the personal and company sector (public enterprises are included in Table 5 but not in data underlying the graphs): Reserve Bank of Australia, *Bulletin*, Table D3, Credit to the private sector from financial intermediaries (household long-term debt liabilities = housing loans (column 6), short-term debt liabilities = other loans to personal sector (column 7)) and Table D4, Financial assets and liabilities of the domestic non-financial private sector. Household share holdings include unit trusts, debt assets include only deposits with banks and financial institutions. Enterprise debt assets include only bank deposits; total liabilities = source total minus shares issued. Trade credit is not identified separately and could not be deducted from sector totals. All series used taken from RBA diskette.

Tangible assets: Households: Table 3: dwellings and consumer durables from RBA answer to questionnaire; graphs: quarterly stock estimates from Tim Callen, RBA Research discussion paper No. 9109 (1991) updated by RBA (letter to BIS 4/9/93). Enterprises: business capital, from "Australian private wealth", Treasury *Round-up*, Summer 1993/94 (supplied by RBA).

Belgium: Tables: individual enterprises included with households, loans from public sector excluded (no allocation by recipient sector provided), all securities on issue and credit from abroad allocated to business sector. Graphs: individual enterprises included in enterprise sector. Banque Nationale de Belgique, *Bulletin*, Table XVI 3b, Debt incurred mainly by individuals; long-term = mortgage credit (column 9); short term = other (columns 4 + 13). Table XVI 6b, Loans from credit institutions to enterprises; long-term = investment and leasing credit (columns 4 + 5); short-term = other types of credit (Column 9 minus columns 4 + 5). Table XVII 2B, columns 6 + 7, bonds issues by private companies and public-sector producing enterprises. All series taken from BIS Data Bank.

Canada: Household sector: Financial liabilities (excluding individual enterprises): Bank of Canada, *Review*, Table E2; long-term = mortgages (B938) plus, in Table 3, medium-term consumer credit; short-term = consumer credit (B140). From BIS Data Bank. Financial and real assets (including unincorporated enterprises): Table 3: Bank of Canada estimates. Graphs: Statistics Canada, *National Balance Sheet Accounts 1992* (1993 estimated by BIS in the light of questionnaire answers). Share holdings estimated by BIS on the basis of the proportion of shares to other assets shown in M.-C. Montplaisir, article in Bank of Canada Review, July 1992, page 8. Total financial assets = National Balance Sheet Accounts, line 2100 minus line 2520 plus estimated market value of share holdings. Debt assets = lines 2311 to 2424.

Enterprise Sector: Statistics Canada, *Quarterly Financial Statistics for Enterprises*, Table 5, Total non-financial industries (series used taken from Cansim via DRI). Non-financial assets = Capital assets net plus stocks (D86230 + D86234). Total financial assets = total assets minus non-financial assets and accounts receivable (D86227 - (D86230 + D86235 + D86229)). Debt assets, short-term = cash, deposits and loans (D86228 + D86233), long-term = portfolio investments (D86232). Financial liabilities: total = source total minus accounts payable (D86236 - D86237); debt liabilities, long-term = bonds and mortgages (D86244 + D86245) plus 44% of loans and overdrafts (D86239 x .44 - the proportion given for 1993 in the Bank of Canada's answers to the BIS questionnaire. In Table 3 the figure given in the questionnaire for 1983 is used for that year); short-term = acceptances (D86243) and 56% of loans and overdrafts.

France: Financial assets and liabilities of corporate and quasi-corporate enterprises (S10) and households, including individual enterprises (S80). Private institutions serving households (S70) are excluded from Table 3 but included in household sector in the graphs. Banque de France, *Bulletin* Second Quarter 1994, *Etudes*, pp. 177ff. Total liabilities and assets = source totals minus trade credit, "décalages comptables" (items F65, F66 and F75) and, in the case of enterprise liabilities, shares (F50). Debt assets and liabilities = currency, deposits, securities and credit; long-term (F40 + F70 - F75), short-term (F00 + F10 + F30 + F60 - F66 - F65) and, in the case of household assets, short-term mutual fund shares (F'531), which is excluded from shares. All series used from Bank of France TOF diskette.

Non-financial assets: INSEE, Comptes de patrimoine. Enterprises, total; households (graphs), housing assets only.

Germany: Financial assets and liabilities of households and producing enterprises with 80% of the liabilities of the separate housing sector added to those of households and 20% added to those of producing enterprises. Deutsche Bundesbank, *Monthly Report*, May 1994, pp. 19ff. Eastern Germany is included as from 1992. Total assets and liabilities = source adjusted to include shares at market value (for households: Bundesbank, ibid. p. 32; for enterprises: BIS estimates for 1992 and 1993). Trade credit is deducted from enterprise sector assets and liabilities in Table 5 but only the assets could be deducted for the graphs. The debt claim maturity breakdown for assets in Tables 3 and 5 is from questionnaire answers - in the graphs, assets = placements with banks and building and loan associations and bonds (small amounts of money market paper are omitted); for liabilities, short-term = short-term bank loans; long-term = long-term bank loans plus loans from building associations and bonds (at book values). Household pension claims include funds placed with insurance enterprises and "other claims" in the source, which consist largely of pension claims on non-financial enterprises. Most series used from BIS Data Bank.

Non-financial assets: enterprises; Federal Statistical Office, National Accounts, Fachserie 18, Reihe 3.1, Table 3.6.2 (western Germany), structures (excluding rental of housing) and equipment at replacement cost plus stocks (Table 6; BIS estimates for 1992 and 1993). Data in source relate to beginning of year and are used as end-year data for previous year. Households: unpublished Bundesbank estimates for total household tangible assets at replacement cost.

Italy: Financial assets and liabilities: individual enterprises are included in the household sector in the tables but in the enterprise sector in the graphs (data for years prior to 1989 are available only on the latter basis). Bank of Italy, Supplement to Statistical Bulletin, Conti Finanziari (quarterly data as from 1990). Earlier data from OECD, Financial Accounts of OECD countries, 1991 (based on series published in Bank of Italy Annual Report appendices in previous years). Methodology for the two data sets differ. No adjustments made for trade credit except in the case of the enterprise sector in Table 5. Debt claims = currency, deposits, securities and credit; maturity breakdown as in source (long-term includes medium and long-term securities).

Series for household tangible assets from answers to BIS questionnaire.

Japan: Financial assets and liabilities, household and corporate business sectors. Bank of Japan, *Flow of Funds Accounts in Japan* and *Economic Statistics Monthly*. Totals exclude trade credit and, in the case of corporate liabilities, shares. Sectoral share holdings are at market values but on the liability side of the balance sheet they are shown only at book values. In the graphs, debt assets include, for households, only currency and deposits and for the corporate sector, only deposits and CDs. In the tables fixed interest securities are included, classified, together with all time deposits, as long-term. Long-term household debt liabilities = housing credit, subject to instalment repayments, total for all institutions shown in Bank of Japan, *Economic Statistics Monthly,* Table 58. Long-term company debt liabilities = bonds; total = loans plus bonds.

Non-financial assets: Economic Planning Agency, Annual Report on the National Accounts, 1994, Table 2 II 1 (end of calendar year). Non-financial incorporated enterprises: total, stocks fixed assets, land, subsoil, timber tracts and other non-reproducible assets (lines 1 + 2 + 3); households: stocks, fixed assets and land, excluding timber tracts etc. (lines 1 + 2 + 3i).

Netherlands: Bank deposits and credit to individuals and enterprises, including public enterprises, from banks, insurance companies and pension funds only. Tables: loans only; graphs: loans and securities, including participations (counted as long-term debt claims). Netherlands Bank, *Quarterly Bulletin,* Tables 2.1.3, banks (columns 5, 11, 16) and 2.2.1, insurance companies and pension funds (tables, loans only; graphs: column 8, total capital market investments - counted as long-term debt but includes participations and a small amount of short-term credit).

Spain: Non-financial enterprises and households, including individual enterprises and non-profit-making private bodies. Bank of Spain, *Cuentas Financieras de la Economía Español.* Credit and total financial assets and liabilities exclude trade credit (credit from domestic non-financial sectors) and, in the case of enterprise liabilities, shares issued. Debt assets and liabilities include (where relevant) cash, transferable and other deposits, short-term securities and (for enterprises only) bonds and credit granted (in the graphs a small amount of non-negotiable securities held by households is omitted). Long-term liabilities include only bonds. Total enterprise debt liabilities include substantial amounts of credit from abroad. Most series used taken from OECD Financial Accounts diskette, updated to 1993 from the *Cuentas Financieras.*

Sweden: Financial assets and liabilities of enterprises and households, including unincorporated enterprises. Statistiska Meddelanden, Finansräkenskaper. Total financial assets and liabilities exclude trade credit so identified and, in the case of enterprises, inter-company liabilities. Household assets are adjusted to include shares at market value. Debt assets include cash, transferable and other deposits securities and credit. Long-term debt: for households, credit granted by mortgage banks; for companies, bonds only. Total household debt liabilities include substantial amounts of credit from the public sector. Most series available on OECD Financial Statistics diskette.

Household housing assets = value of housing, owner-occupied, multi-unit and for recreational purposes and land used for all three types of housing. Data supplied by Statistics Sweden (letter 11/12/93).

Switzerland: Bank lending to individuals and enterprises, including public enterprises. Swiss National Bank, *Das Schweizerische Bankwesen im Jahre ....*, Sectoral breakdown of (bank) assets. 1993 Table 33.4. Long-term debt liabilities: in tables = mortgages and fixed-term advances; in graphs: mortgages and securities; short-term = other forms of bank loan.

United Kingdom: Balance sheets of industrial and commercial company sector and personal sector, including unincorporated enterprises. Central Statistical Office, *The Blue Book* (National Accounts) and *Financial Statistics,* Tables 9.1j and 9.1l. In the tables, financial assets and liabilities exclude trade credit, accruals adjustments and miscellaneous instruments; in the graphs the unadjusted source totals are used, except for company liabilities, which exclude trade credit and shares = British company securities minus debenture and loan stock. Debt assets include, in the tables, deposits and claims on the public sector; in the graphs currency and, in the case of companies, deposits with building societies are omitted. Long-term debt, households = loans secured by dwellings, total; companies, debentures and loan stock issued (series supplied by CSO). Other debt of companies and (in the table) households includes bank credit other than for housing, finance leasing, other lending by financial institutions and by the public sector plus (table only) Bank of England issue department transactions in bills. In the graphs other household debt is consumer credit (*Financial Statistics*, Table 3.2b).

United States: Financial assets and liabilities: Federal Reserve Board, *Flow of Funds Accounts*. Households, including non-profit organisations (Ll00) and all non-financial business (L101) (Non-farm corporate business (L104) for certain graphs, as expressly indicated). Total assets and liabilities exclude trade credit. Debt assets = deposits and credit market instruments; debt liabilities = credit market instruments; long-term = bonds and mortgages. Enterprise shares on issue: corporate equities at market value plus (table only) household holdings of equity in unincorporated enterprises at book value. All series used from Flow of Funds tape.

Tangible assets: Federal Reserve Board, *Balance Sheets for the US Economy*, Total tangible assets at current cost (Tables B100 to 102, line 2). FOF tape.

II. FINANCIAL FLOWS FOR HOUSEHOLDS AND ENTERPRISES

1. Interest received and paid by households and enterprises

Australia: Interest paid and received by private corporate trading (non-financial) enterprises and households (including unincorporated enterprises), financial year ending in year for which the data is entered (from RBA answers to BIS questionnaire = national accounts) plus, in the case of household receipts, imputed interest on life and superannuation funds, Australian Bureau of Statistics, *National Accounts 1991-92,* Table 15, Household income (1992-93: BIS estimate).

Belgium: Interest received and paid by households (S70 + S80) and net payments by companies (S10 + S40 + S50) from BNB answer to BIS questionnaire (= National Statistical institute, National Accounts data) updated by BIS estimates, annual.

Canada: Interest, dividends and miscellaneous investment income received by households, Statistics Canada, *National Income and Expenditure Accounts*, quarterly estimates, Table 6, Sources of personal income, line 9; interest rates paid by households on consumer and mortgage credit, calculated and supplied by Bank of Canada (letter 28/2/94); non-financial business, Statistics Canada, *Quarterly Financial Statistics for Enterprises*, all non-financial enterprises, Table 5, interest and dividends received (D86262), and total interest on borrowings (D86264).

France: Interest rates received and paid by households and by companies and quasi-companies. INSEE, *Comptes Nationaux Trimestriels,* Compte de revenu, ensemble des ménages et sociétés et quasi-sociétés non-financières, intérêts effectifs et (household revenue only) int. sur contrats d'assurances (= Annual supplied in Banque de France answer to BIS questionnaire).

Germany: Interest received, persons, from Bundesbank answer to questionnaire; households, western Germany, interest and interest paid on consumer credit (Bundesbank answers to questionnaire and national accounts), plus interest paid on housing credit, estimated and supplied by Bundesbank (letter 2/9/93) - 1992: BIS estimate; interest paid by enterprises (Bundesbank answers to questionnaire and national accounts): interest received by production enterprises, western Germany, *Volkswirtschaftliche Gesamtrechnung*, Fachserie 18, Reihe 1.3, Table 3.3.1, interest, lines 67, 68, 69, 72 (includes some other entrepreneurial income).

Italy: Interest paid and received by households and non-financial enterprises, all from Bank of Italy answer to BIS questionnaire (Statistical Office, National Accounts data).

Japan: Households (including private unincorporated non-financial enterprises), interest income and consumer debt and other interest paid (Economic Planning Agency, *Annual Report on the National Accounts*, 1994, Table 3(1)II.5 (quarterly series), lines 13(1) and 2 (1+2); Non-financial incorporated enterprises, ibid. , T 1(2)II.1 (calendar years), lines 9(1) and 1(1).

Netherlands: Interest receipts and payments of households and non-financial enterprises, Central Bureau of Statistics, *National Accounts*, Table S 80.1 and S 10.1, code 2112 (rente).

Spain: Interest receipts and expenditure of households and non-financial enterprises, Bank of Spain answers to BIS questionnaire (= Bank of Spain, *Financial Accounts*, income account S70/80 and S10, item 6.1 plus, in the case of household receipts, item 6.4 (imputed interest on insurance contracts)).

Sweden: Household interest payments from Riksbank answer to BIS questionnaire (from national accounts), receipts: Statistiska Meddelanden, *Nationalräkenskaper*, Table 7.VI, Income and outlay account, line 3 (excludes dividends), non-financial enterprise interest payments, net: ibid., Table 7.I, line 12 (excludes dividends).

Switzerland: Households, interest received (excluding dividends) and interest paid on consumer debt (only), Federal Statistical Office, *Swiss National Accounts*, Table 4, Vermögenseinkommen der privaten Haushälte, lines (a) and (c).

United Kingdom: Total receipts and payments of interest and dividends by the personal sector and industrial and commercial companies, CSO, *Bluebook*, Table 3.8 (Annual data only) series GJDL, GJDK, XAGB and XAFZ. Corresponding unpublished quarterly data supplied by CSO (series excluding dividends are available for interest payments).

United States: Personal interest income, Dept. of Commerce, *Survey of Current Business*, National Income and Product Accounts, Table 2.1, line 14; interest paid by non-financial corporations and by persons on consumer and mortgage credit, calculated and supplied by Federal Reserve Board (letter 11/3/94).

Other series used: "Property and entrepreneurial income receipts and expenditure, interest", OECD National Accounts Volume II, Table 7, income and outlay account, lines 8 and 26 (OECD tape).

2. Enterprise operating surplus

For ***Australia***, gross operating surplus of private corporations (answer to questionnaire, annual); for ***Belgium***, disposable income for non-financial enterprises (answer to questionnaire updated by BIS estimates, annual); for ***Canada***, operating profit, Financial Statistics for Enterprises, Table 5, quarterly (Cansim/DRI); for ***France***, gross disposable income of corporate and quasi-corporate enterprises (answer to questionnaire, annual; BIS Data Bank, quarterly); for ***Spain***, gross operating surplus, Bank of Spain, Financial Accounts, operating accounts of non-financial enterprises, 1993 p. 116, annual; for the ***United Kingdom***, gross trading profits of companies and public corporations (BIS Data Bank, quarterly); for the ***United States***, US internal surplus of non-farm corporations (Flow of Funds tape, quarterly). For **other countries**, "Operating surplus, corporate and quasi-corporate enterprises", OECD National Accounts Volume II, Table 7, income and outlay account, line 1 (OECD tape).

3. Company internal financing, financial deficit and investment

Provisionally, for all countries from OECD National Accounts Volume II, Table 7, capital accumulation account. Internal financing = net saving and consumption of fixed capital, lines 1 and 2, external financing = net lending, line 18, and gross investment = increase in stocks, investment in fixed capital and purchases of land and intangible assets, net, lines 8 to 13 (OECD tape).

4. Share issues by non-financial companies

BIS Data Bank except ***Italy***, as from 1990: Bank of Italy CD-ROM, prior to 1990, as for ***Spain*** and ***Sweden***, from OECD Financial Accounts.

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The structure of credit to the non-government sector and the transmission mechanism of monetary policy: a cross-country comparison[1]

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Bank for International Settlements

I. INTRODUCTION

Credit has long been recognised as an important variable in the transmission mechanism of monetary policy. Admittedly, the attention given to it has varied markedly, not only over time and across countries, but also as between policy-makers and academic economists. It seems fair to say that central bankers, accustomed to tracing the effects of their actions through the financial system, have probably laid more emphasis on credit than academics, who are more used to thinking in terms of simple paradigms where credit may not even appear explicitly. Similarly, credit has traditionally been more prominent in policy discussions in several continental European countries than in some Anglo-Saxon ones, especially the United States, partly because of a less pervasive monetarist tradition and the active use of direct controls on lending in the implementation of policy. At the same time, these differences have tended to narrow in recent years: monetary authorities have abandoned direct controls; in the wake of the broader deregulation process, financial structures have moved closer together; under the impetus of new analytical tools, the economics profession has revalued the role of credit in the context of asymmetric information between providers and users of funds; and the balance-sheet adjustments following the pronounced asset price cycles of the 1980s and early 1990s in several countries, not least the United States, have led to concerns about a "credit crunch".

The aim of this paper is to provide a comparative overview of the structure of credit to the non-government sector in the fourteen countries covered by the project on the transmission mechanism. Several aspects of potential interest are considered: who provides the credit; who receives it; its currency composition; whether it takes the form of loans or securities; its maturity breakdown; the adjustability of the contractual interest rates charged; terms and conditions that may limit the suppliers' ability to control the amounts extended in the short term; and collateral. The main focus is on the amounts outstanding at the most recent comparable date available. Where possible, the situation in the early 1980s is also considered so as to identify any major changes over time.

An analysis of this kind can be of significant interest. On a priori grounds, there are good reasons for believing that the aforementioned aspects contribute to shaping the pattern of responses of spending decisions to monetary conditions. They affect the incidence of policy as between different sectors, such as households and businesses. They help to determine the relative significance of the channels of transmission, such as those operating through changes in the cash flow and balance-sheet positions of agents and those taking effect via changes in interest rates at the margin. They can affect the intensity of the response of private agents to a given policy impulse.

Indeed, several recent episodes have highlighted the relevance of these aspects of financial structure for the transmission of policy. The experience of those countries that have witnessed large credit/asset price cycles has hammered home the message that the conjunction of the overstretching of agents' balance sheets with falling asset prices and hence collateral values can blunt the effectiveness of cuts in policy rates. More generally, it has brought to light the significance of non-interest rate restrictions on the availability of credit. Similarly, the autumn 1992 ERM crisis

1 I would like to thank Philippe Hainaut and also Gerd Schnabel for invaluable statistical assistance.

uncovered hitherto largely unnoticed differences in the speed and intensity of the response of interest rates on new and, above all, existing debt contracts to short-run increases in policy rates geared to defending external parities. Together with differences in the health of the balance sheets of financial and non-financial agents, these implied a marked divergence in the ability of monetary authorities to sustain exchange rate commitments.

And yet, despite such compelling theoretical arguments and empirical evidence, we still know very little about international differences in financial structure impinging on the transmission mechanism. While a very useful step, the work done in the context of last year's BIS meeting of central bank economists could not cover all the relevant aspects systematically. Admittedly, the structure of credit to the non-government sector, while important, is but one element of the whole story. The findings of this study should therefore be considered in conjunction with the accompanying papers on the complete balance sheets of non-financial agents and on the responsiveness of lending rates to policy rates (Kneeshaw (1995) and Borio and Fritz (1995)).

This inquiry is largely based on the central banks' responses to the questionnaire on financial structure and on subsequent contacts. It also relies on BIS estimates based on other sources of information. Boxes in the text and Annex I contain information about the data used and the main assumptions underlying the figures in the tables. This should facilitate the assessment of the reliability of the estimates made as well as the identification of potential pitfalls and possible improvements.

The structure of the paper is straightforward. The first section provides an overview of the main arguments and findings. It is written so as to be relatively self-contained. In the second section the empirical findings relating to the various characteristics of credit are discussed sequentially in more detail. Each of them is preceded by conjectures about their potential relevance for the transmission mechanism.

II. OVERVIEW AND SUMMARY

Some of the main findings of this inquiry may be more easily summarised with the help of Table 1. The table highlights certain key characteristics of credit to the non-government sector. For any given characteristic, it assigns to each country a score ranging from 1 ("comparatively very low") to 4 ("comparatively very high");[2] details on the measures and percentage brackets are shown in Box 1. As a heuristic device, Anglo-Saxon countries are grouped together: one interesting question is the extent to which this popular classification can be useful in identifying similarities and differences across countries.

The distinction does seem to perform rather well in a number of respects. This is not so much true for the ratio of total credit to GDP:[3] Anglo-Saxon economies do all fall in the mid-range, but by implication other countries are either ranked above (notably Japan, Switzerland, Sweden and Germany) or below. It applies, however, to three ratios, all comparatively high in Anglo-Saxon countries, viz. the shares of credit to households, in the form of securities and granted by non-banks. The United Kingdom is the member of the group that fits least well, mainly because of the ambiguity in the definition of a "bank".[4] Similar definitional problems cloud the position of Sweden and Japan, otherwise more akin to that of countries in the non-Anglo-Saxon group.

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2 The terms "comparatively high/low" should be interpreted loosely. The ranges were not chosen so as to necessarily split the set of countries in the sample into two groupings of equal size.

3 Total credit is defined to exclude any direct credit from non-residents (unless in the form of securities) as well as trade credit and direct lending from the government sector.

4 It would have been true also for the share of securities in total credit (score = 2) had it not been for the very large recent upward revision. See below.

As regards changes over time, a preliminary inspection hardly reveals a tendency towards convergence with respect to the aforementioned characteristics. The ratio of total credit to GDP has tended to grow comparatively fast in both Anglo-Saxon and other high-ratio countries. The polarisation of the share of credit going to the household sector has, if anything, increased. The share of securities in total credit has tended to rise in Anglo-Saxon countries;[5] with the exception of Japan, France and Germany, little growth can be detected elsewhere. That of "banks" has either remained broadly stable or fallen in the Anglo-Saxon group, and has risen or changed little in a majority of other countries; a sharp increase, though, can be observed in Australia, partly as a result of changes in the legal status of certain institutions.

The findings concerning convergence, in particular, should be treated with caution. The use of estimates at only two points in time may be misleading, not least because of the different cyclical positions of the economies. Similarly, comparing stock figures at ten-year intervals tends to understate the impact of more recent changes, which would be reflected primarily in flows. Nevertheless, the findings do suggest that convergence has primarily occurred in other dimensions. One example is the development of commercial paper markets, generally of older vintage in Anglo-Saxon countries[6] and opened mainly in the second half of the 1980s elsewhere. Not only have they come to represent in several cases a considerable proportion of total securities outstanding and a significant factor contributing to competitive pressures in the banking sector; their structure and organisation, while retaining many country-specific features, have come to resemble more closely those of seasoned markets. More generally and importantly, the main aspect in which financial systems have converged is the relaxation of direct controls and constraints on the balance sheets of financial institutions. This dimension, of great significance for the transmission of monetary policy, cannot be captured by the above statistics.

In fact, from the perspective of the transmission mechanism, most of the above findings, taken in isolation, are of only moderate significance. The comparatively high share of credit to households in Anglo-Saxon and a few other countries suggests that the analysis of the impact of monetary policy should pay particular attention to this sector. At least for the Anglo-Saxon countries, this conclusion is reinforced by considering household sector debt in relation to income and assets (Kneeshaw (1995)). A high share of disintermediated finance indicates that the relative characteristics of the supply of credit are likely to play a significant role. Although precise generalisations are difficult, on balance in securities markets interest rates typically adjust faster and investors are less willing to temporarily insulate borrowers from adverse changes in economic conditions.

Of more immediate interest is the maturity breakdown and, complementary to it, the degree of adjustability of interest rates on debt contracts. For present purposes, "variable" or "adjustable" rate debt has been defined to comprise debt on which interest rates are reviewable within one year (including, therefore, all short-term credit) *and* move primarily in relation to short-term rates. The second criterion is important because in a number of countries rates may be adjustable at any time or at short intervals but, mainly because of the sources of financing of institutions, they tend to behave more like long-term rates. This is the case, for example, in Switzerland, Spain, Japan and, to a lesser extent, Germany, especially in the mortgage market. On a priori grounds, one would expect that, the larger the share of variable rate financing, the stronger will be the cash-flow and income effects associated with monetary impulses. Moreover, as highlighted by the ERM crisis of 1992, the widespread use of variable rate financing can complicate the pursuit of exchange rate targets in the short run: it can speed up and amplify the transmission of higher short-term rates geared to defending the external value of the currency, a rather uncomfortable situation, especially in the presence of weaknesses in the balance sheets of both non-financial and financial sectors.

The available estimates are still rather tentative, at least with regard to adjustable rate financing. They suggest that the basic criterion chosen for classifying countries performs rather well

5 The short sample period makes it difficult to compare Australia, where it has fallen, with the rest.

6 The United Kingdom is the exception; the market opened there in 1987.

Table 1

Summary of findings[1]

(scores on cardinal scale)

	AU	CA	UK	US	AT	BE	FR	DE	IT	JP	NL	ES	SE	CH
Total credit	2	2	3	3	1	1	1	3	1	4	3	1	4	4
Credit to households[2]	3	4	4	4	2	3	2	2	1	1	3	2	2	3
Securitised credit	3	4	4	4	1	2	3	2	1	2	1	2	1	1
Non-bank credit	3	4	4/2[3]	4	1	1	3/2[4]	1	1	4	2	1	4	2
OFI loans	4	4	4/1[3]	4	1	1	3/1[4]	1	1	4	3	1	4	2
Short-term credit	4	1	3	1	2	2	1	1	4	3	1	4	2	2
Adjustable rate credit[5]......................	4	3	4	1	1	2	2	1	4	1	1	2	1	1
households	4	3	4	2	..	1	1	2	2-3	1	1	..[6]	..	2
businesses	2	4	3	1	..	4	4	2	4	2	2	..[6]	..	1
Real estate collateral[7]	2	4	4	4	2	2	3	2	2	..	2	2	4	4
Credit lines[7]	2	2	1	2	4	1	1	1-2	3	1	2	2	..	2
Foreign currency credit[7]	1-2	3	1-2	..	1	2	1	1	4	2	1	1	3	1

[1] Scores on a cardinal scale ranging from 1 ("comparatively very low") to 4 ("comparatively very high"). The key shares together with the corresponding ranges are shown in Box 1. [2] Narrowly defined; where not available, based on likely size of the unincorporated sector. [3] Excluding/including building societies from/in the definition of banks. [4] Excluding/including specialised financial institutions from/in the definition of banks. [5] Related to short-term rates. [6] Probably similar to France and Belgium. [7] Where no precise figures are available, the classification is only approximate.

Box 1: Background information to Table 1*

Total credit:	measure: ranges:	percentage of GDP. ≤ 90; 91-110; 111-130; > 130.
Credit to households:	measure: ranges:	share of credit to households (narrowly defined) in total credit. ≤ 25; 26-40; 41-50; > 50.
Securitised credit:	measure: ranges:	share of securities in total credit. ≤ 5; 6-10; 11-15; > 15.
Non-bank credit:	measure: ranges:	share of OFI loans plus securities in total credit. ≤ 20; 21-34; 35-49; > 49.
OFI loans:	measure: ranges:	share of OFI loans in total loans. ≤ 15; 16-25; 26-35; > 35.
Short-term credit:	measure: ranges:	share of short-term credit in total credit. ≤ 20; 21-29; 30-39; > 39.
Adjustable rate credit:	measure: ranges:	share of adjustable rate credit related to short-term rates (up to and including one-year maturity) in total credit. ≤ 40; 41-50; 51-60; > 60.
Households:	measure: ranges:	share of that type of credit in total credit to households. ≤ 20; 21-40; 41-60; > 60.
Businesses:	measure: ranges:	share of that type of credit in total credit to businesses. ≤ 35; 36-45; 46-55; > 55.
Real estate collateral:	measure: ranges:	share of loans backed by real estate collateral in total lending. ≤ 30; 31-40; 41-50; > 50.
Credit lines:	measure: ranges:	share of credit line financing in total lending. ≤ 10; 11-19; 20-29; > 29.
Foreign currency credit:	measure: ranges:	share of foreign currency financing in total credit. ≤ 6; 7-9; 10-12; > 12.

* The ranges have partly been chosen with a view to avoiding bunching around thresholds.

in this case too, although subject to important qualifications. Anglo-Saxon countries appear on average to exhibit comparatively high shares of short-term and variable rate credit. This is especially true for households. Indeed, in sharp contrast to most other countries, in all of them the share of household credit at variable rates appears to be at least roughly as high as that of the business sector, and considerably higher in the United Kingdom and Canada. The specificities of housing finance and the comparatively high share of fixed rate long-term securities are primarily responsible for this result.

A major exception to the aforementioned pattern is the United States. In terms of the share of both short-term and adjustable rate financing the country ranks very low, its characteristics apparently being considerably closer to those of, say, Germany and Switzerland. One important qualification is the ease with which agents can switch between variable and fixed rate debt. In contrast to most other countries, the *marginal* cost of switching is very low. Although agents may and often do pay up front for this flexibility, no pecuniary penalties attach to the early repayment of much of the debt at the time of the switch. This is true at least in the mortgage sector and for a sizable fraction of corporate bond financing, which is usually in the form of callable securities. The evidence indicates that early repayment is indeed quite common. A second qualification is that the use of off-balance-sheet instruments, notably swaps, for the management of interest rate risk exposures appears to be considerably more widespread than elsewhere. The quantitative significance of this factor, however, is much harder to assess.

Among non-Anglo-Saxon countries, one significant exception to the general pattern is Italy: its financial system exhibits the highest share of variable rate credit, possibly as high as around three-quarters. Admittedly, the definition of short-term credit for Italy extends to eighteen months. But the main reasons for this finding appear to be the exceptionally high share of current account, reviewable rate credit from banks and the size of the adjustable rate sector in the mortgage market.

Information on changes in the share of variable rate financing over time is extremely limited. Countries were able to provide estimates only for the present situation, and even then only very rough ones. Better data are available, however, on the maturity breakdown, a key element for calculating total adjustable rate debt. The share of short-term credit appears to have remained remarkably stable compared with the early 1980s, generally falling only slightly, by around 2-5 percentage points. The only two countries where a marked fall has been observed are Sweden and the United Kingdom; even so, this fall may be overstated by the assumptions underlying the breakdown. Far less is known about the evolution of the share of medium and long-term debt at adjustable rates. There are some indications that it has risen in certain segments, notably in the mortgage sector in those countries where variable rate lending was introduced only during the 1980s, typically as a result of deregulation. Sweden and Belgium are two such examples. By contrast, it appears to have fallen in the same sector in other countries, especially the United Kingdom and the United States. These few pointers, taken in isolation, would suggest a certain degree of convergence. They are not, however, sufficient to form an overall view of developments.

Interest rates, the "price" of credit, are but one, albeit the most important, factor influencing the response of agents to changing supply and demand conditions. A second dimension concerns those elements that affect, broadly speaking, the "availability" of credit. Collateral is one of them. A second is rationing, i.e. the refusal to grant as much credit as is demanded on the observed interest and non-interest terms.

Changes in the value of collateral can affect the availability of credit for two reasons. Ex ante, they change the expected pay-off to lenders in the event that the borrower defaults. Ex post, they affect lenders' actual loss experience, influencing the terms on which they can in turn obtain funds and their perceptions of risk. The positive relationship between the value of collateral and credit availability can generate a self-reinforcing process, in both the upward and downward direction. Clear signs of this process were evident in several countries during the 1980s and early 1990s, especially in some Anglo-Saxon and Nordic countries and also in Japan: asset prices, notably real estate prices, went through a boom-bust cycle; easy access to credit gave way to concerns about a potential credit crunch. Ample credit availability was due in no small measure to structural developments, namely deregulation and heightening competitive pressures. But at least in those countries experiencing the largest asset price movements, it was also connected in part with comparatively easy monetary conditions. In general, the collateral channel would tend to reinforce monetary impulses: a tightening/easing of policy would be associated with downward/upward pressure on the value of collateral. The quantitative significance of this channel increases with the sensitivity of collateral values to interest rates and with the use of collateral in debt contracts.

Information on collateral is very limited. Fortunately, some data are available for the real estate component, a key one in the present context. Barring definitional problems, the evidence suggests that even here the distinction between Anglo-Saxon and other countries performs rather well. More importantly, it points to a considerable overlap between the set of countries where the interaction between asset prices and credit has been most pronounced and those where the share of real estate collateralised loans is highest or has risen most sharply. Three out of the four Anglo-Saxon countries exhibit comparatively high shares of total loans backed by real estate collateral; Australia appears to be an exception, being broadly in line with the rest. Outside this group, the share is very high in Switzerland and Sweden. No precise figures are available for Japan, but there are indications that the country may rank relatively high. Data for the early 1980s suggest that these countries and Australia are also the ones that have experienced the largest increase in the share over time,[7] whereas it has mostly remained broadly stable or fallen elsewhere. On the whole, the evidence lends some support to the view that the interaction between credit availability and collateral may have had a significant role in the aforementioned developments during the recent business cycle.

Direct evidence on rationing is difficult to obtain. Regulation-induced rationing is not likely to play a significant role nowadays given the general relaxation of restrictions on credit institutions' balance sheets and interest rates. It is most likely to have survived in the housing sector in some countries; even so, the general expansion of an unconstrained finance segment limits further its macroeconomic relevance. On the other hand, rationing may also arise in the absence of regulation. Rather than attempting to identify where it applies, this survey has less ambitiously looked for indicators of its absence.

Credit extended under standing facilities, giving borrowers discretion over the timing of drawdowns, is one easily observable, albeit imperfect, example. This information is also one element that may help to explain differences in the timing of the response of credit to monetary policy impulses. Available evidence indicates that in this area the basic criterion for country classification appears to be of little use: it is not possible to detect systematic differences in the share of credit drawn under standing facilities in the two groups. The share is exceptionally high in Austria. It is also quite high in Italy, where as much as half of total lending by short-term credit banks falls within this category. Somewhat surprisingly, it appears to be quite low in the United Kingdom, once known as an "overdraft economy". The rapidly rising share of housing credits is part of the explanation. It has not as yet been possible to establish the extent to which issues of definition or coverage may also be responsible.

Explicit consideration of the currency composition of credit discloses an additional dimension of the transmission mechanism. Changes in domestic interest rates do not have a *direct* effect on the part of the indebtedness of residents denominated in foreign currency, which depends on foreign monetary conditions. On the other hand, the relevance of the exchange rate in the transmission mechanism is heightened, through its effect on the domestic currency value of outstanding debt. Proper assessment of the significance of this channel would call for a consideration of both assets and liabilities together with on and off-balance-sheet exposures. The data collected here look at only one, though important, side of the story but exclude credit received directly from non-residents unless it is in the form of securities (where available). Here again, the basic criterion for classifying countries is of little help. Foreign currency denominated credit is typically of the order of 5% or less of total credit in most countries. It is considerably higher only in Italy and, to a lesser extent, Sweden and Canada.

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7 The exception is Switzerland, where the share has remained broadly stable.

Turning next to more general conclusions, this inquiry has revealed a significant gap in existing information about the characteristics of debt contracts. Some of these characteristics, such as the degree of adjustability of interest rates, are probably at the heart of the transmission mechanism of monetary policy. No doubt some improvements in the estimates presented under the various headings can be made relatively easily; others will most likely remain beyond reach. This has two implications. For the narrow purposes of this study, it complicates an assessment of the margin of error surrounding the findings, especially as regards international comparisons. From a longer-term perspective, it raises the question of whether some effort on the part of central banks to upgrade information in this area may not be justified.

The study makes little attempt to *explain* the reasons for the specific configuration of debt contracts observed. An understanding of what lies behind them would clearly be of interest. It would cast light on the extent to which certain characteristics are likely to persist over time as well as on their probable future evolution. Above all, it would help to identify the extent to which certain features are, directly or indirectly, shaped by the course of monetary policy itself, most notably the average maturity and degree of interest rate variability of debt contracts. This may not matter so much in the short run. It is, however, of considerable relevance in the long run to the extent that the monetary authorities have some preference for one type of system over another.

III. CREDIT CHARACTERISTICS: WHAT THEY ARE AND WHY THEY MATTER

1. Total credit to the non-government sector

The basic credit aggregate examined in this study covers the credit obtained by domestic households and businesses from domestic financial institutions plus any securities outstanding (not held by those institutions). It thus generally excludes trade credit and loans from abroad and from the government.[8] For simplicity, it will be henceforth be referred to as "total credit to the non-government sector" or "total credit" for short.

The ratio of total credit to the non-government sector to GDP typically ranges from around 80% to 130% in the countries considered (Table 2). It is by far the highest in Japan, at around 200%, and the lowest in Italy, at less than 70%. The ratio is also comparatively high in Switzerland, Sweden and Germany; in Anglo-Saxon countries it is somewhat higher than in several continental European economies.

Generally speaking, the countries with relatively higher ratios and in the Anglo-Saxon group have experienced the faster increases during the past decade.[9,10] The United States does not seem to fit this pattern clearly; the size of the rise, however, is somewhat underestimated, as by end-1993 a considerable downward adjustment in indebtedness had already taken place.

8 In some cases the aggregate may not fully meet these criteria. The discrepancies would in any case be small. For the treatment of public sector enterprises, see Table 3. The accompanying paper on balance sheets uses a more comprehensive definition of credit and debt.

9 Unfortunately, the figures for Australia cannot illustrate the increase as the earliest observation relates to 1988.

10 The large increase in Germany is partly due to reunification.

Table 2

Credit to the non-government sector[1]

(as a percentage of GDP)

	1993[2]	1983[3]		1993[2]	1983[3]
Australia	98	102	Japan	202	158
Austria	88	73	Netherlands	115	93
Belgium	86	77	Spain	79	80
Canada	108	87	Sweden	143	94
France	90	71	Switzerland[4]	179	139[5]
Germany	125	97	United Kingdom ...	117	58
Italy	64	57	United States	114	96

[1] Loans from banks and other financial institutions as well as securities outstanding; excluding trade credit. [2] Sweden and Switzerland: 1992. [3] Australia: 1988; Belgium and Sweden: 1982; Italy: 1989. [4] Pension fund and life assurance company loans partly estimated. [5] Excluding securities.

2. Breakdown by recipients: households and businesses

The breakdown of total credit into the amounts received by households and businesses may help to cast light on the relative incidence of monetary policy on the two sectors. Both the level and, above all, the structure of indebtedness of the two categories of borrower are generally quite different, not least in terms of contract characteristics such as maturity, adjustability of interest rates, marketability of the claims, collateral and control over the timing and size of disbursements.[11] Several factors underlie such differences: the use of the funds (primarily housing expenditure and consumer credit for households vs. short-term and long-term capital needs for businesses), the size of the borrowing units, the sources of repayment, the information available about reimbursement capabilities, the ease of access to alternative funding sources, the sophistication of cash-flow management and targeted government policy in the pursuit of economic and social objectives. The differences in contract terms can affect the responsiveness of spending decisions to changes in monetary conditions as well as the specific channels of transmission.[12] Housing expenditure, for instance, is typically a component of aggregate demand found to be comparatively sensitive to interest rate changes; mortgage debt accounts for the bulk of credit to the household sector in all countries.

A breakdown of credit between households and businesses is available for all countries. International comparisons, however, should take into account the lack of uniformity in the definition of the sectors. The main problem relates to the treatment of unincorporated businesses (Table 3). Owing to lack of information, in seven countries (Australia, Belgium, Japan, Spain, Sweden,[13] Switzerland and the United Kingdom) this sector is considered together with households; only in some of these cases are some very rough estimates as to its size possible.[14] For five other countries

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11 What follows focuses exclusively on the characteristics of contract terms. Other factors are of course relevant to the assessment of the responsiveness of the two sectors to monetary policy impulses. Gearing ratios and the assets side of balance sheets are considered in Kneeshaw (1995).

12 A rapidly expanding literature on the relevance of liquidity constraints to expenditure and production decisions, for instance, is beginning to document these.

13 For Sweden, separate data appear to exist at least for loans granted.

14 Obtained residually by estimating credit to the household sector narrowly defined. The sector comprising households narrowly defined and unincorporated businesses is sometimes referred to as the "personal" sector.

Table 3

Treatment of unincorporated and public sector enterprises

	Unincorporated businesses			Public sector enterprises
	Sectorisation[1]	Official statistics[2]	Estimate	Inclusion
Australia	H			*
Austria	B	5		*
Belgium	H			*
Canada	B[3]		*	*
France	H	*		*
Germany	H[4]	5	*	*
Italy	H	*		*
Japan	H		*	
Netherlands	B			*
Spain	H		*	*
Sweden	H	5		*
Switzerland	B/H			*
United Kingdom	H		*	
United States	B	*		

H = households; B = business; * = yes.

[1] Standard official sectorisation. In some countries where the sector is mainly included under households, units of sufficient size are included in the business sector. [2] Indicates the availability of official estimates at least for the amount of credit received by the sector; the precise statistical definition of the sector appears to differ across countries. [3] Answers to the questionnaire; included with households in the flow of funds. [4] Answers to the questionnaire. [5] Banking statistics only.

(Canada, France, Italy, the United States and, recently, Germany),[15] separate estimates for credit to the unincorporated business sector are available, even though precise definitions or criteria for classification appear to differ[16] and there may be comparatively limited data about credit terms. The narrow definition of the household sector is used in Austria and the Netherlands. In Switzerland small unincorporated units are likely to be included at least in part in the household sector.[17]

The unincorporated sector will generally include a wide spectrum of borrowers, ranging from self-employed individuals to possibly comparatively sizable business units.[18] Given the heterogeneity of the grouping, the terms on which credit is obtained will differ considerably, in some cases being relatively close to households regarded as consumer units, in others to those of larger production units. In order to facilitate comparisons, in the following paragraphs separate figures for alternative definitions of the household and business sectors will be provided whenever possible.

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15 Strictly speaking, in Germany this is so only for the banking statistics; their coverage, however, is very broad.

16 For example, at least in the case of Italy sole proprietorships and partnerships without an independent identity would be grouped with the business sector if larger than a threshold size (twenty employees). This may be typical of several continental European countries. The US classification does not appear to make any such distinction, an approach that seems common in Anglo-Saxon countries. The reason may be that comparatively large unincorporated businesses are rare.

17 The criterion is whether the personal and business accounts are kept separate or not.

18 Moreover, the size and composition of this sector will vary significantly across countries depending on the structure of production, legal, regulatory and tax factors impinging on the decision to incorporate, the precise statistical criteria adopted and the accuracy of reporting systems.

The available information indicates that, narrowly defined ("consumers"), the household sector accounts for less than half of total credit outstanding in almost all countries (Table 4). The main exceptions are the United Kingdom (well over 50%), the United States and Canada (not much over 50%).[19] At the other end of the spectrum, the share of credit to the household sector is lowest in Italy and Japan, the two countries with the highest saving ratios, in the region of 15%. On average, the share appears to be higher in Anglo-Saxon countries than elsewhere.

The amount of credit absorbed by the unincorporated sector varies considerably across countries. It ranges from less than 10% in the United Kingdom, France and, probably, Sweden to almost 20% in the United States.

A second source of lack of uniformity in the breakdown of credit between households and businesses arises from the treatment of public sector enterprises. The available information appears to indicate that they are included in the business sector in most countries (Table 3); the United Kingdom and Japan are two notable exceptions. Given the share of credit absorbed by these companies, the main impact is likely to be on the relative size of the stock of debt securities outstanding (see below).

As regards movements over time in the share of the various sectors, credit to households appears to have grown faster than that to the business sector in a majority of countries. Its share has tended to rise in those belonging to the Anglo-Saxon group; no clear pattern emerges elsewhere. The increase has been especially pronounced in Australia (broad definition).[20] By contrast, marked declines have taken place only in Germany and Sweden. A sharp fall in the share of credit to the unincorporated sector is apparent in the United States.

3. Breakdown by suppliers: credit intermediaries versus markets

A stylised distinction is often made between credit provided through credit intermediaries, such as banks and other financial institutions, and through the money and capital markets. This distinction would be of no relevance to the transmission mechanism if borrowers were indifferent between the two sources of funds. Several factors, however, limit the substitutability between them. Some of these are of a legal and regulatory nature. For example, at least until recently, several countries have tended to impose restrictions on the development of firms' access to money and capital market financing. One reason is that it was felt that their expansion could either undermine the "effectiveness" of monetary policy, especially if exercised through direct controls on credit intermediaries, or interfere with credit allocation objectives.[21] Other factors are of a more fundamental character. In particular, the greater the need for ex ante screening and ex post monitoring on the part of the lender because of the nature of the borrower or the use of the funds, the greater is the likelihood that the finance will be provided by a credit intermediary and take the form of a non-marketable loan rather than tradable security. The main reason is that it is difficult credibly to transfer the information on which the transaction is based to other potential lenders, which limits the marketability and liquidity of the claim.

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19 The very high Swiss figure may in part reflect the extensive use of housing credit at relatively attractive amortisation conditions: capital is never repaid while the borrower retains the benefits of the capital gain. Nevertheless, in relation to household income, indebtedness remains suspiciously high. See Kneeshaw (1995).

20 It also appears to have been very large in Spain (narrow definition), but the underlying estimates are very rough.

21 The former argument applies mainly to the development of money markets such as the commercial paper market, and the latter to that of longer-term capital markets.

Table 4

Breakdown by recipients: households and businesses

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993													
Households[1] …………	53	32	48	52	38	53	29	28	43	41	37	51[2]	59	53
Consumers …………	..	32	..	52	29	38	16	16[2]	43	31[2]	..	51[2]	54[2]	53
Unincorporated ….	..	–	..	–	9	15[2]	13	12[2]	–	10[2]	..[3]	..	5[2]	–
Businesses ……………	47	68	52	48	62	47	71	72	57	59	63	49[2]	41	47
Unincorporated ….	–	..	–	10	–	–	–	–	..	–	–	..	–	18
Total …………………	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
	1983													
Households ……………	42	27	40	44	41	60	30	23	44	32	49	56[2]	65	48
Consumers …………	..	27	..	44	..	47	..	13	44	15[2]	..	56[2]	54[2]	48
Unincorporated ….	..	–	..	–	..	13[2]	..	10	–	17[2]	..	–	11[2]	–
Businesses ……………	58	73	60	56	59	40	70	77	56	68	51	44[2]	35	52
Unincorporated ….	–	..	–	13	–	–	–	–	..	–	–	..	–	26
Total …………………	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

– = not applicable (given definition used in reply to the questionnaire); .. = not available.

[1] Generally including non-profit-making institutions. [2] Estimate. [3] Some 7% of bank lending to households and businesses.

Given these possible limitations on substitutability, regardless of their origin, supply conditions impinging on the provision of the two basic forms of finance cannot be disregarded. And to the extent that monetary policy instruments have a differential impact on the two, they will also be of relevance to the transmission mechanism. For example, ceteris paribus, the poor state of banks' balance sheets in the United States is widely believed to have blunted the expansionary impact of cuts in policy rates; but the problem would presumably have been more severe in the absence of well-developed securities markets, through which other, less constrained lenders could directly meet the higher demand for funds.

It is not straightforward to make propositions of general validity regarding the relationship between the degree of development of disintermediated finance across countries and the likely strength of the response of the economy to monetary policy impulses. Much will depend on the factors explaining the comparative size of the markets in specific cases. Nevertheless, on balance, compared with loan ("customer") markets, in securities ("auction") markets interest rates typically adjust faster[22] and investors are less willing to temporarily insulate borrowers from adverse changes in economic conditions. This is especially so when loan markets are characterised by close relationships between lenders and borrowers.

Confirming widely held views, the available data indicate that securities generally make up a larger share of overall credit in Anglo-Saxon countries than elsewhere (Table 5). The quantitative significance of securities is highest in the United States and, surprisingly, the United Kingdom,[23] where they account for close to one-fifth of overall credit.[24] It is lowest in Austria, where less than 2% of overall credit takes this form. In addition, the above statistics probably underestimate the gap between the two groups of countries, since in several non-Anglo-Saxon economies the main issuers tend to be public sector enterprises, whose behaviour is likely to be less responsive to economic incentives and constraints.

As regards changes over time, the picture is mixed. In some countries there has been a considerable rise in the share of securities, most notably in the United Kingdom, Japan, France, Germany and the United States. Elsewhere, the share has mostly remained broadly unchanged or has even declined. At this level of aggregation at least, the figures suggest that often-heard claims of a pronounced *generalised* trend towards disintermediation of credit institutions do not appear to be justified.[25] They also fail to identify any marked tendency towards convergence between Anglo-Saxon and other countries.

Certain caveats should be borne in mind when interpreting the above data. There is a grey area surrounding the stylised distinction between intermediated credit/loans, on the one hand, and market financing/securities, on the other. This in some instances affects the comparability of national statistics and may have a bearing on the transmission mechanism more generally. Two significant examples relate, respectively, to the long and short-term ends of the maturity spectrum.

The markets for *private placements of long-term securities* represent a half-way house between those for public offerings and for loans: in general, there is less publicly available information about would-be borrowers than in public markets, independent screening is more important and the securities are far less liquid. Whether the markets behave more like those for loans or securities is an empirical question; the answer will depend, inter alia, on the legal and regulatory environment supporting the development of the markets, the types of investor involved and broader institutional factors. In national statistics, in fact, these markets are not treated uniformly. In the

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22 On these issues, see Borio and Fritz (1995).

23 In the United Kingdom, this results from a recent sizable upward revision in total securities, accompanied by a more moderate downward revision in bank lending. Before the revision, the share of securities was less than 10%.

24 Securitised mortgages are not included in the above figures.

25 The picture may of course be somewhat different if specific sub-sectors, maturity brackets or periods are considered.

Table 5

Breakdown by instruments: loans and securities[1]

(in percentages of total)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]													
Loans	88	98	93	83	85	94	95	90	97	91	96	95	81	80
Securities	12[3]	2	7	17	15	6	5	10	3	9	4	5	19	20
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
	1983[4]													
Loans	84	97	88	83	92	98	93	96	96	90	95	..	97	83
Securities	16	3	12	17	8	2	7	4	4	10	5	..	3	17
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	..	**100**	**100**

[1] Excluding trade credit. [2] Sweden and Switzerland: 1992. [3] Including short-term securities (bank bills) held by OFIs (17%); including also those held by banks (21%). [4] Italy: 1989; Australia: 1988; Belgium and Sweden: 1982.

Table 6

Backup liquidity and credit support for commercial paper

	AU	BE	CA	FR	DE	JP	NL	ES	SE	UK	US	FI	NO	ECP
Formal liquidity backup	*	*	*	*	*	*	*		*	*	*		*	*
% issues/outstanding	high	very small	high	some	small	small	very small		small	some	very high		small	sizeable
% coverage (typical)	high	low	high	variable	variable	low	low		low	variable	very high		high	variable
Formal credit enhancement	*	*	*	*	*		*		*	*	*	*	*[1]	*
Parent guarantee[2]	*	*	*	*	*		*		*	*	*	*	*[3]	*
Letter of credit/bank guarantee	*										*[4]	*	[1]	*
% issues/outstanding.......	sizeable	sizeable	some	small	some		some		some	very small	15[5]	very small	some	sizeable

FI = Finland; NO = Norway; ECP = Euro-commercial paper market.

[1] Financial institutions are not allowed to issue backup guarantees for certificates. [2] Including government guarantees for public sector issuers, where applicable. [3] Issues by certain specialised long-term credit institutions ("State banks") are government-guaranteed. [4] Including indemnity bonds issued by insurance companies. At mid-1992 some 6% of commercial paper outstanding was 100% backed by third-party credit enhancements. [5] As a percentage of commercial paper outstanding, mid-1990.

Source: Alworth and Borio (1993).

United States, and probably most other countries, the private placement market is included under securities; in the United States it accounts for around one-fifth of the amounts outstanding. In certain continental European countries with a universal banking tradition, where these markets are quite large and may dwarf public offerings, such as Germany, Switzerland, the Netherlands and Austria, they are classified as loans. In contrast to the United States, in these countries banks are also active investors, which partly explains the choice of classification.

Several markets for *short-term securities* rely at least in part for their existence on the ability of traditional credit intermediaries to extend credit. This is even true of commercial paper markets, which in most countries account for the bulk of short-term securities issued by non-financial companies (Table 6). The support typically consists of bank backup liquidity lines but may also include bank credit guarantees, both more or less formal depending on country-specific factors.[26] Under these conditions, whatever affects the supply of such backups will also have an impact on the terms on which borrowers can obtain funds through short-term securities; a certain degree of complementarity between the two sources of funds is introduced. More generally, just as with long-term debt, the line between securities and loans may be a fine one indeed and create some ambiguities in the classification. For example, in Canada bankers' acceptances, because of their specific characteristics, are essentially indistinguishable from commercial paper backed by bank standby letters of credit but are grouped with loans if held in the portfolio of the bank issuing the guarantee. In Australia an essentially similar instrument, which accounts for the bulk of short-term securities, is also classified as a loan whenever it is held in the portfolio of a financial institution on the reasoning that it performs an analogous function.

4. Breakdown by suppliers: banks versus other intermediaries

As regards the implications of the structure of credit for the transmission mechanism, it is not clear whether the distinction between banks and other financial intermediaries is of much interest. Conceptually, the specificity of "banks" has traditionally been regarded as deriving mainly from the liabilities side of the balance sheet, i.e. their ability to issue means of payment or short-term deposits. By contrast, the characteristics of credit contracts that may be relevant are captured only to a limited and varying extent by the dividing line between banks and other institutions. This is true, for example, for maturity, the adjustability of interest rates, the degree of reliance on private information and the illiquidity of the instruments. Nor can the incidence of direct controls be regarded any longer as a significant discriminating factor. And with the broader process of financial liberalisation, legal and regulatory differences between several types of loan-granting institution have been eroded, although long-standing distinctions are still easily traceable in the composition of their balance sheets, especially for those involved in the housing credit market. In fact, probably the main reason why the bank/non-bank division is of interest from the present perspective is essentially practical: the authorities often have more detailed information about whatever institutions they define as "banks", not least because of the special attention paid to them is the context of prudential regulation and supervision.

These ambiguities are clearly reflected in Table 7, which reports the breakdown of total loans between banks and other institutions found in the replies to the questionnaire. In countries with a long-standing universal banking tradition (Germany, Switzerland, Austria and the Netherlands), or in those that have recently enacted the EC legislation setting out the contours of the single market in financial services, "banks" account for the bulk of lending; the main institutions excluded are either

26 Formal backup is especially significant in the United States and the Euro-markets; elsewhere, particularly in Europe, less formal arrangements are more common but have been growing as markets become better established and ratings spread. The strength of the support, however, does not necessarily depend on how formal it is: informal mechanisms may in fact provide substantial protection in the presence of strong relationships between banks and borrowers.

Table 7

Loans from banks and other financial intermediaries

	Panel A - as % of total loans				Panel B - as % of total credit			
	1993[1]		1983[2]		1993[1]		1983[2]	
	Banks	OFIs	Banks	OFIs	Banks	OFIs	Banks	OFIs
AU	65	35	48	52	57	31	41	43
AT	99	1	97	3	97	1	94	3
BE	90	10	84	16	84	10	74	14
CA	60	40	58	42	50	33	49	35
FR	74/85[3]	26/15[3]	70/88[3]	30/12[3]	63/72[3]	22/13[3]	64/80[3]	27/11[3]
DE	89	11	84	16	84	10	82	16
IT	89	11	89	11	85	10	83	10
JP	54	46	45	55	49	42	44	53
NL	73	27	66	34	71	26	64	32
ES	91	9	98	2	82	8	88	2
SE	39	61	57	43	37	58	54	41
CH	81	19	81	19	77	18	81	19
UK	56/92[4]	44/8[4]	56/95[4]	44/5[4]	45/75[4]	36/6[4]	54/93[4]	43/5[4]
US	50	50	66	34	40	40	54	28

[1] Sweden and Switzerland: 1992. [2] Australia: 1988; Belgium and Sweden: 1982; Italy: 1989. [3] If specialised credit institutions are classified as banks. [4] If building societies are classified as banks.

Table 8

Sectorisation of loan-granting financial institutions

	Commercial banks	Savings banks/ building societies	Credit coop./ unions	Specialised medium and long-term lenders[1]	Other credit institutions[2]	Life assurance/ pension funds
AU	B	O	O	–	O	O
AT	B	B	B	B	B	O
BE	B	B	B	B	B	O
CA	B	–	O[3]	O	O	O
FR	B	B	B	O	O	O
DE	B	B/O[4]	B	B	B	O
IT	B	B	B	B[5]	O	O
JP[6]	B[7]	–	O	B[8]/O	O	O
NL	B	B	B	–	B	O
ES	B	B	B	B	O	O
SE	B	B	B	O	O	O
CH	B	B	B	B	..	O
UK	B	O	–	–	O	O
US	B	B	B	–	O	O

B = banks; O = other financial intermediaries.

[1] Mainly including institutions that have historically belonged to the public sector or with special status. [2] Including private specialised lenders (e.g. mortgage and finance companies) and, where appropriate, securities firms. [3] Including Caisses populaires. [4] Bausparkassen. [5] Special credit institutions ("long-term banks"). [6] The definitions change considerably from table to table. [7] Including trust banks. [8] Long-term credit banks.

certain specialised lenders (e.g. "Bausparkassen" in Germany), life assurance companies and pension funds. These are particularly important in Switzerland, where they account for one-fifth of total credit. In the Anglo-Saxon countries, Japan and Sweden the banks' share is considerably smaller, but even then there is a degree of arbitrariness in the classification, as indicated by the list of institutions included (Table 8). In the case of the United Kingdom, for example, the share would be not much different from that in continental European countries if building societies were classified as "banks".

5. Breakdown by maturity: short-term versus medium and long-term

The term to maturity is one of the key characteristics of a debt contract. Ceteris paribus, the shorter the maturity of an instrument, the greater is the scope for lenders and borrowers to alter the terms on which they transact funds, ranging from pricing to availability: at maturity new contracts must be entered into. As a result, ceteris paribus, the shorter the maturity of the contract, the higher is the speed with which the terms on which credit is granted can respond to monetary policy impulses. This is especially significant when policy changes have not been anticipated and hence have not been taken into account when entering into the transactions.

Two important qualifications, however, are in order. First, strictly speaking the term to maturity determines the *maximum* interval between the setting of contract terms: contracts may be renegotiated and often contain clauses that allow for the revision of certain terms either at the discretion of one of the parties or according to predefined rules. Early repayment and interest rate adjustment clauses are obvious examples. A correct picture of the room for response to monetary policy must also take such aspects into account (see below). Second, at any given point in time it is the *residual* rather than the *original* maturity of debt contracts that best captures the longest re-setting interval. Except for ad hoc surveys, the available information relates to original maturity.

Table 9 shows the breakdown of credit into short-term and medium and long-term. In almost all cases short-term is defined as credit with an original maturity of up to and including one year; the exceptions are Italy (eighteen months) and the Netherlands (two years). With the partial exception of Canada, it also includes various forms of revolving credit, such as advances on credit accounts and overdraft facilities. The breakdown is generally more accurate for continental European countries;[27] estimates play a greater role elsewhere, especially for non-bank financial intermediaries.

The figures suggest that medium and long-term credit accounts for well over half of total credit almost everywhere. The only exception is Italy, where it is about half. The share is especially high in most of the countries with a long-standing universal banking tradition (typically around 80% or higher), which are also those that have enjoyed historically lower inflation rates. Elsewhere, it is also relatively high in France, Canada and the United States, although in Canada the medium-term component appears to be comparatively large, partly owing to the treatment of revolving credits. In no small measure the relatively high US figure reflects the breadth and depth of the corporate bond market.

Medium and long-term securities in fact account for the bulk of debt securities in virtually all countries. The only exceptions are Australia (if bank bills are included) and Spain, where the commercial paper market is quite developed (Table 10).

Household debt is predominantly medium and long-term everywhere: mortgage debt is by far the largest component and consumer debt, with the exception of credit card and other personal credit line borrowing, is typically medium-term (Table 11). The maturity of business credit is comparatively shorter. Italy again stands out as the country with the highest share of short-term credit for both households and businesses. The United Kingdom follows close behind.

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27 Except for Sweden and Switzerland.

Table 9

Breakdown by maturity: short-term versus medium and long-term[1]

(as a percentage of total credit)

	1993[2]			1983[3]		
	Short-term	**Medium and long-term**	**Total**	**Short-term**	**Medium and long-term**	**Total**
Australia[4]	40	60	100	38	62	100
Austria	27	73	100	25	75	100
Belgium	23	77	100	..	..	..
Canada	19	81	100	24	76	100
France	17	83	100	20	80	100
Germany	16	84	100	19	81	100
Italy	51	49	100	53	47	100
Japan	30	70	100	39	61	100
Netherlands	17	83	100	21	79	100
Spain[5]	40	60	100	..	..	..
Sweden	29	71	100	38	62	100
Switzerland[4]	22	78	100	24	76	100
United Kingdom	31	69	100	46	54	100
United States	15	85	100	18	82	100

[1] Short-term: up to one year (Italy: up to 18 months; Netherlands: up to two years). [2] Sweden and Switzerland: 1992. [3] Australia: 1988; Sweden: 1982; Italy: 1989. [4] Excluding certain non-bank financial institutions (Australia: 11% of total credit in 1993). [5] Excluding foreign currency loans.

Since the early 1980s the share of medium and long-term debt has generally either remained broadly stable or risen slightly (Table 9). The increase appears to have been pronounced only in the United Kingdom and Sweden. In both cases, however, shortcomings in the assumptions underlying the estimates may be partly responsible. The broad, albeit mild, trend is probably associated with lower inflation and, in several cases, higher shares for real estate and household credit.

Available information on early repayment clauses and conditions is limited (Box 2). On the whole, however, it suggests that the above picture needs to be modified only slightly. In most countries advance repayment of fixed-term loans is possible but not common. Although this may partly result from the range of interest rate movements observed and repricing clauses (see below), it would appear that penalties and other administrative costs associated with early repayment typically make it uneconomical. In Austria advance repayment of fixed rate debt is very difficult or virtually impossible in practice. The main exception to this general pattern is the United States. Most business and consumer loans as well as home mortgages can be repaid early at par without incurring any penalty at the time of the switch;[28] refinancing of mortgages has been very common. This suggests that the relatively high share of long-term financing in the United States overstates the effective maturity of the contracts and understates the freedom to adjust terms. Comparatively high room for manoeuvre also appears to exist in Australia and Canada, where penalties apply only in some cases.[29]

28 In addition, most corporate bonds are callable.

29 A more complete picture should also take into account additional refinancing costs in all countries.

Table 10

Breakdown by maturity according to type of instrument[1]

(as a percentage of each category of instrument)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]													
Loans:														
Short-term	38	27	23	16	17	16	54	32	17	41	29	23	38	17
Medium and long-term	62	73	77	84	83	84	46	68	83	59	71	77	62	83
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Securities:														
Short-term	52	–	12	32	16	5	–	11	5	40	22	–	3	8
Medium and long-term	48	100	88	68	84	95	100	89	95	60	78	100	97	92
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
	1983[3]													
Loans:														
Short-term	36	26	..	22	21	20	57	41	22	..	40	24	47	20
Medium and long-term	64	74	..	78	79	80	43	59	78	..	60	76	53	80
Total	**100**	**100**	**..**	**100**	**100**	**100**	**100**	**100**	**100**	**..**	**100**	**100**	**100**	**100**
Securities:														
Short-term	47	–	–	29	–	–	–	–	..	14	4	..	–	6
Medium and long-term	53	100	100	71	100	100	100	100	..	86	96	..	100	94
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**..**	**100**	**100**	**..**	**100**	**100**

[1] Short-term: up to one year (Italy: up to 18 months; Netherlands: up to two years). See also the footnotes to Table 9. [2] Sweden and Switzerland: 1992. [3] Italy: 1989; Australia: 1988; Belgium and Sweden: 1982.

Table 11

Breakdown by maturity according to borrowing sector[1]

(as a percentage of each sector's borrowing)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]													
Households:[3]														
Short-term	..	..	7	4	4/8	6/10	22/41	3	8	...	..	21	18	9
Medium and long-term	..	..	93	96	96/92	94/90	78/59	97	92	..	..	79	82	91
Total	**..**	**..**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**..**	**..**	**100**	**100**	**100**
Businesses:														
Short-term	..	..	37	35	22/27	21/22	57/56	35	23	..	..	24	50	19
Medium and long-term	..	..	63	65	78/73	79/78	43/44	65	77	..	..	76	50	81
Total	**..**	**..**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**..**	**..**	**100**	**100**	**100**

[1] Short-term: up to one year (Italy: up to 18 months; Netherlands: up to two years). See also the footnotes to Table 9. [2] Switzerland: 1992. [3] Belgium and United Kingdom: broadly defined; France, Germany and Italy: narrowly/broadly defined respectively.

Box 2: Summary of replies on early repayment of medium and long-term loans

Australia:	Possible; penalties in some cases.
Austria:	Possible, but very difficult.
Belgium:	Possible but discouraged; penalties (e.g. 3-6 months' interest).
Canada:	Most business loans under credit lines repayable at no cost; residential mortgages at significant cost except at repricing intervals. Corporate bonds usually callable.
France:	..
Germany:	Generally possible; plays little role; expensive penalties.
Italy:	Mortgage loans: possible; penalties. Consumer credit: possible; no penalties.
Japan:	Possible but not significant; penalties.
Netherlands:	..
Spain:	Possible; fixed rate loans generally subject to penalties.
Sweden:	Possible; penalties.
Switzerland:	Generally possible; not common; penalties.
United Kingdom:	Possible; penalties (e.g. 6 months' interest for fixed rate mortgages).
United States:	Generally possible without penalty (home mortgage, consumer and bank business loans). No information about non-bank business loans. Corporate bonds usually callable.

6. Adjustability of interest rates

The extent to which interest rates are free to adjust to changing economic conditions is probably the most important dimension of the transmission mechanism. These movements translate into changes not only in the *marginal* cost of funding, but also, and perhaps more significantly, in the *cash flow and income* of agents. At least three aspects of credit contracts have a bearing on this issue: the (residual) maturity; explicit or implicit clauses allowing for the revision of interest charges; and the basis on which those revisions take place, notably any reference rates. A fourth aspect, viz. the actual frequency, intensity and speed of the adjustment of rates on new and existing contracts is of course of interest but less amenable to descriptive analysis; these aspects are discussed in Borio and Fritz (1995) with reference to short-term bank loan rates.

Conceptually, two polar cases may be distinguished. At one extreme, maturities are very short or, if long, interest rates are revisable at very frequent intervals and tend to move together with other short-term rates. At the other extreme, maturities are long and interest rates are fixed until maturity. Ceteris paribus, in the flexible, short-term interest rate economy the response of interest rates to changes in policy controlled rates is likely to be faster and more intense; the variations in the short-run marginal cost of funding, income and cash flows would be correspondingly larger. This tends to front-load or accelerate the impact of monetary policy. Admittedly, the response to the change in the *marginal* cost of funds may arguably not be very different in the two economies to the extent that it depends on views about the *persistence* of the change. Nevertheless, cash flows would respond more quickly and intensely, reacting directly to the interest rate change rather than indirectly to any induced effect of policy on output and prices. The difference in the pattern of responses between the two stylised cases increases with the size of outstanding indebtedness and, at least for a policy tightening, with the skewness in its distribution: owing to the risk of default, the effect on highly indebted agents may be disproportionate. It may also depend on the extent to which indebtedness is concentrated among agents who, by their nature, are likely to face greater limitations on their access to external funding. Households and small firms are typical examples.

Building on the previous information on maturities and given other data limitations, it seems reasonable to adopt two complementary measures of the adjustability of interest rates on outstanding contracts. The first defines as adjustable rate all those debt instruments that are short-term or medium and long-term with rates *adjustable at no longer than one-year intervals*. The second adds to short-term instruments those which are medium and long-term with rates which tend to behave like *short-term rates*. In general, the interval of adjustment is likely to be a good guide to the flexibility of the interest rate charged: if, say, the interest rate is reviewed at yearly intervals, the setter need not take into account expected changes in reference rates over longer horizons. In some cases, however, this is not true: interest rates may be revisable at any time at the discretion of the lender but be de facto set in relation to rates or combinations of rates that themselves behave like longer-term ones.[30]

Despite the comparatively broad categories chosen, the available information on the adjustability of interest rates is extremely limited. What follows is largely based on estimates made on the basis of the nature of the business and samples of institutions. Care should therefore be taken when comparing the results: even if point estimates are given, in most cases there is significant uncertainty surrounding them.[31] The possibility of making comparisons over time is extremely limited.

A useful starting-point is the mortgage market: it accounts for a sizable share of medium and long-term lending, especially for the household sector; available information is somewhat greater; and it is there that the distinction between the two measures of adjustable rate contracts is most important. Several points emerge from a brief overview of the characteristics of mortgage contracts summarised in Table 12.

First, rates fixed *for the whole duration of the contract* are generally not common. The exceptions are Austria, France, Sweden and the United States, where the share ranges from 75 to over 90%. The option of refinancing without incurring penalties in the United States, however, qualifies the extent to which debt charges are truly fixed, i.e. unresponsive to broader interest rate changes. Elsewhere, the provision of fixed rate financing appears to derive from a combination of state involvement (subsidies), stable long-term funding sources and penalties for early repayment.

Second, there exist three types of variable rate loan depending on the nature of the contract.[32] With *reviewable rate* loans the lender retains the discretion to adjust the rate at any time and is not tied to any particular formula. Such loans are the norm in Australia, the United Kingdom

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30 Similarly, and regardless of loan maturity, rates may be revisable but very unresponsive to other rates generally. This appears to be the case, for example, with rates on credit card lending in the United States and also elsewhere. No such adjustment, however, has been made in the estimates shown below.

31 See Annex I for details on the methodology adopted in the various countries.

32 These definitions follow those adopted by the European Community Mortgage Federation.

Table 12

Adjustability of interest rates in the mortgage market[1]

(approximate percentage shares/existence)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
Adjustable[2]	> 90	25	maj. of free	100	5[3]	90	75	60	> 90	80	10	70	90	15
Indexed[4]	–	..	–	–	5[3]	–	75		–	80	–	–	small	15
Reviewable[5]	> 90	..	–	–	–	> 45[6]	–	60	..	–	10	70	> 80	–
Renegotiable[7]	–	..	maj. of free	100	–	< 45	–	–	..	–	–	–	small	–
Fully fixed	< 10	75[8]	rest[9]	0	95	10[10]	25	40[11]	< 10	20[12]	90	30	10	85
Memorandum items:														
% adjustable within one year	*> 90*	*≤ 25*	*0*	*60*	*95*	*> 45*	*75*	*60*	..	*80*	*10*	*70*	*90*	*15*
% short-term rate related	*> 90*	*0*	*0*	*60*	*0*	*< 30*	*≤ 75*	*0*	*≈ 0*	*< 10*	*10*	*0*	*90*	*15*
Main short-term rate	*3-mth*	–	–	*1-year*	–	..	*6-mth*	–	–	..	*6-mth*	–	*3-mth*	*1-year*

1 Rough estimates based on various sources of information. 2 In contrast with the remaining tables, adjustable rate debt is here defined as debt with rates that are not *fully* fixed, regardless of the length of the adjustment intervals. 3 Only loans granted by some specialised private lenders (since 1988) and certain subsidised loans. 4 The contract specifies the rate for the adjustments. 5 The lender retains discretion over the timing and size of the adjustments (possibly between certain limits). 6 "Commercial", savings and cooperative banks only. 7 Adjustment of rates at fixed intervals specified in the contract. 8 The whole of the subsidised sector. 9 Including all the subsidised sector. 10 Bausparkassen; mortgage banks also have some small amounts outstanding. 11 A fraction of the lending by the House Loan Corporation. 12 Almost all the subsidised sector, including the Banco Hipotecario de España and a fraction of the lending by deposit-taking institutions.

Sources: Central banks and European Community Mortgage Federation.

and Switzerland, and seem to be common in Germany.[33] With *renegotiable rate* loans, standard in Canada and actively used in Belgium and Germany, rates are subject to renegotiation at contractually fixed intervals.[34] With *reference rate* or *index-linked* loans, widespread in Italy and Spain, the rate varies in relation to some other rate according to an explicit formula specified in the contract.

Third, the share of loans whose rate is adjustable *at no longer than one-year intervals* (the first measure) is very high (at least 70% but even 90% or more) in countries where reviewable rate loans are standard (Australia, the United Kingdom and Switzerland) and only somewhat lower (70-80%) where index-linked ones are the norm (Spain and Italy). It is also comparatively high in Canada (around 60% of residential mortgages), the only country where the periodicity of the adjustment for renegotiable rate loans is short, and in Japan.

Fourth, in a number of countries the share of loans at a rate that moves in line mainly with short-term rates (the second measure) is considerably lower than might be inferred from the periodicity of adjustments. This is especially true of Switzerland, Spain and Japan; it also applies to a lesser extent to Germany and Austria. In Switzerland and Germany this reflects the stable long-term sources of funding. In Spain it results from the choice of reference rate, typically itself the rate on medium-term mortgages applied by a group of institutions. This suggests that the purpose of indexation in Spain is not primarily protecting lenders against adverse movements in funding costs. The situation is similar in Japan, where a large proportion of total mortgages have rates which are adjusted generally twice a year, but are linked to long-term rates.[35]

Finally, the short-term interest rate to which the adjustments in mortgage rates are predominantly related varies across countries. Its maturity is especially short in the United Kingdom and Australia (three-month); it appears to be considerably longer-term in the majority of other countries (often a one-year rate).

Turning next to total credit, Table 13 provides some very rough estimates of its breakdown between adjustable and fixed rates. The table provides estimates for the two definitions of variable rate debt; for simplicity, however, what follows focuses only on variable rate debt at short-term rates, i.e. short-term maturity plus medium and long-term at short-term rates (i.e. short-term plus adjustable medium and long-term on definition (b) in the table).

Subject to the qualifications outlined above, the share of variable rate credit appears to be especially high in the United Kingdom and Italy, at close to 75%. It is also relatively high in Australia (about two-thirds). At the other end of the spectrum, variable rate debt related to short-term rates appears to be lowest in the Netherlands (around one-quarter), Switzerland and Germany (around one-third). It is of a similar order of magnitude in the United States and, possibly, Sweden and Japan.

A rough, still very preliminary breakdown between households and businesses is available for fewer countries. Given the assumptions required to obtain it, it should be treated with even greater caution than the estimates relating to total credit.

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33 The freedom to adjust rates may, however, be constrained. For example, in Germany, legal provisions require that any change be objectively fair in accordance with commercial practice, pursuant to the relevant case law.

34 In Germany, where it is widespread, this type of loan is assimilated to a fixed rate loan.

35 The rate on adjustable rate loans of the Housing Loan Corporation is based on the funding rate set by the Government, in turn moving in line with the coupon rate on new issues of ten-year government bonds. These rates have a cap of 5.5%. The adjustable rate on bank housing loans is set in relation to the long-term prime rate, itself linked to the five-year interest-bearing debenture issued by three long-term credit banks. Since early 1994 a new type of bank housing loan, related to the short-term prime, appears to have been allowed.

Table 13

Breakdown by type of interest rate: adjustable and fixed[1]

(as a percentage of total amounts outstanding)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]													
Short-term	40	27	23	19	17	16	51	..	17	40	29	22		14
Adjustable medium and long-term:								..						
(a) ≤ one year	26	47	21	40	27	> 23	22	> 35[3]	> 8	24	6	52	73	20
(b) at s-t rates	26	> 0	21	40	27	23	≤ 22	35[3]	8	3	6	8		20
Predominantly fixed:														
(a) > one year	34	26	56	41	57	< 62	26	< 65	< 75	36	65	25	27	66
(b) at medium and long-term rates	34	< 73	56	41	57	62	≥ 26	65	75	57	65	69	27	66
Total[4]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

[1] See Table 9 for maturity definitions and sectoral coverage. [2] Sweden and Switzerland: 1992. [3] Short-term plus corresponding adjustable rate medium and long-term component. Since the source of information is different from that of the maturity table, maturity is shown as not available. [4] Short-term plus adjustable and predominantly fixed in categories (a) and (b) respectively.

In Anglo-Saxon economies the share of predominantly fixed rate debt of the household sector appears to be of a similar order of magnitude (United States and Canada), or even lower (Australia and the United Kingdom) than for the business sector (Table 14). This results mainly from the conjunction of the characteristics of the mortgage market and a sizable stock of outstanding fixed rate long-term securities. By contrast, and for much the same reasons, in continental European countries the household share of predominantly fixed rate debt is typically considerably larger than for the business sector. Germany and Switzerland seem to be two exceptions, in that the orders of magnitude appear to be similar. This may partly be due to the inaccuracy of the estimates made.[36]

Despite the considerable variation across countries, the share of medium and long-term debt at predominantly fixed rates of the household sector is generally around 50% or higher. It is significantly lower only in the United Kingdom and Australia.

The equivalent share for the business sector generally ranges between one and two-thirds. As might be expected, the share tends to be comparatively high where it is so also in the aggregate. Some exceptions exist, however, mirror-imaging the polarisation of the composition of household debt. The share is quite low in Belgium and, to a lesser extent, in France; it appears to be relatively high in Australia.[37,38]

A rough estimate of the breakdown of total loans between banks and other lending institutions according to the flexibility of interest rates charged is presented in Table 15. Confirming a priori stylised views, it indicates that the share of predominantly fixed rate medium and long-term lending is comparatively high (around 50% or more) in several countries with a long-standing tradition of universal banking, such as Germany, the Netherlands and Switzerland.[39] It is also of a similar order of magnitude in Belgium and, interestingly, the United States. Elsewhere, it is generally lower.

The breakdown of credit between fixed and adjustable rate may give an incomplete picture of the sensitivity of borrowers' cash flow to interest rate changes in at least three cases. First, as already discussed, where agents have the option to repay early without incurring penalties. Secondly, when lenders offer mechanisms to help insulate their customers from "excessive" interest rate movements, a typical example being maturity adjustments aimed at smoothing total servicing payments. The information available suggests that these are especially common in Australia, of some quantitative significance in Canada but of less relevance elsewhere, including the United Kingdom;[40] in general, where present, they tend to apply mainly to housing loans (Box 3). Finally, borrowers may actively use derivatives to alter the characteristics of their interest rate risk profile. Derivatives are primarily employed by large companies, routinely by those with access to the international markets. They have long been a significant risk-management tool especially in the United States and other

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36 In the case of Germany, the result is driven by the assumption that three-quarters of consumer credit is at variable rates.

37 The share also appears to be comparatively high in the United Kingdom upon the upward revision in the stock of debt securities.

38 There are indications that the overall pattern in Spain may be quite similar to those in France and Belgium.

39 No comparable results are available for France. However, some indications can be drawn from a 1992 central bank survey of nine large banks, accounting, respectively, for half and around one-third of bank and total loans to households and businesses. The survey indicated that 52% of total French franc denominated loans to these sectors were at predominantly fixed rates. The definition of variable rate used covered two sets of contracts: (i) those with a residual maturity of at most three months; (ii) those at rates adjusted with a periodicity not exceeding one year. Class (ii) corresponds to one of the definitions used in the text.

40 In the United Kingdom, however, it has been estimated that around 40% of all mortgage borrowers are on an annual review scheme, whereby the interest charges are changed only once a year. Any underpayment arising from differences in the timing of the review of interest rates and interest charges is capitalised and added to the interest payments in the following periods.

Table 14

Breakdown by type of interest rate according to borrowing sector[1]

(as a percentage of total borrowing of each sector)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES[2]	SE	CH	UK	US
	1993[3]													
Households:[4]														
Short-term		..	7	4	4	6	22/41	..	8	..	..	21		9
Adjustable medium and long-term:														
(a) ≤ one year	77	..	11	49	9	> 30	37/28	69[5]	> 0	..	..	56	90	25
(b) at short-term rates		..	11	49	9	30	≤ 37/28	17[5]	0	..	..	8		25
Predominantly fixed:														
(a) > one year	23	..	82	48	87	< 64	41/31	31	< 92	..	..	23	10	66
(b) at medium and long-term rates	23	..	82	48	87	64	≥ 41/31	83	92	..	..	71	10	66
Total[6]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Business:														
Short-term		..	37	35	22	21	57/56	..	23	..	..	24		19
Adjustable medium and long-term:														
(a) ≤ one year	40	..	30	31	34	> 19	20/20	> 38[5]	> 14	..	..	48	48	15
(b) at short-term rates		..	30	31	34	19	≤ 20/20	38[5]	14	..	..	8		15
Predominantly fixed:														
(a) > one year	60	..	33	34	44	< 60	23/24	< 62	< 62	..	..	28	52	66
(b) at medium and long-term rates	60	..	33	34	44	60	≥ 23/24	62	62	..	..	68	52	66
Total[6]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

[1] See Table 9 for maturity definitions and coverage. [2] There are indications that the pattern in Spain is probably similar to those in France and Belgium. [3] Switzerland: 1992. [4] Australia, Belgium and the United Kingdom: broadly defined. Italy: households narrowly and broadly defined respectively. [5] Short-term plus corresponding adjustable rate medium and long-term component. Since the source of information is different from that of the maturity table, maturity is shown as not available. [6] Short-term plus adjustable and predominantly fixed in categories (a) and (b) respectively.

Table 15

Breakdown by type of interest rate according to loan-granting institutions[1]

(as a percentage of total lending by each sector)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]													
Banks:														
Short-term	43	28	26	26	..	18	57	..	24	42	70	29		20
Adjustable medium and long-term:														
(a) ≤ one year	28	48	25	44	..	27	22	> 57[3]	> 11	28	0	51	85	15
(b) at short-term rates	28	> 0	25	44	..	27	≤ 22	57[3]	11	5	0	11		15
Predominantly fixed:														
(a) > one year	29	24	49	30	..	55	21	< 43	< 65	29	30	20	15	64
(b) at medium and long-term rates	29	< 72	49	30	..	55	≥ 21	43	65	53	30	60	15	64
Total[4]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
OFIs:														
Short-term	24	0	0	0	..	0	27	..	0	24	3	0		14
Adjustable medium and long-term:														
(a) ≤ one year	37	0	0	56	..	> 0	40	> 14[3]	> 0	0	10	70	≥ 90	30
(b) at short-term rates	37	0	0	56	..	0	≤ 40	14[3]	0	0	10	0		30
Predominantly fixed:														
(a) > one year	39	100	100	44	..	< 100	33	< 86	< 100	76	87	30	≤ 10	56
(b) at medium and long-term rates	39	100	100	44	..	100	≥ 33	86	100	76	87	100	10	56
Total[4]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

[1] See Table 9 for maturity definitions and coverage. [2] Sweden and Switzerland: 1992. [3] Short-term plus corresponding adjustable rate medium and long-term component. Since the source of information is different from that of the maturity table, maturity is shown as not available. [4] Short-term plus adjustable and predominantly fixed in categories (a) and (b) respectively.

Box 3: Procedures to alleviate the burden of interest rate adjustments[1]

Australia:	Maturity adjustment for housing loans common. No information on other loans.
Austria:	Floors and caps for loans related to money market rates.
Belgium:	* Generally none; some cases of interest ceilings.
Canada:	Maturity adjustment in the case of some mortgages.
France:	* Duration adjustment in some cases (e.g. new formulae by specialised mortgage companies).
Germany:	* Some smoothing possible; recently loans with interest rate caps on offer.
Italy:	* Maturity adjusted only exceptionally.
Japan:	Not significant.
Netherlands:	* Maturity adjusted only in some cases.
Spain:	Maturity adjustments not normal practice.
Sweden:	Maturity adjustments used very sparingly.
Switzerland:	..
United Kingdom:	Building societies may adjust maturity if the borrower is in difficulty.
United States:	..

[1] Responses to the questionnaire and additional information on the mortgage market obtained from the EC Mortgage Federation (denoted by an asterisk).

Anglo-Saxon countries. Because of the dearth of data, however, it is difficult to determine their impact on the aforementioned stylised findings.

7. Non-price restrictions on credit extension

The extent to which lenders can influence the timing and amount of credit extensions other than through the interest rate (and related fees) is another dimension of the transmission mechanism of monetary policy. One possibility is setting non-price terms in the contracts; the most common of these is collateral. A second, complementary one is simply to retain discretion over the timing and amount of credit supplied on any given interest and non-interest terms. This is the case, for instance, with loans not provided under committed credit lines, since the lender may simply refuse to grant as much credit as is demanded, i.e. he may decide to ration it. Rationing can easily result from regulatory controls on interest rates or quantities,[41] but it can also occur in their absence: given limited information about the characteristics of individual borrowers and insufficient control over

41 Or, indeed, other non-interest terms such as collateral requirements.

their behaviour, restricting the amount supplied may be necessary to provide the lender with an adequate ex ante return on the funds granted.

(a) *Collateral*

Collateral may matter in the context of the transmission mechanism for at least two reasons. First, for a *given set of characteristics of the borrowers*, changes in monetary policy may have an impact on the collateral terms required by lenders at any given interest rate. Tougher/easier collateral requirements can be one way of helping to restrict/encourage credit growth. Second, and more importantly, for any *given set of terms called for by lenders*, monetary policy may have an effect on the characteristics of borrowers. Directly, via changes in the interest rates, and indirectly, via induced changes in output and prices, it can have a significant influence not only on the likelihood of default of borrowers but also on the value of the collateral at their disposal. In general, the collateral channel would tend to reinforce the impact of policy. Higher policy rates, for instance, would lead ceteris paribus to a deterioration in the creditworthiness of lenders and a decline in the value of collateral taking the form of financial and real assets. This in turn would reduce the availability of credit at any given interest rate.

On a priori grounds, the first channel, felt through altered conditions in the supply of credit, may be expected to be effective primarily when banks' freedom to adjust interest rates is constrained or when monetary policy results in changes in banks' balance sheets that alter their incentive or ability to take on risks. A possible example would be the interaction of a policy tightening with a weak capital position of the institutions and a competitive or political environment hostile to sizable increases in interest rates. Elements of such a scenario have clearly been present in those countries where there have been concerns about a credit crunch, notably Anglo-Saxon ones. More generally, however, unless the balance sheet of lenders is especially vulnerable or policy is implemented through direct controls, this channel is unlikely to be important. The replies to the questionnaire, couched more broadly in terms of non-interest conditions, are not inconsistent with this view. They do acknowledge, however, a widespread lack of information, in part due to problems in identifying the direct impact of policy (Box 4).

By contrast, the second channel, that operating via induced changes in the characteristics of borrowers, is likely to be more important. Ceteris paribus, those features of the financial structure that raise the sensitivity of the borrowers' probability of default to changing monetary conditions should also tend to heighten the quantitative significance of this channel; the level and skewness of indebtedness is but one example of this (see above and Kneeshaw (1995)). The same is true of those features that magnify the valuation effect of monetary policy on collateral; an obvious candidate is the share of total credit backed by assets whose price is in principle quite responsive to interest rate changes, most notably real estate.

That this channel may indeed be quantitatively significant seems to be confirmed by the experience of several countries since the early 1980s. Major increases in asset prices, especially real estate prices (Graph 1), have typically gone hand in hand with a rapid expansion in credit, especially in several Anglo-Saxon and Nordic countries and also in Japan. This has at times appeared to generate a vicious circle. Higher asset prices relax credit conditions, which in turn pushes up prices further, an analogous process occurring in the downward direction but possibly amplified by defaults and bankruptcies.[42] Admittedly, collateral is only part of the story. Asset prices may simply be correlated with expectations regarding the prospects of the economy and contribute to the formation of views regarding returns on investments, factors which would normally affect lending decisions. Similarly, changes in the stance of monetary policy are only one possible reason for the observed credit expansion; deregulation has had a major independent effect. Nevertheless, it is equally difficult to argue that the valuation of collateral has played a minor role or that monetary policy has not been in

42 The process can of course interact with the supply factors discussed in the context of the first channel.

Box 4: Summary of replies on the response of non-interest terms to monetary policy

Australia:	Survey evidence suggests that the availability of finance moves inversely with interest rates; not clear if this reflects supply or demand factors.
Austria:	No noticeable response to monetary tightening; common when credit risk increases.
Belgium:	Normally no response.
Canada:	Econometric evidence indicates that, if present, availability is negatively correlated with loan rates; ample anecdotal evidence of relevance (e.g. for small businesses). Not possible to measure correlation with monetary conditions, however.
France:	Anecdotal evidence that non-interest terms vary in the course of the cycle. No concerns about credit crunch.
Italy:	Not considered in econometric model.
Japan:	Evidence of response of non-interest terms.
Netherlands:	Majority of banks claim to ration the riskiest borrowers as a reaction to tight monetary policy.*
Spain:	..
Sweden:	..
Switzerland:	..
United Kingdom:	Non-interest terms likely to respond to monetary tightening. Common perception supported by survey evidence that non-interest terms for small businesses were tightened significantly during last recession.
United States:	Survey evidence indicates that non-price terms reinforce price terms.

* For details, see Swank (1993).

part responsible for these developments, at least in those countries experiencing the largest movements.[43]

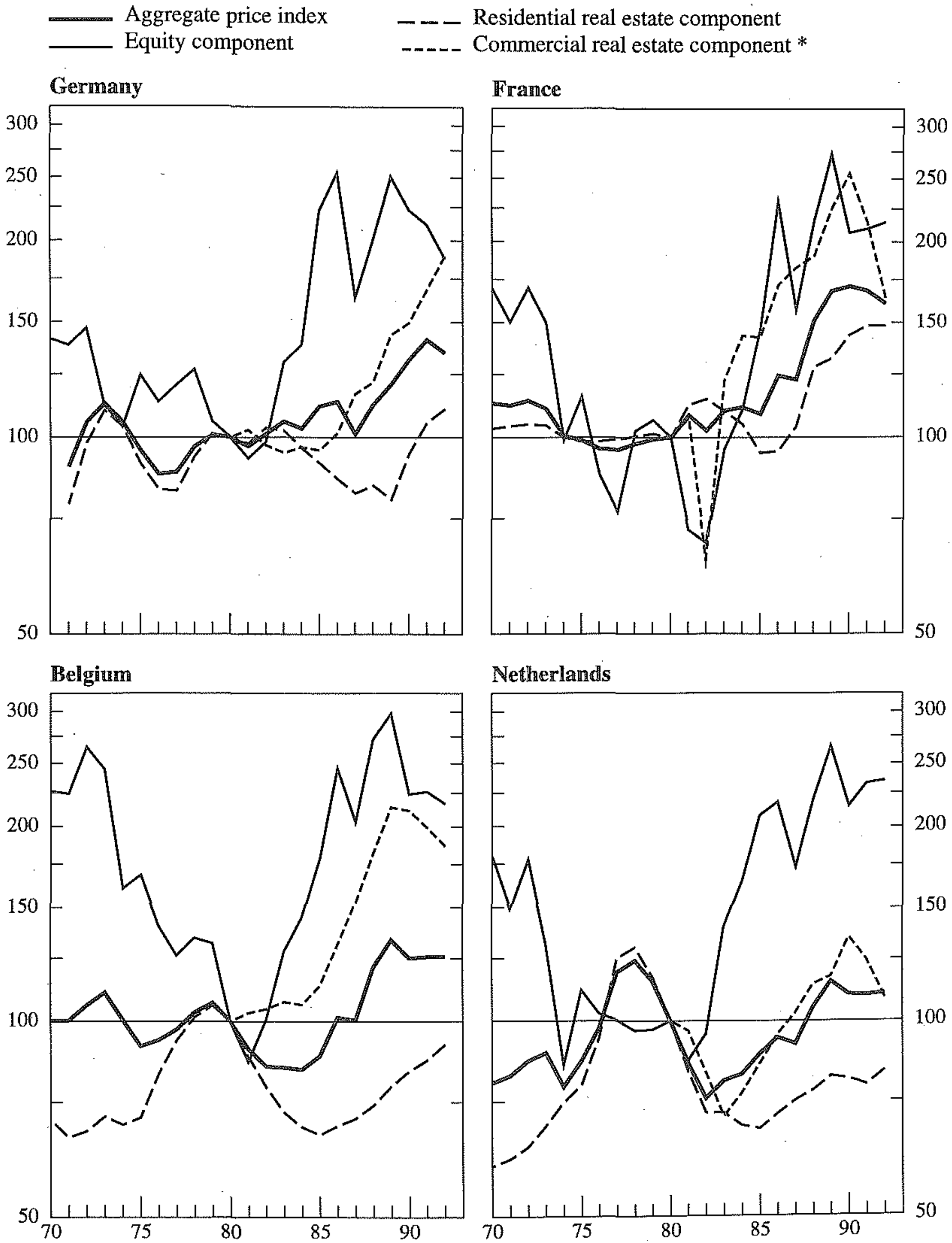
The very limited and preliminary information available on collateral is summarised in Table 16. Again, the figures should be treated with caution. In particular, it has as yet not been possible to establish the extent to which the information is comparable across countries owing to possible differences in definition and coverage.

43 For a detailed cross-country analysis of these issues, see Borio et al. (1994).

Graph 1

Real asset prices: aggregate and components

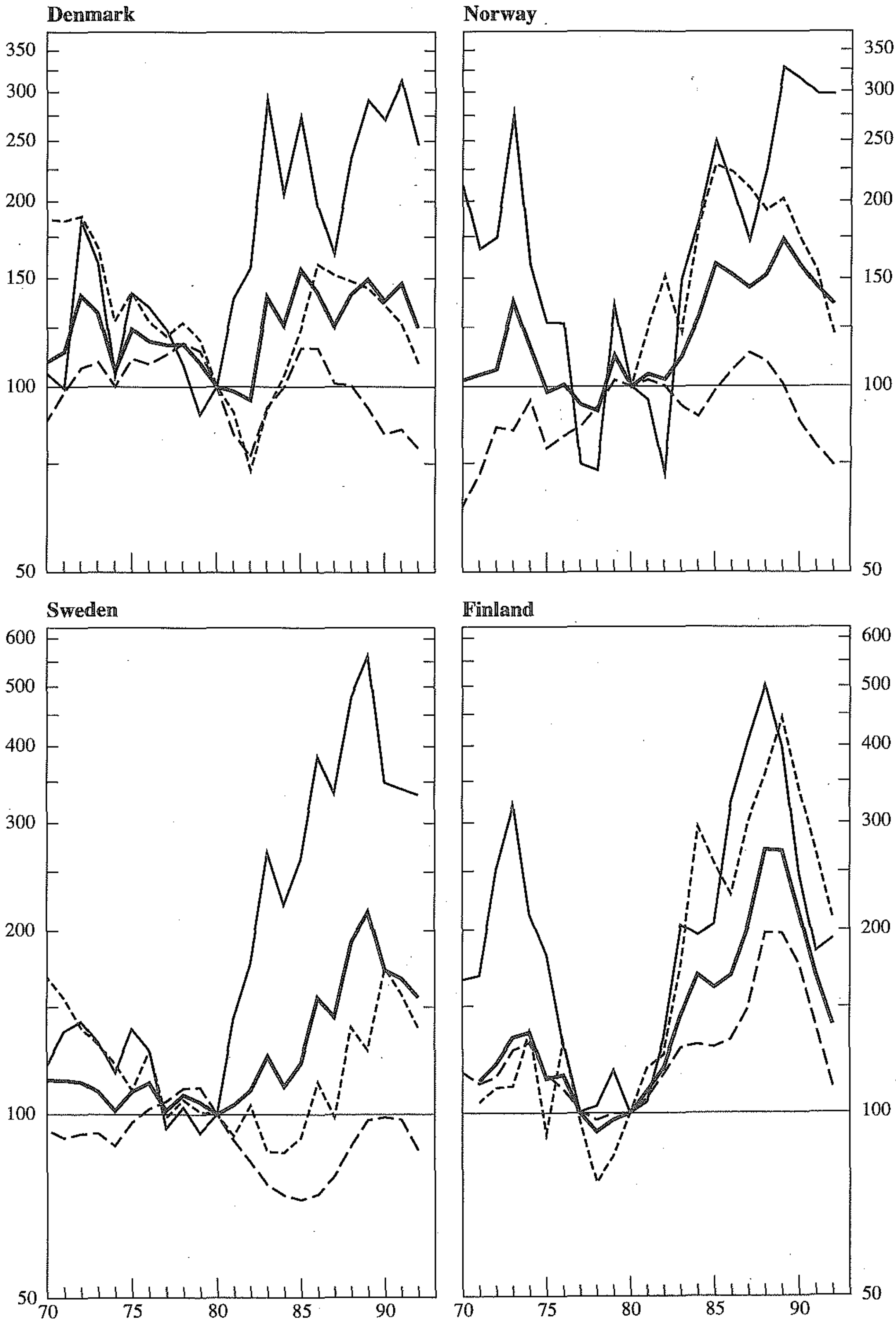
(1980 = 100; semi-logarithmic scales)



Note: The real aggregate asset price index is a weighted average of equity and residential and commercial real estate price indices deflated by consumer prices. The weights are based on the composition of private sector wealth.

* Index not shown for the above countries and Norway in the 1970s as it is proprietary information.

Graph 1 (cont.)


Denmark
Norway
Sweden
Finland
350
300
250
200
150
100
50
600
500
400
70
75
80
85
90

Graph 1 (cont.)

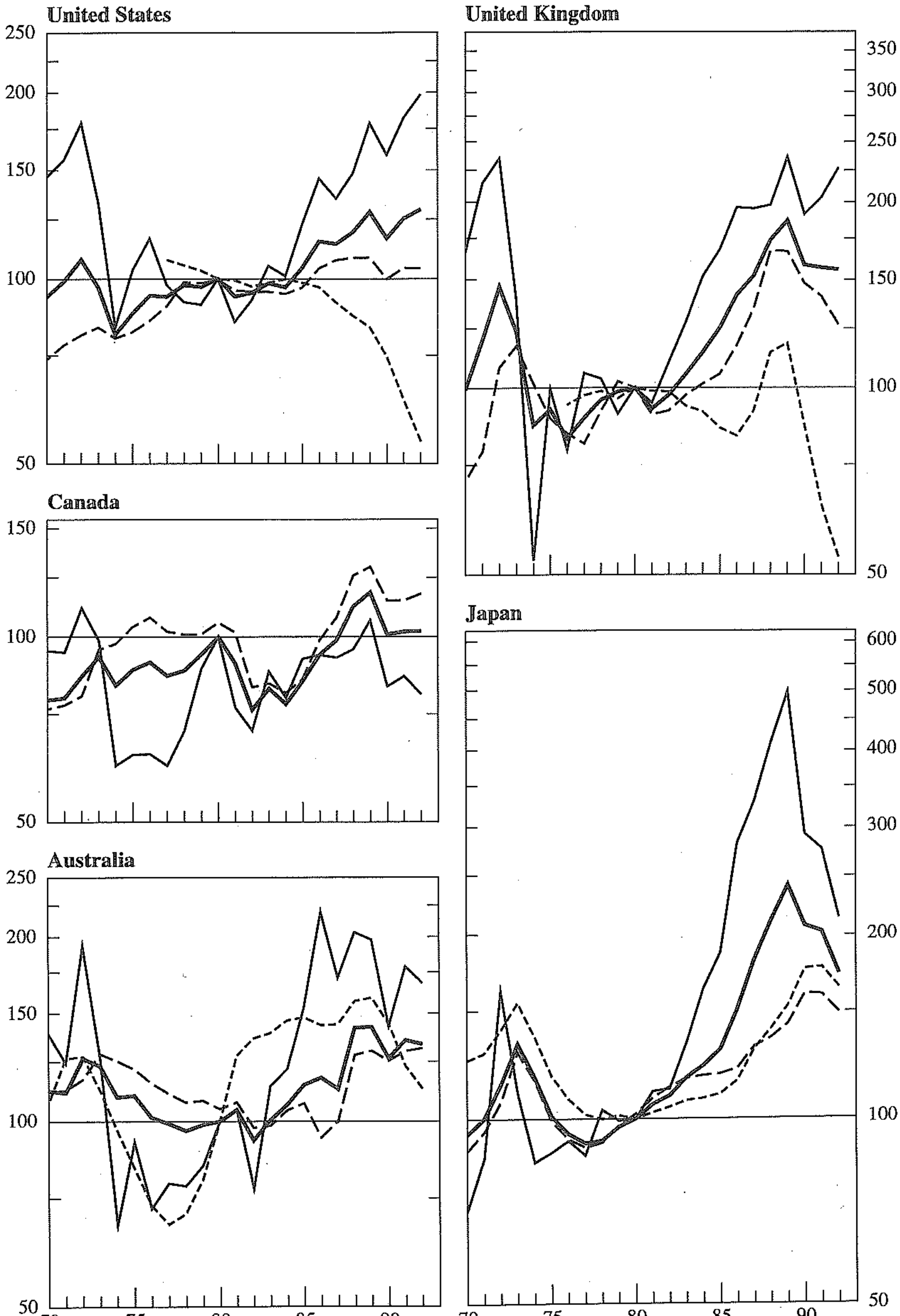

United States
250
200
150
100
50
United Kingdom
350
300
250
200
150
100
50
Canada
150
100
50
Australia
250
200
150
100
50
70
75
80
85
90
Japan
600
500
400
300
200
100
50
70
75
80
85
90

Table 16

Collateralisation of loans

(as a percentage of each sector's lending)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[1]													
Banks	..	70	..	90	..	v. high	66	68[3]	..	33[4]	..	86	..	63
Real estate	48	31	26	43	44	30	45[2]	28[3]	36	32[4]	..	81	32	56
Other	..	39	..	47	..	..	21[2]	40[3]	..	1[4]	..	6	..	7
OFIs	..	..	..	90	..	v. high	..	..	..	37	100	42	..	92
Real estate	9	..	100	75	33	90	..	..	37	37	100	41	92	76
Other	..	..	..	15	..	..	..	..	..	..	..	1	..	16
Total	..	69	..	90	..	v. high	..	..	..	34	..	78	..	78
Real estate	34	31	34	56	41	36	40	..	36	33	> 61	73	59	66
Memorandum item: *Real estate backing bank loans to businesses (%)*	..	*28*	..	*4[5]*	..	*27*	..	*25*	*4*	*25*	..	*73*	..	*43*
	1983[6]													
Banks	..	73	..	..	..	v. high	61	61	..	16[4]	..	88	..	60
Real estate	14	34	28	20	41	37	..	24	38	..[4]	..	81	15	54
Other	..	39	..	..	..	..	..	37	..	..[4]	..	7	..	6
OFIs	..	..	..	..	..	v. high	..	..	..	48	100	44	..	86
Real estate	9	..	100	77	42	90	..	..	30	48	100	42	93	66
Other	..	..	..	..	..	..	..	..	..	..	..	2	..	20
Total	..	71	..	..	..	v. high	..	..	..	21	..	79	..	69
Real estate	12	33	39	44	42	45	..	..	35	..	> 43	73	50	58
Memorandum item: *Real estate backing bank loans to businesses (%)*	..	*26*	..	*1*	..	..	..	*18*	..	..	..	*73*	..	*37*

[1] Sweden and Switzerland: 1992. [2] For short-term credit banks (66% of total bank loans in 1993), for which accurate figures exist, the shares of real estate and other collateralised loans are 19% and 31% respectively. Rough estimate for long-term credit banks. [3] Excluding trust accounts. [4] Excluding official credit institutions, included among OFIs for present purposes (6% and 11% of total bank loans in 1993 and 1986 respectively). [5] For all financial institutions, 10% and 7% in 1993 and 1983 respectively. [6] Australia: 1988; Belgium and Sweden: 1982; Italy: 1989; Spain: 1986.

Box 5: Series used to approximate real estate collateral	
Australia:	Housing credit, for owner-occupied and investment purposes.
Austria:	Mortgages (includes also some loans to local authorities).
Belgium:	Mortgages (commercial and residential) (EC Mortgage Federation, ABCI).
Canada:	Mortgages (commercial and residential).
France:	Housing credit (crédit à l'habitat).
Germany:	Mortgages (commercial and residential).
Italy:	Loans collateralised with real estate.
Japan:	Bank loans collateralised with real estate and housing credit.
Netherlands:	Mortgages on dwellings.
Spain:	Loans with real guarantees.
Sweden:	Loans from housing credit institutions only (excludes banks; lower bound).
Switzerland:	Mortgages and other lending collateralised with real estate.
United Kingdom:	Loans collateralised with dwellings.
United States:	Commercial and residential mortgages.

For the countries for which information is available, the share of total loans backed by collateral is in the region of 70% or over. The only exception appears to be Spain, for which it is only one-third. The difference is such that it raises doubts about the comparability of the figures. As regards banks, the share is especially high in countries with a long-standing universal banking tradition and also in Japan and Canada; it is considerably lower in Italy and Spain.

Loans collateralised with *real estate* make up a least one-third of total loans in all countries. The share is exceptionally high in Switzerland, at around three-quarters; it is around 60% or over in most Anglo-Saxon countries and Sweden. Indications suggest that it may also be quite high in Japan. The pattern is similar as regards the banking sector. The extent to which these results owe to limitations in the coverage of the underlying statistics and methodology of estimation is unclear (Box 5 and Annex I).

Over time, the share of real estate backed loans has tended to rise, at times markedly, precisely in those countries where it is now comparatively high; it has remained broadly stable or fallen elsewhere. In most cases, these are also the countries where the interaction between asset prices and credit has caused greater concern. This finding lends some support to the hypothesis that collateral may have had a significant role to play in these developments.

(b) *Regulation-induced rationing*

There are at least three typical mechanisms through which regulation may induce rationing. First, the authorities may set direct limits to the quantities of credit granted and the lenders may find it unprofitable to set the interest rate (and other terms) that would clear the market; this may result, for instance, from valued customer relationships, fears of inducing defaults or broader competitive reasons. Second, the authorities may limit the flexibility of lending institutions in attracting funds, as through ceilings on the rates applied to funding instruments. Finally, they may constrain the flexibility of adjustment of lending rates; if the institutions' behaviour is profit-oriented, this may lead to margins which make it unattractive to extend credit.[44] More often, perhaps, it may cause rationing if the public funds or guarantees typically supporting the interest rate restrictions are limited.

These various types of restriction were quite common in the past but are now rare following the deregulation process which gathered momentum during the 1980s. Lending ceilings have disappeared. The remaining constraints on the remuneration of the liabilities of financial institutions generally affect only a small proportion of their funding sources. Loans at preferential rates appear to be quantitatively significant only in a few countries and to apply mainly to credit for housing.[45] Such constraints can no doubt help to insulate certain borrowers, at least in the short run, from changes in market rates; it is harder to speculate whether they also give rise to sizable rationing effects, a question which would call for more precise knowledge of the arrangements. Moreover, the expansion in all countries of a competitive housing loan sector whose lending rates are unconstrained limits further the macroeconomic significance of any credit rationing that may be present.

(c) *Lenders' control over the timing and amount of disbursements*

In general, the presence and quantitative significance of credit rationing, whether regulation-induced or not, is very difficult to assess, statistically or otherwise. On the other hand, it is more straightforward to identify indicators of its *absence*. Credit extended under standing facilities is a clear example. In this case, the borrower has discretion over the timing and the amounts drawn up to a predetermined limit, if any, set by the lender.[46] In addition, information about such facilities may cast some light on the time pattern of the transmission of policy. Arguably, by limiting the discretion of lenders, the facilities would tend to delay the slowdown of credit following a tightening and hence any contractionary effect on the economy.

Estimates of the stock of loans drawn under standing facilities are shown in Table 17. The figures should be treated with some caution: it is not clear whether the identified amounts, even for the set of institutions for which data are available, comprise all the borrowing in the relevant category (Box 6). They tend to suggest that credit line financing is especially high in Austria and, to a lesser extent, Italy, at around one-third of total loans; indeed, for Italian short-term banks close to half of their lending takes this form. By contrast, credit line financing appears to be far less significant in

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44 Unless, of course, the limits are compensated for by appropriate subsidies; in fact, the subsidies may be the reason why limits are introduced in the first place.

45 For instance, in France 28% of total lending outstanding in 1992 was at preferential rates; two-thirds of that amount was for housing. Similarly, almost three-quarters of bank housing credit in Austria is at subsidised rates. Preferential rates appear to be common also for public sector financial institutions in Japan; those institutions account for one-quarter of total lending.

46 Of course, the limit itself may be less than what the borrower would like to obtain on the terms specified by the lender. There are also some questions regarding the precise conditions under which the lines may be withdrawn.

Table 17

Credit outstanding under credit lines[1]

(as a percentage of loans of each category of institution)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
	1993[2]													
Banks	21	32	9	30	7[3]	<17	46[4]	17	16	18	..	16	15	29[5]
OFIs	lower	–	–	lower	low	–	low	6[6]	–	low	..	–	low	low
Memorandum item: *Identified as % of total loans*............	*14*	*31*	*8*	*18*	*7*[7]	*<15*	*27*	*10*	*12*	*16*	..	*13*	*8*	*14*
	1983[8]													
Banks	27	30	..	50	5[3]	<20	51[4]	3	..	18	..	18	31	30[5]
OFIs	lower	–	–	lower	low	–	low	1[6]	–	low	..	–	low	low
Memorandum item: *Identified as % of total loans*............	*13*	*29*	..	*29*	..	*<17*	*30*	*1*	..	*18*	..	*15*	*17*	*19*

[1] Overdrafts, credit accounts, revolving credit facilities; see Box 6 for country details. [2] France and Switzerland: 1992. [3] "Universal" banks ("Banques AFB") only (close to 50% of total bank loans in 1992). [4] Short-term banks ("aziende di credito") only. [5] Based on survey evidence on gross extensions of commercial bank loans to businesses under commitments. [6] Only Shoko Chukin bank, Shinkin banks and credit cooperatives. [7] Total for all credit institutions. [8] Australia: 1988; Italy: 1989.

Box 6: Basic series and estimates underlying the table on credit line financing

Australia:	Revolving credit.
Austria:	Current account credits to domestic non-banks ("Kontokorrentkredite").
Belgium:	Current account credits.
Canada:	Demand loans and loans under revolving credit facilities. For banks, 30% of non-mortgage business credit (excluding leasing) and 20% of personal non-mortgage credit.
France:	Overdrafts ("avances en comptes débiteurs").
Germany:	Total short-term advances ("Buchkredite") and loans; no breakdown available.
Italy:	Current account credits.
Japan:	Overdrafts.
Netherlands:	Current account credits and call money.
Spain:	Current account credits and overdrafts.
Sweden:	..
Switzerland:	Current loans.
United Kingdom:	Overdrafts.
United States:	Credit drawn under credit commitments to businesses; gross extensions; survey of terms on bank lending. A survey on the stocks found that 70% of business loans were drawn under commitments in 1983; the figure for gross extensions for that year is over 60%. The figures shown in the table apply the percentage for gross extensions to all business loans by commercial banks and thrifts.

Japan, Belgium, France and the United Kingdom, at 10% or less of total loans. The figures for the United Kingdom are somewhat surprising; they hardly identify an "overdraft economy", as the UK system has sometimes been referred to. This may be due in part to limitations in the statistical definition of "overdraft" used, but it also reflects the high share of lending for housing.

Indeed, since 1983 in the United Kingdom the share of overdrafts in total lending has halved, most likely reflecting the concomitant growth in housing credit (see also Table 16). A similar development, and for much the same reasons, has taken place in Canada. A sharp rise, on the other hand, has occurred in Japan, mainly in order to avoid stamp duty on bill financing.

8. Credit denominated in foreign currency

When borrowers obtain funds in foreign currency, the domestic currency equivalent of their average funding costs and debt burdens will subsequently depend on the actual path of the exchange rate and, if the borrowing is at variable rates, of foreign interest rates. If these variables do not follow their anticipated paths, the ex post cash flow, income and balance-sheet positions could differ substantially from the anticipated ones, thereby exerting a significant influence on lending, borrowing and spending decisions.[47] Thus, changes in domestic interest rates no longer have a *direct* effect on part of the indebtedness of residents, which comes to depend on foreign monetary conditions.[48] On the other hand, the importance of the exchange rate in the transmission mechanism is heightened.

The quantitative significance of this channel will depend, inter alia, on the size and distribution of the net positions of agents in foreign currency. At the aggregate level, a rather crude indicator is the share of foreign currency denominated credit in the total.[49] Though incomplete, the available information suggests that this share was typically of the order of 5% or less at the end of 1993 (Table 18). It was considerably higher, however, in Italy, Sweden and Canada.[50] In the two European countries, a significant rise took place in the years preceding the ERM crisis of autumn 1992,[51] as companies borrowed abroad to avoid high nominal interest rates at home and the exchange rate was under persistent upward pressure.

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47 If the financial intermediaries themselves take open foreign currency positions, there may also be an independent effect on the supply of credit through unexpected deteriorations or improvements in the intermediaries' profit and loss accounts and balance sheets.

48 Of course, the *ability* to invest and borrow freely in foreign currencies raises also the usual questions about the autonomy of national monetary policies even if the *actual size* of the positions is not large.

49 Note that since the present aggregate excludes credit obtained abroad unless it is in the form of securities, it tends to *underestimate* overall foreign currency credit. For complementary indicators, see Kneeshaw (1995).

50 However, some other countries could fall within this category, depending on the share of foreign-denominated securities, for which figures are sometimes not available.

51 Because of the dates chosen, this is only partly reflected in the above figures.

Table 18

Loans denominated in foreign currencies

(as a percentage of total loans of each category of institution/borrowing)

	AU	AT	BE	CA	FR	DE	IT	JP	NL	ES	SE	CH	UK	US
							1993							
Banks	5	6	9	8	4	1	15	4	5	5	24	3	10	..
OFIs	..	0	0	..	2	..	0	3[1]	..	..	0	..	0	..
Securities	..	..	..	36	16	0	24	36	..	..	25	..	..	..
Memorandum items:														
Identified loans as % of:														
Total loans	*3*	*6*	*8*	*5*	*4*	*1*	*14*	*4*	*4*	*5*	*9*	*3*	*5*	..
Business loans	*8*	*8*	*17*	*13*	*7*	*1*	*19*	..	*6*	*8*	*15*	*6*	*19*	..
Identified total as % of:														
Total credit	*3*	*5*	*8*	*10*	*6*	*1*	*14*	*8*	*3*	*4*	*10*	*3*	*4*	..
Business credit	*6*	*8*	*14*	*21*	*9*	*1*	*20*	..	*6*	*7*	*16*	*5*	*11*	..
							1983[2]							
Banks	8	5	7	14	6	0	13	7	3	5[3]	20	3	15	..
OFIs	..	0	0	..	0	..	0	3	..	..	0	..	0	..
Securities	..	..	..	32	26	0	18	21	..	..	44	..	..	..
Memorandum items:														
Identified loans as % of:														
Total loans	*4*	..	*6*	*8*	*4*	*0*	*11*	*6*	*2*	..	*11*	*2*	*9*	..
Business loans	*7*	..	*11*	*17*	*7*	*1*	*17*	..	*4*	..	*23*	*5*	*26*	..
Identified total as % of:														
Total credit	*3*	..	*5*	*12*	*6*	*0*	*12*	..	*2*	..	*13*	*2*	*8*	..
Business credit	*5*	..	*9*	*22*	*10*	*1*	*17*	..	*4*	..	*25*	*5*	*24*	..

[1] Excluding certain institutions (the OFIs covered account for about one-quarter and one-third of total OFI loans in aggregate and maturity tables respectively; correspondingly, total loans covered here amount to over 60 and 80% of the total loans in those tables). [2] Australia: 1988; Austria: 1987; Belgium: 1982; Italy: 1989; Japan: 1988. [3] Deposit-taking institutions only.

ANNEX I

Main assumptions/estimates underlying the tables

In order to help form a better view of the margin of error surrounding the final figures included in the various tables and to facilitate any improvements, this annex lists the main assumptions/estimates that underlie them. When the same assumption is made in more than one table, it is mentioned only in the first case. Unless otherwise shown in brackets, the estimates have been made by the central banks.

Table 2: Credit to the non-government sector

Switzerland: total lending of pension funds in 1983 is estimated by assuming that the change in the ratio of loans backed by real estate collateral to total loans is the same as for insurance companies over the period 1983-92 (BIS).

Table 4: Breakdown by recipients: households and businesses

Canada: credit to the unincorporated sector is calculated as the difference between credit to the personal sector (flow-of-funds accounts) and to households narrowly defined (consumers, answers to the questionnaire) (BIS).

Japan: credit to consumers is calculated by adding housing credits and instalment consumer credit (Bank of Japan statistics). It therefore excludes at least non-instalment credit (BIS).

Switzerland: pension fund loans, all to the business sector; life assurance company loans, 70% to the business sector.

Table 5: Breakdown by instruments: loans and securities

Netherlands: bonds from the BIS database (1993).

Switzerland: bonds from the BIS database.

Table 9: Breakdown by maturity: short-term versus medium and long-term

Note: with the exception of Canada, where they are classified as medium and long-term, in all cases revolving credits repayable at any time are classified as short-term.

Australia: breakdown for non-bank deposit-taking institutions estimated on the basis of a variety of sources.

Canada:	all loans, excluding credit card and business demand loans, are assumed to be medium and long-term.
Germany:	OFI loans, all medium and long-term (BIS).
Japan:	breakdown for the loans made by a variety of financial institutions (19% of total credit in 1993) has been estimated (BIS).
Sweden:	bank loans, 70% short-term (very rough); OFI loans, 97% medium and long-term (BIS).
Switzerland:	short-term bank loans equal to current account loans plus 50% of fixed-term loans and advances (rough). OFI loans all medium and long-term.
United Kingdom:	bank loans, excluding mortgages and leases, all short-term; OFI loans, all medium and long-term (BIS).
United States:	short-term: 5% of tax-exempt debt; 10% of commercial mortgages; all credit card debt; 35% of consumer credit; 40% of all bank loans not classified elsewhere.[52]

Table 13: Breakdown by type of interest rate: adjustable and fixed

Note:	for short-term, see the annex notes to Table 9. In what follows, medium and long-term debt with a rate adjustable at intervals no longer than one year is referred to as "adjustable (a) ", and that whose rate moves broadly in line with short-term rates as "adjustable (b)". In the absence of specific information, (a) and (b) were assumed to coincide.
All countries:	unless otherwise specified, all securities are regarded as fixed rate.
Australia:	rough estimates based on a variety of sources (Reserve Bank of Australia). Some adjustments were needed for a consistent treatment of bank bills (BIS).
Austria:	(a) = 78.5% of medium-term and 64.2% of long-term bank loans (66% of total medium and long-term loans). OFI loans, all medium and long-term at fixed rates (BIS). Some minor adjustments necessary to add to securities. 5% of securities at variable rates.
Belgium:	no estimates appear to have been necessary. (a) = (b).
Canada:	(a) = (b) includes 40 and 60% of non-residential and residential mortgages respectively; 20% of personal loans and 100% of the remaining medium and long-term loans (all rough).
France:	(a) = (b) = 43 and 9% of lending to businesses and households (narrowly defined) respectively. Estimates based on the surveys on the cost of credit. The results are very similar to those that can be obtained on the basis of the survey on the sensitivity of banks' balance sheets to interest rate changes (see main text).
Germany:	(b) = 1/3 of medium and long-term lending (rough). Because of the presence of other reviewable rate loans whose rate behaves more like a long-term rate, (a) is higher.

52 See L.J. Radecki and V. Reinhart (1994).

Italy:	OFIs (a) = (b) assumed to be the same as for long-term credit banks (55.2%) (BIS).
Japan:	BIS estimates made from a variety of sources.
Netherlands:	(b) = 15% of bank medium and long-term lending; (a) > (b); OFI medium and long-term loans, all at predominantly fixed rates (all rough) (BIS).
Spain:	(a) = all variable rate loans in credit statistics (rough, upper limit). (b) assumes that all variable rate mortgages are not related to short-term rates. Variable rate mortgage loans are estimated as 100% of those from mortgage companies and 75% of those from deposit-taking institutions.
Sweden:	(a) = (b) = 10% of OFI loans; 0% of bank medium and long-term loans (BIS).
Switzerland:	(a) = 70% of mortgage lending (BIS) plus 80% of half of fixed-term loans and advances; (b) = 80% of half of fixed-term loans and advances (BIS).
United Kingdom:	80-90% of bank loans are short-term or variable rate (a) = (b) (figures based on survey of three large clearing banks.)[53] Some 90% of building society loans belong to the same category.
United States:	(a) = (b) = 5% of tax-exempt debt and corporate bonds; 30% of home mortgages; 10% of consumer credit; 40% of bank loans not classified elsewhere and of residual other loans category.

Table 14: Breakdown by type of interest rate according to borrowing sector

Australia:	estimates based on a variety of sources.
Germany:	households (narrowly defined): 90% of mortgage debt and 15% of consumer credit are at predominantly fixed rates (rough). (a) > (b) for reasons already outlined. Business sector: calculated residually given total.
Italy:	the share of adjustable rate loans in medium and long-term loans granted by short and long-term credit banks respectively is assumed to be the same for households and businesses.
Japan:	households: short-term plus (a) = 60% of housing loans plus all consumer instalment credit; short-term plus (b) = 0%; businesses: short-term plus (b) calculated residually; (a) > (b) (BIS).
Netherlands:	all variable rate medium and long-term debt assigned to businesses (BIS).
Switzerland:	for both households and businesses the breakdown for mortgages and fixed-term loans and advances is assumed to be the same as in the aggregate.
United Kingdom:	households: short-term plus (a) = short-term plus (b) = 90% of credit (rough). Businesses: 80-90% in the same category (mid-range estimate used to add to securities).
United States:	calculated by applying the aforementioned percentage estimates for the various categories of credit. This assumes that within each category (e.g. loans not classified elsewhere) the breakdown is similar for households and businesses (BIS).

53 It is not clear, however, whether original or actual maturity is used in calculating these figures.

Table 15: Breakdown by type of interest rate according to loan-granting institutions

Australia:	(a) = (b): percentage of variable rate medium and long-term loans is the same for banks and near-banks (BIS, rough).
Belgium:	OFI loans all predominantly fixed rate.
Canada:	application of previous estimates based on the nature of the instrument to the loan portfolio (BIS).
Germany:	all variable rate medium and long-term loans allocated to banks; none to OFIs (BIS).
Spain:	application of previous estimates on variable rate mortgage lending.
Switzerland:	mortgages granted by life assurance companies and pension funds treated like those granted by banks (BIS).
United States:	application of previous estimates based on the nature of the instrument to the loan portfolio (BIS).

Table 16: Collateralisation of loans

	Procedure for estimating the share of bank loans to businesses backed by real estate collateral (all by BIS):
Austria:	mortgages (including some loans to local authorities) minus housing credits ("für den Wohnbau").
Canada:	non-residential mortgages.
Germany:	mortgage loans minus residential mortgages to households ("consumers").
Japan:	bank loans backed by real estate collateral minus bank housing loans.
Netherlands:	mortgages on dwellings to businesses.
Spain:	mortgages of deposit-taking institutions minus housing loans to individuals.
Switzerland:	assumes that the ratio of current account credits and other non-mortgage loans backed by real estate collateral is the same for households and businesses.
United States:	commercial and multi-family residential mortgages granted by commercial banks and thrifts.

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The response of short-term bank lending rates to policy rates: a cross-country perspective[1]

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I. INTRODUCTION

The issue of the size and speed of the response of bank lending rates to changes in policy-controlled interest rates represents an important dimension of the transmission mechanism of monetary policy. Bank lending rates are a key, if not the best, indicator of the *marginal* cost of short-term external funding in an economy. Moreover, they can also provide useful information about developments in the *average* cost of borrowing, to a degree that depends on agents' reliance on short-term or adjustable rate financing at those rates. Such opportunity cost and cash-flow effects are two of the main channels through which monetary policy impulses are transmitted to the rest of the economy. This explains concerns related to the widening of lending spreads in those countries experiencing extensive balance-sheet restructuring in the financial and non-financial sectors during the latest recession, especially in some Anglo-Saxon and Nordic countries as well as in Japan. It is also part of the reason for the short-term difficulties in defending external parities in the face of rapid adjustments of lending rates to policy-controlled rates brought to light by the ERM crisis in the autumn of 1992.

The following study compares the response of key short-term bank lending rates to policy rates in all the countries covered by the project on the transmission mechanism for which appropriate data were available; Austria and Switzerland are excluded. It does not address the question of the determination of long-term lending rates, which in some countries apply to a sizable proportion of bank lending.[2] Nor does it address the issue of how representative short-term rates are of average funding costs, an aspect examined in Borio (1995). The study builds on earlier work carried out at the BIS (1994).

Section II presents a summary of the main findings. Section III discusses briefly the conceptual underpinnings of the analysis; it highlights the insights that the theory of bank behaviour can provide as a guide to empirical work. Section IV describes the basic data used. It focuses on the extent to which the lending rates available differ across countries and are representative of short-term funding costs and on differences in the characteristics of the policy rates chosen. The section also provides simple summary statistics of the behaviour of lending, money market and policy rates and of the relationship between them. Plots of the original series and related spreads are reproduced in Annex I. Section V contains the core econometric results on the short and long-run determination of lending rates, considering in some detail the time path of the response of these rates to changes in money market and policy rates. Possible changes in the relationships over time are also examined. Section VI turns to three specific questions: whether there is evidence of asymmetric adjustments in the upward and downward direction; whether movements in certain less frequently changed official rates, such as discount rates, can help to speed up adjustment in loan rates, possibly by strengthening signals of the direction of policy; and whether the average rather than the marginal cost of funds is more relevant in determining loan rates.

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1 We are grateful to Stephan Arthur for graphical assistance.

2 A preliminary cross-country analysis of the setting of long-term lending rates, with special attention to the mortgage market, can be found in the introduction to BIS (1994).

II. OVERVIEW AND SUMMARY

Economic theory suggests that the *minimum* specification of a loan rate setting equation for a bank should consider money market rates and policy rates as potential proximate determinants. The money market rate acts as the basic proxy for the *marginal* opportunity cost of extending a loan. The rationale for the policy rate is threefold: under certain conditions it can represent the marginal cost of funds; where it is less volatile than money market rates, it can be a better guide to underlying market conditions; and in oligopolistic markets, partly for the above reasons, it could be used by banks as the key reference rate for loan rate setting.

Given this "benchmark" minimum specification, the response of the loan rate to the policy rate has been examined through two different simulation exercises. In the first, *all* the rates that appear as proximate determinants in the loan rate setting equation are shocked simultaneously by 100 basis points (permanently). In the second, only the policy rate is changed and a separate equation is used to endogenise the response of the money market rate to the policy rate. A comparison of the two exercises can help to disentangle the effects that result from loan rate setting procedures of banks from those that reflect differences in the pass-through of policy to market rates.

Graph 1 summarises the main results. It plots countries on the basis of two parameters, viz. the point estimates of the loan rate response after one month and one year respectively when *all* proximate determinants are changed simultaneously. One year is chosen because in most countries the pass-through is complete and the difference between one and two years - the benchmark period for the central bank econometric model simulations - is minor.

Panel A describes the results when the equations are estimated since the mid-1980s (the "whole period"). In a first group, comprising the United Kingdom, the Netherlands, Canada and Belgium, the responsiveness is comparatively high. It is full and immediate in the United Kingdom and the Netherlands but considerably lower, at least in the short run, in Belgium. Responsiveness is comparatively low in the remaining countries, especially within the first month; the differences are far less pronounced at one year.[3,4]

The general picture is largely unchanged if only policy rates are shocked: policy rates survive the specification search to remain proximate determinants in several loan rate setting equations and, even where they do not, the relationship between policy and market rates is typically quite close. The adjustment is now considerably smaller only in the case of Japan, where the overnight rate was chosen as policy rate.

The above findings generally survive the re-estimation of the regressions over the more recent period, typically since around 1990 (Panel B).[5] In most cases the changes in point estimates are remarkably small, well below 10 basis points. The two countries for which the largest differences are apparent are Spain and Japan, where the response is increased almost throughout the time horizon;[6] it remains, however, comparatively low, at least at very short horizons. In Australia and the United States, the response around one month is considerably faster, bringing the countries within the faster adjustment group. By contrast, the one-month response is somewhat lower in the Netherlands. There is some evidence that the change in the loan rate is slower in Germany too.

Economic theory points to a number of factors that can influence the responsiveness of loan rates to market and policy rates. The degree of stickiness is likely to depend positively on several

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3 Sweden is not shown in the graph because the equation is estimated only on quarterly data. After one year the adjustment is around 0.85 (average of two rates used). After one quarter it is around 70%, similar to Italy and Australia.

4 In Australia, the second-month response is considerably higher.

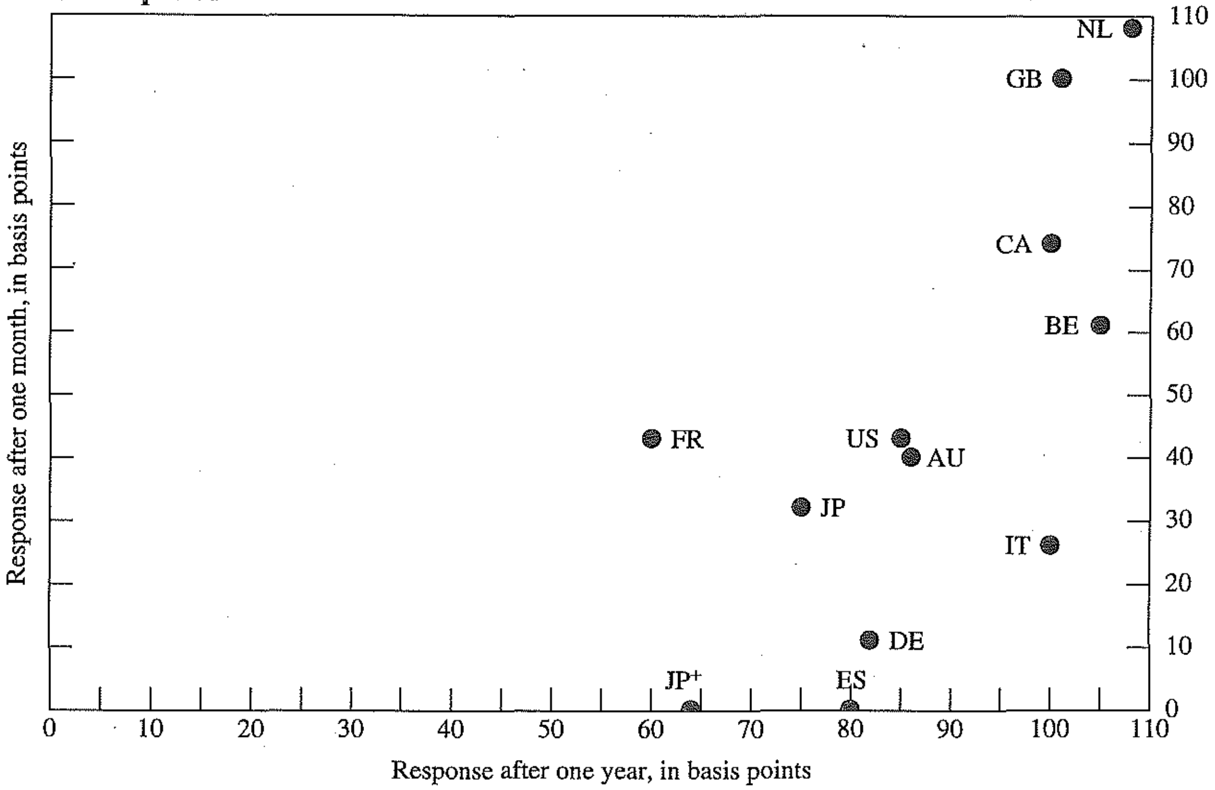
5 The exact periods differ somewhat internationally to take country-specific factors into account.

6 The graph understates the increase in the speed of adjustment for Spain, where after one quarter the response is already 100 basis points.

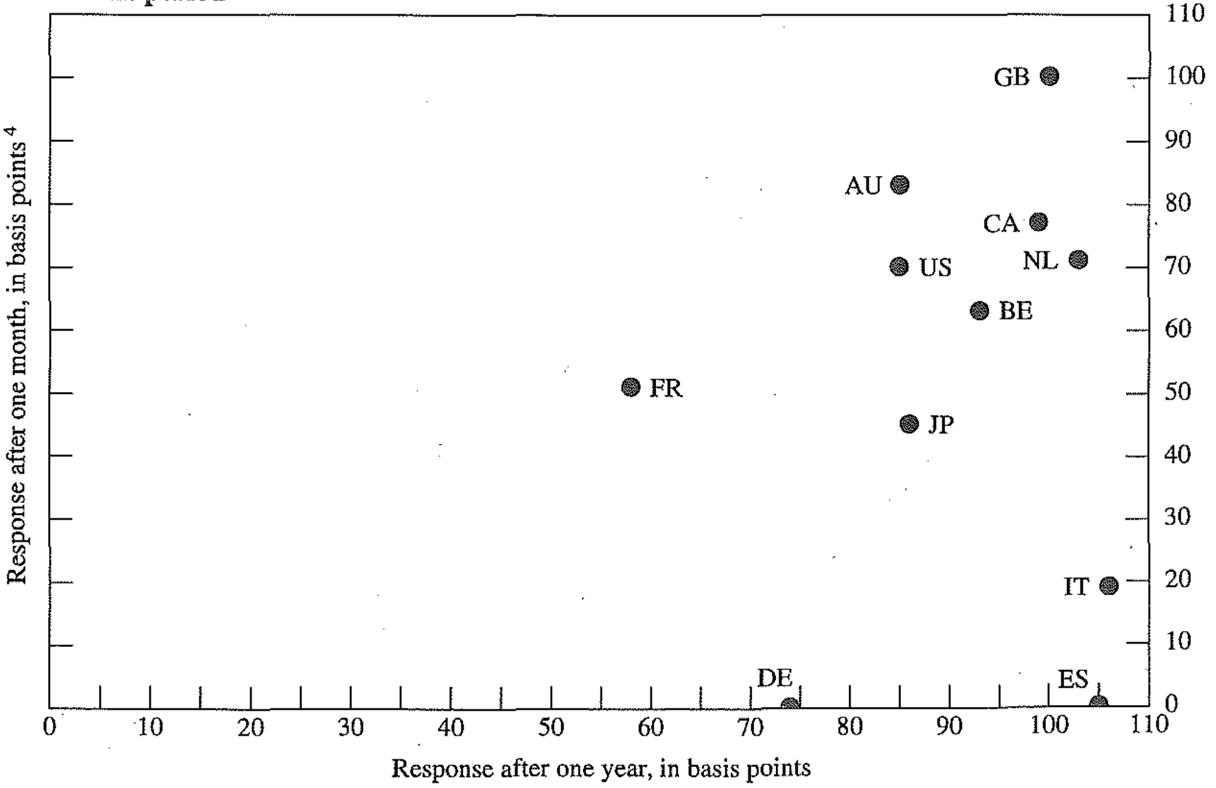
Graph 1

Responsiveness of the loan rate [1]

Whole period [2]



Recent period [3]



[1] Response to a 100 basis point simultaneous increase in policy and money market rates. JP+ refers to a 100 basis point increase in the policy rate only (money market rate endogenous). [2] The period is country-specific but is generally 1984:1 – 1994:7. [3] The period is country-specific but is mostly since around 1990. [4] For Australia, average of first two months owing to overshooting.

elements: (a) the degree of monopoly power[7] in the loan market segment covered; (b) customers' aversion to variable interest rate payments; (c) when average, rather than marginal, cost pricing prevails, the degree of stickiness in *overall* funding costs; and (d) the volatility of market and policy rates. In addition, in any empirical analysis based solely on interest rate variables, the correlation between these and other relevant omitted factors may be important. In particular, procyclical movements in market rates would lead to slow responses if credit risk premia are counter-cyclical or banks' appetite for risk is procyclical. For instance, if a fall in market rates coincides with a recession, a rise in credit risk premia and bank retrenchment are likely to follow, tending to raise the loan spread with respect to the market rate.

This study has not looked in any depth into the issue of interpretation. Nevertheless, certain informed conjectures may be made. While no doubt relevant, the stability of the estimates over different samples suggests that cyclical influences are not dominant.[8] By contrast, the degree of monopoly power in the loan market segment is likely to be important. Formal statistical evidence and casual observation indicate that the largest, typically highest-quality customers tend to borrow at money market related rates, either from the banks themselves or, where possible, directly from the markets. Since these customers are also those that can more easily offset any undesired variability in interest charges, it is possible that aversion to excessive loan rate variability plays a role. Low responsiveness of average funding costs to market rates is likely to be the second important determinant. Though not formally tested, there does appear to be a reasonable correlation between this factor and the cross-country pattern of responses: the United Kingdom (at one end) and Japan and Germany (at the other) are just three such examples. Moreover, confirming previous evidence, the weighted average cost of deposits is indeed significant when added to the benchmark specifications in the only three countries for which such an exercise was possible (Germany, Italy and Spain). Finally, the variability of policy or market rates may also play some role. The faster one-month response of the loan rate to the policy rate in Australia and the United States in the more recent period is at least consistent with this hypothesis. In both countries it has coincided with the adoption of operating procedures designed to provide markets with clearer signals about the authorities' operating objectives for the overnight rate, a strategy which has reduced the "noise" present in its movements.

The dependence of the degree of stickiness on the monopoly power of banks within a specific loan market segment raises the issue of the extent to which the cross-country differences detected may be influenced by the lack of homogeneity in the loan rates used. The available information is not sufficient to form a definite view. Nevertheless, the overall picture is probably not misleading. There does not appear to be a systematic relationship between country classification and potential bias. Admittedly, in some cases the loan rate used may exacerbate differences. For instance, in the case of the Netherlands and Belgium, two fast-adjusting countries, the loan rates appear to apply to the best, largest customers. For other countries, however, the available loan rates may actually mitigate international differences. For example, by comparison with some countries in the slow adjustment group, notably Germany and Japan,[9] the rates used for the United Kingdom and the United States (the "base" and "prime" rate respectively) nowadays appear to be more representative of the "retail" loan segment. In fact, a more broadly based rate for the United States, available only on a quarterly basis, exhibits a considerably higher adjustment speed than the prime.

The tests for asymmetric responses of loan rates generally failed to detect their presence. The only two significant exceptions are Japan and Germany. In Japan the finding seems to reflect primarily the unprecedented widening of the spread in the recent period in the wake of widespread balance-sheet restructuring among financial and non-financial businesses. In Germany, too, the phenomenon can only be detected statistically in the latest interest rate cycle; the impact of reunification may be partly responsible.

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7 In the sense of an imperfectly elastic demand curve for loans.

8 A more definite conclusion would require the inclusion of appropriate variables in the equations.

9 In Japan, the rate covers all short-term loans but price differentiation is very limited.

There is evidence that revisions in infrequently changed rates on official standing facilities[10] generally speed up the adjustment of loan rates. Over the whole sample period, when added to the benchmark specification, the rates are statistically significant and raise the response of the loan rate in all the countries for which they could be tried, viz. Belgium, France, Germany, Italy, the Netherlands, Japan and the United States. In the more recent period their influence only be traced in Belgium and France; in the remaining countries the response remains broadly unchanged.

In the case of the Netherlands, the additional explanatory power of the official rate reflects the variable but administered mark-up linking the discount rate to the loan rate (the minimum rate on unsecured current account credits).[11] For the remaining countries the best interpretation of the statistical finding is not clear. The fact that in several cases the effect is limited to the contemporaneous change in the official rate is consistent with a "signalling" role: the rate can be used to underline the persistence of a specific policy move and thus help to crystallise expectations about future interest rates. In Japan and Italy, for instance, this role has been explicitly recognised. In Germany and Japan, however, lagged changes are also present. One possible explanation is that the rates act as proxy for slow-adjusting deposit rates relevant in the loan rate setting decision. This hypothesis, however, was not formally tested.

III. THE CONCEPTUAL FRAMEWORK

A useful starting-point to organise the various insights that economic theory can yield on the determination of loan rates is to think of "the" contractual loan rate (RL) as being some function of another observable rate or combination of rates (RC). There are at least four questions that deserve attention:

(i) What is the most relevant set of rates RC that can be thought to determine the loan rate?

(ii) What factors affect the relationship between RL and RC, a question that can also be rephrased as: what determines the spread between the two?

(iii) What factors impinge on the response of RL to RC in equilibrium? In particular, is the spread invariant with respect to changes in RC?

(iv) What factors shape the adjustment path of RL to changes in RC?

The variable RC is best thought of as the rate determining the opportunity cost of the lending decisions made by the bank. When banks strive to maximise a particular objective, such as asset size or profits, this is inevitably a *marginal* rate, beyond the banks' control. The most widely used benchmark is a money market rate, seen as the key variable that determines the marginal cost of funds or the revenue forgone by extending a loan.[12] Other rates, however, may also be relevant. One example, especially significant in the present context, is a policy rate, beyond the control of the intermediary. Under certain conditions, it can represent the marginal cost of funds for the institution.[13]

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10 With the exception of France, discount rates were used. For France, the rate chosen was that on five to ten-day repurchase agreements ("pensions").

11 This was true until the end of December 1993. Since then the loan rate has been linked to the rate on central bank advances.

12 The seminal articles by Klein (1971) and Monti (1971), modelling a bank by analogy with a two-product (loan and deposit) monopolistic firm given risk neutrality (or perfect certainty), stress the relevance of such an exogenous rate, to which the marginal revenue (costs) of the other assets are related. Empirically, a money market or equivalent rate is the one most often used in estimating loan equations.

13 In models that stress uncertainty regarding the withdrawal of deposits and the illiquidity costs of loans, penalty costs associated with, say, central bank borrowing play an important role. See, for instance, Hester and Pierce (1975) and subsequent articles.

In the presence of oligopolistic market arrangements, it can be a convenient reference for the setting of rates, as it reflects changes in objective, general market conditions rather than discretionary decisions on the part of individual institutions. And when money market rates are particularly volatile, it may be a better indicator of their persistent, rather than purely transitory, movements. A second such example is deposit rates. They may be particularly relevant if mark-up or full-cost pricing, not necessarily geared to maximising profits, is widespread; deposits often still represent the main portion of average funding costs.[14]

Several factors help to determine the spread between the loan rate and "the" opportunity cost rate. A first factor is the degree of competition in the loan market. In general, the more competitive the market, the smaller is the spread. The sources of market power range widely. They may, for instance, reflect legal and regulatory entry barriers. They may result, more generally, from the existence of set-up and other costs that segment markets. One significant example is the costs associated with limited information, whether on the part of lenders (regarding borrower characteristics and behaviour) or fund users (regarding alternative borrowing opportunities).[15] Differences in this respect are probably a key reason for the division between the retail and wholesale segments of the market. A second factor determining the size of the spread is the risk of loss on the loans: the higher the probability of default of (a given class of) borrowers and the loss in the event of default, the larger the wedge between the expected return on the loan, which drives decisions, and the loan rate. The vulnerability of the financial position of borrowers and whether and how loans are collateralised are particularly significant in this context. A third factor is the basic orientation of the banks' policy: if market share is given priority over profitability, margins will tend to be lower.[16,17]

The responsiveness of the loan rate to changes in the opportunity cost of funds *in equilibrium* is one of the two dimensions of stickiness considered in the literature. The degree of competition is likely to be relevant in this context too. For example, under perfectly competitive market conditions and assuming a constant credit risk premium, the loan rate would move one-for-one with marginal funding costs. One may generally expect the movement to be smaller in the presence of monopolistic power and oligopolistic structures.[18,19] In addition, mark-up pricing, typical of such situations, suggests that the composition of banks' sources of funds and their sensitivity to market

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14 In the basic Monti-Klein set-up the opportunity cost is independent of the characteristics of the deposit market; deposit rates, therefore, do not help to determine loan rates. Various ways have been explored to break down this separability, other than mark-up pricing in oligopolistic or non-profit maximisation structures. These include joint production costs (Baltensperger (1980)), allowing the bank to set the deposit rate to limit the risk of penalty liquidity costs by raising the expected deposit volume (Tobin (1982)) and others (see Bank of Spain (1992) for some references). None of them, however, has the realistic appeal of mark-up pricing.

15 "Search" and "switching" costs fall within this category. See, for instance, Diamond (1971) and Klemperer (1987).

16 This is true, for example, in Klein-Monti type models as long as loans enter into the measure of size, since they would be expanded beyond the profit-maximisation point (see, for example, Takeda (1985)).

17 In addition, in any empirical analysis, term structure effects may be significant. In principle, the loan and opportunity cost rates should refer to the same horizons; in practice, the empirical counterparts to the theoretical concepts may fall short of this requirement. This, however, is less likely to be a problem when short-term lending rates are examined.

18 Unless the demand curve has a constant semi-elasticity this is true in the textbook monopoly case; see also Klemperer (1987) for monopolistic power in the presence of switching costs. Similar arguments would apply to collusive oligopolistic markets. The famous "kinked" demand curve is probably the best-known example in the context of non-collusive behaviour (Stigler (1947)).

19 By analogy with models of firm behaviour, it is also possible to argue that the degree of response will partly depend on whether banks are more interested in size than in profits. The detailed results, however, depend crucially on the specifications of the model and few generalisations seem possible (e.g. Monti (1974) and Takeda (1985)).

rates may be important. A large share of deposits at relatively unresponsive interest rates, for instance, would tend to limit the change in loan rates.[20]

The relevance of the degree of competition in loan and deposit markets loses part of its force once a time dimension is explicitly considered. Demand curves are likely to be more inelastic in the short than in the medium run. Fixed search and switching costs, for instance, hardly seem to justify a *permanent* limited response to changes in the opportunity cost of funds. The forces of arbitrage between different banks or between banks and alternative sources of credit and uses of funds become more powerful as time elapses.

This also suggests that, while analytically correct, it may in practice be quite difficult to distinguish the first form of stickiness just described (adjustments in equilibrium) from the second, viz. non-instantaneous adjustment *between* equilibria. Unless adjustment is costless, banks may wish to smooth movements in the lending rates. There are administrative costs associated with such changes. In addition, borrowers may dislike the induced fluctuations in their incomes and cash flows.[21] Since for any given adjustment costs the profits forgone decrease with the degree of monopoly power, once again rates should be expected to be stickier in less competitive market segments.[22,23] Moreover, the speed of adjustment is likely to increase with the degree of anticipated *persistence* in the change in the opportunity cost of funds.

The aforementioned explanations of stickiness relate correctly to the response of the loan rate to market rates. In any empirical analysis, however, apparent stickiness may be detected if the influence of variables excluded from the analysis is not properly controlled for and their movements are correlated with the interest rates included in the specification. In particular, stickiness can emerge if money market rates move procyclically and default risk premia do so counter-cyclically or banks' appetite or ability to take risks and price agressiveness move in sentiment with economic activity. In this case, spreads would tend to narrow in upswings and widen in downswings.

A final question regarding the adjustment path is whether and, if so, under what conditions revisions in the loan rate are likely to be *asymmetric* with respect to increases and decreases in the rates measuring opportunity costs. Several arguments in fact suggest that the response may be faster when such rates rise. First, there may be a lag in the response of borrowers to changes in the price of credit; if so, revenue is temporarily forgone when rates are lowered but gained when they are raised. Second, in oligopolistic structures banks may expect their competitors to be more likely to follow rate reductions than increases, especially if mistaken for attempts at gaining market share;[24] as outlined above, the comparatively more responsive demand for loans in the event of rate increases

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20 Stickiness may also result from rationing (e.g. Stiglitz and Weiss (1981)). This rationale, however, is unlikely to be very relevant for the category of borrowers covered in the present study (see below).

21 Fried and Howitt (1980) develop a model in this spirit though with reference to real interest rates. Borrowers essentially pay in the form of a higher premium for the insurance provided by the bank.

22 Drawing on Rotemberg and Saloner (1987), Hannah and Berger (1989) generalise this argument to a variety of non-collusive oligopolistic structures and apply it to the deposit market. Their tests confirm the hypothesis that price stickiness increases with market concentration (for details of the empirical tests, see alternatively Hannah and Berger (1991)).

23 Moreover, the generalisation regarding the degree of competition relates only to stickiness with respect to changes in opportunity cost interest rates. In non-perfectly competitive environments, where objectives other than profit maximisation are more tenable, loan rates may actually be *more* responsive to *other* types of shocks. For example, in the case of full-cost pricing or when size is traded off against profits or pursued subject to minimum capital levels, any shock affecting *average* profitability could elicit a rise in the spread. The reason is that the bank would have a reserve of unexploited profit opportunities to tap. This is especially relevant in the context of the large loan losses experienced by banks in several countries in recent years. It implies that the spread would rise *over and above* any increase in perceptions of higher risks *at the margin.*

24 This is, of course, the basis of the "kinked" demand curve; for "small" changes in marginal costs, prices do not move; for larger changes, adjustment is stickier in the upward direction.

means that the costs of being away from equilibrium are larger when market rates are rising. Moreover, in the presence of collusive arrangements, the risk of triggering a price war through rate reductions may make downward revisions inherently costly. Third, as with stickiness, in any empirical analysis the asymmetry may emerge because of changes in variables correlated with interest rate movements and not properly controlled for. For example, the demand for bank funds may become more inelastic during recessions, as bank customer relationships are strengthened and borrowers become more "captive" of their traditional sources of funds. If market interest rates tend to fall during recessions, an asymmetric response would be detected in the data.[25]

The aforementioned discussion implies a number of points for the empirical analysis. First, the smallest set of variables in a general specification of a loan rate equation should contain a money market rate and a policy rate. Deposit rates or the average cost of funds may also be relevant, especially if mark-up pricing is widespread. Indicators of the riskiness of lending could also prove useful; owing to data limitations, however, they are not employed in what follows.

Second, the path followed by the loan rate in response to changes in rates that are its proximate determinants is a function of a number of factors: the degree of competition in the industry and the market segment concerned; the characteristics of the class of borrowers to which the rate applies; the structure of the financial institution's balance sheet, notably its sources of funds; the degree of anticipated persistence in the change of reference interest rates; and "cyclical" elements. Without a detailed analysis and adequate information, it may be quite difficult to disentangle empirically what factors may account for any country differences unveiled by the econometric evidence.[26]

Third, the response path may not be symmetric with respect to increases and decreases in the determining rates. It is worth testing for the presence of such asymmetries.[27]

Finally, whenever a money market rate turns out to be statistically significant in a loan rate setting relationship, its link to the policy rate needs to be explicitly modelled when considering the pass-through of changes in policy.[28] Nevertheless, it is also of interest to consider the reaction of the loan rate to its proximate determinants *separately*, i.e. assuming that money market rates respond fully and instantaneously to policy rate changes. This can help to distinguish cross-country differences reflecting the behaviour of the banks from those that originate in the link between policy and market rates themselves.[29]

IV. A PRELIMINARY LOOK AT THE BASIC VARIABLES

1. Lending rates

The first choice confronting any empirical research on bank lending rates is that of the specific rate variable. The loan market is far from homogeneous. The intended use of the funds lent,

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25 With reference to the credit card market in the United States, Ausubel (1991) puts forward the view that rates may be sticky downwards in part because customers behave irrationally. In contrast to the Stiglitz and Weiss (1981) scenario, where riskier customers are less sensitive to higher borrowing costs (because their probability of default is higher), he points out that the opposite may be true: safe customers systematically *underpredict* the likelihood of incurring charges. He provides some evidence to confirm this hypothesis.

26 Cottarelli and Kourelis (1994), considering a large sample of industrial and non-industrial countries, find evidence that the responsiveness of lending rates is indeed related to structural proxies of the degree of competition in markets.

27 Hannah and Berger (1991), for instance, find evidence of such asymmetries for US bank deposit rates.

28 Similar arguments would clearly apply to any other rate influencing the loan rate setting decision (e.g. deposit rates).

29 This, of course, does not apply when *only* policy rates turn out to be relevant in the loan rate setting relationship.

the sources of repayment and the characteristics of the borrowers, not least their ease of access to alternative external funding, differ widely. This implies considerable differences in contract terms on the loans, including maturity, covenants, collateral, fee structures and, of course, the interest rate charged. Such differences are only partly moderated by the widespread practice of setting relatively standard terms for broad classes of loans, a practice that probably reflects a mixture of factors, not least the information costs of a finer approach and broader institutional features. As the foregoing sketch of theoretical paradigms indicates, the response of interest rates may be quite sensitive to class-wide and contract-specific characteristics.

From the viewpoint of empirical work, the various types of rate have pros and cons. An average rate calculated over a broad set of classes of (new) loans is a better approximation to the (marginal) cost of borrowing from banks than narrower averages. It is, however, of more difficult interpretation, as it mixes the effect of a greater variety of elements. Actual rates are generally superior to reference rates to which varying spreads are applied. But reference rates may be less sensitive to certain factors (e.g. credit risk) which may be difficult to model separately owing to the limited availability of statistics at the relevant frequency.

Box 1: Bank lending rates[1]

Australia:	Rate on overdrafts and fully drawn loans; large business (≥ $100,000); minimum of a range reported by major banks. (Month-end.)
Belgium:	Rate on overdrafts; prime customers; major banks. (Month-end.)
Canada:	Rate on prime business loans; chartered banks. (Month-end.)
France:	Base rate. (Month-end.)
Germany:	Rate on current account credits; DM 1-5 million; average. (Survey 2nd-3rd week of the month.)
Italy:	Short-term loan rate; average of 89 banks. (Survey 10th, 20th and last day of the month; average.)[2]
Japan:	1. Loan rate on all new loans (*all maturities*); average of all banks. (Month-end.) 2. Loan rate on new short-term loans (over one month, less than one year); average of all banks. (Month-end.)
Netherlands:	Rate on current account credits (unsecured); minimum. (Month-end.)
Spain:	Rate on current accounts; 3 months - 1 year.
Sweden:	1. Rate on bank advances to businesses. (Monthly average at quarter-end.) 2. Rate on bank loans to businesses. Volume-weighted. Central bank survey. (Quarter-end.)
United Kingdom:	Prime ("blue chip") rate (base rate plus 100 b.p.); London clearing banks. (Month-end.)
United States:	1. Prime rate; short-term loans to businesses. (Monthly average.) 2. Rate on short-term loans to businesses; average. (Survey 1st week of mid-quarter month.)

[1] Month-end should be interpreted loosely; in some cases it refers to a day in the last week of the month. [2] Some values interpolated; two-month moving average used owing to very high volatility.

The ideal solution would be to consider the behaviour of rates for key classes of loans as well as some broader averages. In practice, especially in a cross-country context, such an analysis is heavily constrained by the availability of data. It is generally possible to distinguish short from longer-term rates and to identify those that apply to the business sector. Beyond this, however, large gaps and differences exist. Average rates for significant portions of the loan portfolio are almost invariably not available. Standard reference rates (e.g. "prime" rates) are sometimes the only ones for which a historical series exists at frequent observation intervals. Moreover, information about how representative the various rates are is typically limited.

Given these constraints, the following empirical tests will focus heavily on the set of short-term rates deemed to apply primarily to the business sector; where appropriate, more than one rate is used for each country. Given the emphasis on adjustment paths, monthly series (if possible measured at month-end) are used;[30] this was not feasible in the case of Sweden, however, for which only quarterly data were available. The list of variables is shown in Box 1. Unfortunately, in the case of Austria and Switzerland no suitable rates could be found. For five countries (Australia, Belgium, Germany, the Netherlands and Spain), the loan rate refers to current account/overdraft advances. For three of the Anglo-Saxon countries (Canada, the United Kingdom and the United States) as well as for France, the rates are "prime"/"base" reference rates. For Italy and Japan, they are averages for various classes of loans, in Japan including some long-term loans for part of the period. In the case of the United States, an actual rate on short-term loans to businesses, based on survey data and with quarterly frequency, was also chosen. The quarterly rates for Sweden are averages of all loans to businesses; they probably include a very small proportion of longer-term loans.

Box 2 provides some, albeit limited, information about the type of borrowers and percentage of bank lending for which the chosen rates can be regarded as representative. For the group of countries for which a prime/base rate is used, the available evidence suggests that the rate nowadays applies primarily to *small and medium-sized* businesses, with large corporations borrowing mainly at money market related rates; Canada appears to be a partial exception to this pattern. Over time, in the wake of a heightening of competitive pressures in financial systems, the prime rate has clearly lost its original function of basic reference rate for high-quality customers. Overdrafts/current account rates apply mainly to business sector lending. In the case of Australia, the Netherlands and probably Germany and Belgium,[31] the rates chosen relate mainly to large borrowers; the rate for Spain seems to have a broader coverage. The rate for Italy relates largely to the business sector, but clearly includes firms of all sizes, paying rates with possibly varying degrees of stickiness. In the case of Japan, the rate covers all borrowers; given the limited degree of price differentiation that appears to characterise the Japanese loan market, however, this should not give rise to ambiguous interpretations. What could potentially have more serious consequences is the fact that the series actually includes also medium and long-term loans until March 1990. Even so, inspection of the data indicated that this series has behaved remarkably like that for short-term loans in the more recent period: term structure effects do not appear to be significant, as a result of the behaviour of both the component rates and the corresponding shares in total loans.[32] All of these cross-country differences in the nature of the data should be borne in mind when assessing the statistical results.

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30 For the analysis of certain issues, such as the ability to defend exchange rate commitments against speculative attacks, even higher frequency would be desirable.

31 In Belgium, large companies actively use fixed-term loans with rates that are closely linked to market rates.

32 Splicing the two series was preferred to using a rate on all short-term loans outstanding. This in fact exhibited considerably slower adjustment because of "ageing" effects at the relevant frequencies.

Box 2: How representative are the lending rates?[1]	
Australia:	Some one-third of bank short-term and adjustable rate business loans are revolving credits (estimated to be around 20% of total short-term and adjustable rate business credit).
Belgium:	Some 30% of bank short-term business loans take the form of overdrafts (around the same proportion of total short-term business credit).
Canada:	The rate charged on the great majority of business loans is directly linked to the prime rate; practice of applying money market related discounts to highest quality borrowers is infrequent (Clinton and Howard (1994)).
France:	Base rate applicable mainly to small companies; larger companies borrow primarily at money market related rates (questionnaire). Some one-quarter of bank adjustable rate lending is base rate related; around two-thirds is money market related (survey of large banks; Bank of France (1993)).
Italy:	Some 60% of total bank lending (short-term credit) is short-term (up to 18 months) loans to businesses.[2] Only 5% of the institutions' lending is to households (narrowly defined) and 14% to the unincorporated sector.[3] Current account credits amount to over 50% of total short-term credit of these institutions.
Japan:	Probably over 90% of bank ("Zengin") short-term lending is to the business sector (including unincorporated enterprises). There are no significant differences in the rates applied to the household or business sector or to enterprises of different sizes (questionnaire).
Netherlands:	Some 2/3 of total short-term business lending takes the form of current account credits.
United Kingdom:	Some 80% of bank lending to small corporate firms (with a turnover of less than £10 million) is base rate related (survey); only around 40% of short-term borrowing of large corporates (75% of total net assets of the sector) takes the form of bank lending, mainly related to money market rates (Bank of England (1993)).
United States:	Over 40% of commercial and industrial (C&I) loans of commercial banks (including adjustable rate medium and long-term loans) are related to prime; probably around one-third of all prime-related loans are to households (including consumer and home-equity loans). The share of C&I loans related to prime has declined appreciably since the late 1980s, a process that began in the mid-1990s (Senior Loan Officer Survey (1993), Radecki and Reinhart (1994), Wolfson and McLaughlin (1989) and Brady (1985)).

[1] For the ratio of short-term to total bank credit, see also the accompanying paper on the structure of credit. [2] Excluding the unincorporated sector. [3] The remaining portion is mainly to financial institutions or holding companies.

2. Money market rates

The choice of money market rate as the key measure of the marginal opportunity cost of funds in part reflects the characteristics of the countries' financial systems (Box 3). In most cases an interbank loan rate was used. In Italy and Sweden, where for at least part of the period under consideration the interbank market was not well-developed, a government Treasury bill rate was preferred. In Canada and Australia, where private short-term securities markets are important, a commercial paper rate and bank bill rate respectively were selected; the rate on certificates of deposit was taken as benchmark for the United States. In general, the specific choice of rate is unlikely to be important, since market rates of similar maturities tend to move closely together, at least for the precision required for present purposes. The maturity was standardised at three months.

Box 3: Three-month money market rates

Note:	Unless otherwise specified, interbank loan rates. (Month-end.)
Australia:	Bank bills (acceptable by the central bank). (Monthly average.)
Canada:	Prime corporate commercial paper. (Month-end.)
Italy:	Treasury bills (ordinary), tender rate; gross of tax. (Monthly average.)
Japan:	Call money (unsecured); (until 2/93) RP on bonds (Gensaki). (Monthly average.)
Sweden:	Treasury discount notes, market yield. (Monthly average at quarter-end.)
United States:	Certificates of deposit; secondary market rate. (Monthly average.)

3. Policy rates

At the level of operating procedures, all the central banks considered in this study gear their policy instruments towards influencing quite closely short-term interest rates ("operating objectives"). They do so primarily by determining the conditions that equilibrate demand and supply in the market for bank reserves, most notably by setting the terms at which the banks' marginal demand is met. Beyond this common element, approaches differ in respect of the precise instruments and strategies followed. Such differences have implications for the rate that may be deemed as the most appropriate indicator of policy choices.[33]

In a first group of countries, policy is essentially geared to influencing overnight rates. The United States, Australia, Sweden and Japan fall within this category. In all of them the central banks operate frequently in the markets (at least once a day). In the case of Sweden, central bank intentions are signalled more explicitly by the key rate through which the authorities provide marginal finance (Box 4). No such rates are available for the other countries in this group; the overnight rate may contain greater "noise". Nevertheless, in both Australia and the United States during the recent period of falling rates, the central banks have provided markets with clearer indications of their policy objectives for the rate, be it in the form of published standards (Australia, since 1990) or in a less formal fashion (United States, since about June 1989). As a result, the overnight rate has tended to follow even more smoothly the norms set by the authorities.

33 For a detailed analysis of the issues involved and a description of changes in operating procedures of central banks up to the late 1980s, see Kneeshaw and Van den Bergh (1989).

Box 4: Policy rates[1]	
Australia:	Call money (11 a.m. unofficial market). Overnight. (Month-average.)
Belgium:	RP tender rate (bills and government securities). One-week. (Month-end.)
Canada:	Official Bank Rate (average tender rate for 91-day Government of Canada Treasury bills + 25 b.p.). Generally overnight. (Month-end.)
France:	Tender rate. Generally one week. (Month-end.)
Germany:	RP tender rate. Generally two weeks to one month. (Month-end.)
Italy:	1. (Whole period) Effective rate on fixed-term advances; weighted average. 5-30 days. (Month-end.)[2]
	2. (Recent period, from 91:1) RP tender rate; purchases; average. (Month-average.)
Japan:	Call money (unsecured). Overnight. (Month-average.)
Netherlands:	Special loans rate (equivalent to RPs). Generally up to one week. (Month-end.)
Spain:	RP tender rate. 10-day (until 90:4)/overnight. (Month-average.)
Sweden:	Bank of Sweden's marginal loan rate. Generally overnight. (Quarter-end.)
United Kingdom:	Outright purchases (indicator of minimum ("stop") rate, Band 1 bills). 1 day to 2 weeks. (Month-end.)
United States:	Federal funds rate; average. Overnight. (Month or quarter-average, as appropriate.)

[1] Month-end refers to the last working day of the month or the last date on which the relevant transactions take place. [2] A two-month moving average was chosen given the extreme volatility in the rate.

In most of the remaining countries policy hinges on the central bank's provision of reserves at periodic tenders, generally through repurchase agreement transactions, at maturities that typically exceed one day. With the exception of Sweden, all the continental European countries may be classified in this group. The rates applied to the tender operations provide a useful indicator of policy intentions (Box 4). Overnight rates need not be such a good guide. Admittedly, standard facilities for supplying/absorbing reserves, averaging provisions for compulsory reserve holdings and other ad hoc operations are often employed to limit their volatility. Nonetheless, in some countries of this group policy has at times accepted or encouraged substantial fluctuations in the rates on a day-to-day basis. This has been especially true at times when exchange rate commitments have come under pressure.

Canada does not fall neatly within either group. Much of its policy strategy is geared to affecting the overnight rate, but with a clear view to influencing the three-month money market rate. Indeed, the rate at which banks are induced regularly to meet their marginal reserve needs (the Official Bank Rate) is itself set as a mark-up on the weekly three-month Treasury bill tender rate: the overnight rate tracks it relatively closely. Under these conditions, the Bank Rate appears to be a good policy indicator.

Another intermediate case is that of the United Kingdom. By comparison with most continental European countries, operations are much more frequent (more than once a day) and at shorter maturities. At the same time, the overnight rate is not such a good proxy; policy and central bank objectives are better captured by the rate at which its market operations are carried out.

Albeit to different degrees, since the mid-1980s - the basic period for estimation of the regressions - operating procedures have evolved considerably in several of the countries covered, the continuation of a process dating back to at least the late 1970s or early 1980s. True, the fundamental orientation towards short-term interest rate objectives has, if anything, strengthened. Nonetheless, changes in instruments and tactics suggest that shifts in the relationship between policy and market rates may sometimes have taken place. These can in some cases complicate the precise choice of policy indicators for the whole period.

Two examples of possible shifts in the relationship between policy and money market rates have already been mentioned; they relate to the more explicit attitude towards interest rate objectives in Australia and the United States in more recent years. Another such example is the broad reform of operating procedures in Japan in late 1988 and early 1989 aimed at allowing market forces to exert somewhat greater influence on longer-term money market rates and at making it easier for market participants to read policy signals.[34] In none of these cases, however, is the choice of policy indicator affected. A more general trend has been the decreased reliance on standing facilities as a means of meeting banks' marginal reserve needs, yielding ground to more discretionary open market operations. Even so, the conspicuous changes in rates on official facilities often retain an important signalling role: they can help to crystallise expectations about changes in the policy stance. Inspection of the relationship between the various rates involved generally suggests that those on discretionary operations may be a useful indicator for the whole period; any residual influence of changes in those on standing facilities can be tested for separately.

For some countries, however, changes in operating procedures have been so profound as to make a unique choice of policy indicator rate problematic. This is true for Italy and Belgium. While operations have resembled fairly closely those of other continental European countries since the early 1990s, before then a key role was played by the Treasury bill tender rate;[35] in Italy, the penalty rate on fixed-term loan advances[36] was also significant, especially at times when banks were short of reserves. This suggests that, in addition to a standard equation for the whole period, a separate one should be tested for since the early 1990s, with tender rates used as the relevant policy rates. For Belgium, the equation for the whole period includes *only* the three-month interbank rate: this variable tracks the Treasury bill rate extremely closely, and it would make little sense to have both in the regression. For Italy, the rate on fixed-term advances is used as "the" policy rate and included alongside the three-month Treasury bill rate, the proxy for the money market rate. It is clear, however, that in both cases it is rather hard to distinguish meaningfully between "policy" and "market" rates over the period: the money market rate proxies will directly capture much of the policy effect.

Spain appears to be an intermediate case. Starting around 1989 and ending in May 1990, operating procedures were reformed in terms of both instruments and objectives so as to resemble closely those in other continental European countries. This implied considerably greater emphasis on smoothing fluctuations in short-term rates and on more market-oriented instruments of control. Here two different tender rates were spliced, but it is unclear whether that prior to May 1990 is a good approximation to policy influences.

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34 A key step in the reforms was to shorten the maturity of central bank open market operations while greatly increasing their frequency.

35 In Belgium, until the end of January 1991 the National Bank guided money market rates by fixing the rates on one to three-month Treasury certificates (Périlleux and Wouters (1994)). In Italy, until 1988-89 the Bank of Italy was under the obligation to set the minimum price at the weekly Treasury bill tenders. The fact that compulsory reserve holdings could not be used to meet settlement needs also meant that until October 1990 the overnight rate behaved very erratically (Gaiotti (1992)). On both countries, see also Kneeshaw and Van den Bergh (1989).

36 The penalty schedule was set in relation to the frequency with which individual banks had recourse to this form of credit.

Table 1

Characteristics of the relationship between the loan and money market rates

	Spread (RL-RM)						Loan rate $\Delta RL = 0$ (% obs.)	Period
	Mean	Minimum	Maximum	Negative obs.	SD	Trend[1]		
Australia	2.59	- 0.35	4.55	2	1.25	0.03***	42.5	84:1-94:7
Belgium	2.95	1.50	4.12	-	0.69	0.01***	61.4	84:1-94:7
Canada	1.05	- 1.80	2.25	1	0.46	-	46.5	84:1-94:7
France	0.83	- 5.35	2.73	19	1.11	- 0.01***	78.7	84:1-94:7
Germany	2.42	0.54	4.55	-	0.94	0.01***	2.4	84:1-94:7
Italy	2.57	- 0.27	5.42	3	1.27	- 0.02***	3.4	84:7-94:6
Japan	0.46	- 1.37	1.70	29	0.64	0.02***	0.0	84:1-94:7
Netherlands	1.41	0.75	2.13	-	0.30	0.004***	63.8	84:1-94:7
Spain	2.65	- 5.60	5.82	8	1.68	-	0.8	84:1-94:7
Sweden (1)[2]	2.61	1.61	3.71	-	0.58	-	0.0	86:III-92:II (Q)
(2)[2]	2.88	- 0.72	4.62	1	1.15	0.09**	0.0	89:I-94:II (Q)
United Kingdom[2]	0.92	0.06	2.43	-	0.27	0.001**	63.0	84:I-94:7
United States (1)[2]	2.03	1.05	2.95	-	0.54	0.01***	54.3	84:1-94:7
(2)[2]	1.73	0.98	3.53	-	0.48	-	2.4	84:I-94:I (Q)

Note: For a list of symbols used here and in subsequent tables, refer to the Appendix at the end of this paper.

[1] Coefficient of a linear trend in a regression for the spread (including a constant). [2] Refers to the loan rates identified in Box 1.

4. Descriptive statistics

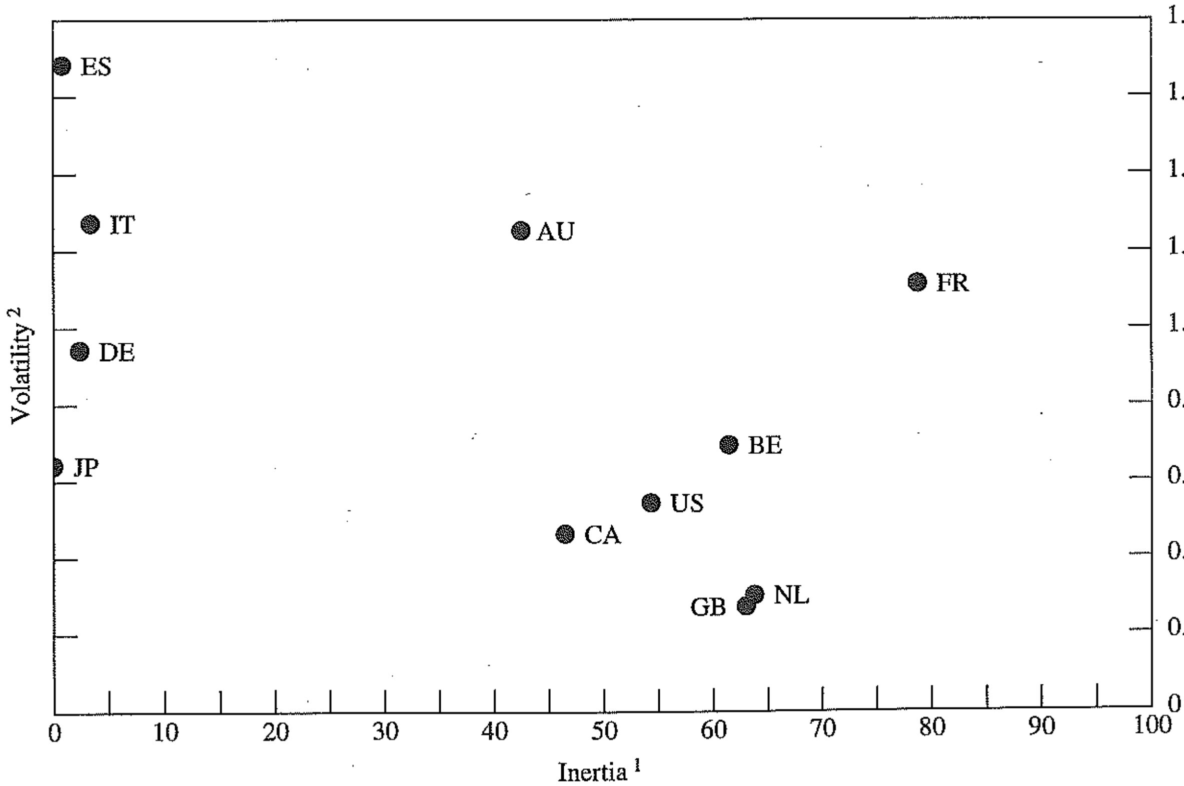
It may be useful to consider briefly some of the main time series characteristics of the data. In order to keep the treatment manageable, detailed plots of the individual series and corresponding spreads are shown in Annex I and what follows limits the attention to two bivariate relationships (loan rate/money market rate and money market rate/policy rate). This is done even though in several cases it is possible to trace a direct relationship between the loan and policy rates (see below).

Table 1 summarises some key features of the behaviour of the loan rate and the loan/money market spread. Several points stand out.

First, the mean of the spread, generally measured since the mid-1980s, while positive, varies greatly across countries. As argued above, however, cross-country differences in this respect are very hard to interpret. In a majority of countries, negative values can be observed. These have typically coincided with episodes of resistance to severe downward pressure on exchange rates, especially in more recent years (Canada and continental European countries); despite similar pressures, the monthly spread has never been negative in the United Kingdom. The only country for which the spread has been negative for protracted periods is Japan. No doubt this reflects at least in part the extensive regulation of deposit rates and the comparatively limited recourse to wholesale funding for much of the period under consideration.

Graph 2

Loan rate inertia and volatility in the spread



[1] Measured by the percentage of observations for which the change in the loan rate is zero. [2] Measured by the standard deviation of the spread between the loan and the money market rates.

Table 2

Characteristics of the spread between the policy and money market rates

	Correlation		Policy rate		Period
	Level	Changes	SD	ΔRP = 0 (% obs.)	
Australia	0.99	0.71	0.93	12.6	84:1-94:7
Belgium	0.97	0.79	0.47	16.7	91:1-94:7
Canada	0.99	0.76	0.59	1.6	84:1-94:7
France	0.90	0.24	0.25	59.1	84:1-94:7
Germany	0.99	0.68	0.23	33.9	84:1-94:7
Italy (1)*	0.85	0.32	0.51	9.5	84:7-94:6
(2)*	0.94	0.81	1.00	2.4	91:1-94:7
Japan	0.99	0.77	0.32	0.0	85:7-94:6
Netherlands	0.99	0.76	0.26	38.6	84:1-94:7
Spain	0.93	0.37	0.73	5.7	84:3-94:7
Sweden	0.84	0.91	6.61	26.8	84:I-94:I (Q)
	0.85	0.95	9.23	23.8	89:I-94:I (Q)
United Kingdom	0.99	0.87	0.70	61.4	84:1-94:7
United States	0.99	0.75	0.30	0.8	84:1-94:7
	0.99	0.90	0.67	0.0	84:I-94:II (Q)

* Refers to the policy rates identified in Box 4.

Second, the percentage of observations for which there is no change in the (monthly) loan rate is typically very high (at least 40% or over); the administered nature of the rate comes out quite clearly. The very low percentages for Italy and Japan are misleading, since the rates are averages of actual rates covering different classes of borrowers. The same is true for Germany, given the way the indicator is constructed.[37]

Third, there is, however, little correlation between the degree to which rates appear to be "administered" and measures of the volatility in the spread - a rough indicator of "stickiness" (Graph 2). Statistically, therefore, the results are unlikely to be fundamentally affected by this aspect of the loan rates chosen.

Finally, in a majority of countries there are signs of a positive "trend" in the spread (Table 1). Inspection of the plots indicates that this results primarily from a widening in the recent recession, especially in those countries where banks have suffered significant losses in the wake of comparatively large asset price movements, notably in real estate prices, and increases in the indebtedness of non-financial sectors (Australia, United States, Sweden and Japan). In the United Kingdom the widening is statistically significant but negligible.[38] Only in Italy and France[39] are there signs of a significant decline. On the whole, the evidence appears to indicate that in most countries the influence on the spread of the recent recession, heightened by the pattern of expansion that preceded it, swamps any downward long-term pressures associated with financial liberalisation.

Policy rates, while generally more flexible than loan rates, also appear not to change for a considerable number of observations in certain countries, notably the United Kingdom, the

37 The rate is an average of reported rates (excluding the observations falling within the top and bottom 5% range of the sample distribution). The rate corresponding to the lower bound, for instance, moves far less frequently: the percentage of observations for which there is no change is around 50%.

38 In Germany, by contrast, the initial part of the recent rise in the spread coincides with rapid credit expansion following the country's reunification.

39 In France, there is a marked narrowing of the spread in 1989; the spread widens again as from 1993 (see Annex I).

Netherlands, Germany and Sweden (Table 2).[40] Here again, however, there is little evidence that greater "inertia" in the above sense is associated with a lower correlation between policy and money market rates. Indeed, as might be expected, the correlation is very high (generally 95% or more) when measured in levels, somewhat lower in first differences. This confirms that econometric results which attempt to distinguish the influence of the two variables on the loan rate should be interpreted with some caution, at least as regards long-run relationships.

V. CORE ECONOMETRIC RESULTS

Following the clues derived from the theoretical discussion and the preliminary look at the data, this section considers the behaviour of loan rates on the basis of the *minimum* set of variables deemed a priori relevant for their determination (policy and money market rates). In identifying the most appropriate specification, a standard general-to-specific approach is followed within the set of equations parametrised in error-correction form, a popular set which allows considerable flexibility in capturing the dynamic interaction between the variables. The dependent variables, therefore, are always measured in first differences. All regressions were estimated by OLS.

1. Minimum specification: whole sample

Table 3 summarises the basic pattern of results for the proximate determinants of the loan rates over the whole sample, typically early 1984 to mid-1994; the detailed findings are contained in Annex I (Table AI.1). The equations describing the *average* behaviour of the rates over the whole period generally appear to be sufficiently well specified. In particular, there are virtually no signs of serial correlation. As a further test of the adequacy of the benchmark specification, the relationships were re-estimated to the end of 1993 and "out-of-sample" forecasts performed; an eye on the potential loss of degrees of freedom counselled against reserving observations *entirely* for such an exercise. In fact, the "best" specification proved to be very stable, both in terms of the size and significance of the coefficients. The post-sample forecasting performance is adequate, in the sense that the projected values lie within the respective confidence bands; Germany is the only exception (Annex I, Graph AI.2). There is, however, some tendency for the forecasts to overpredict, probably reflecting the cyclical position of the economies.

As regards the relevant rates in the set of explanatory variables, one interesting result is that the policy rate often enters *directly* into the equation. It does so not only in the short run but also in the long run. From this perspective, countries can arguably be divided into three groups. In the first, consisting of the United States and Sweden, it is the money market rate that dominates. In a second, comprising the United Kingdom, Canada, the Netherlands and, possibly, Japan, it is the policy rate that stands out more clearly. Elsewhere, no clear pattern emerges. In the case of Belgium and Italy, because at least one policy rate is equivalent to a three-month money market rate for much of the period, interpretation is more difficult.

Subject to the caveats that derive from the high correlation between the money market and policy rates (at least as regards the effect on long-run coefficients), these results point to a significant direct link in most countries. This is so even if the possible effects associated with changes in the rates on official standing facilities are disregarded and when central bank operations are limited to very short maturities (e.g. in the United Kingdom and the Netherlands). Whether the link arises from oligopolistic structures or signalling effects is generally more difficult to say, but not crucial for present purposes.

40 In Germany, however, "inertia" is primarily concentrated in the initial observations of the sample period.

Table 3

Determination of the loan rate: basic pattern of results (whole period)*

	Short-run				Long-run		$\bar{R}^2$	SEE	DW	Sample period
	Δ_t		Δ_{t-i}		RP	RM				
	RP	RM	RP	RM						
AU	*	*		*	*		0.80	0.24	2.15	84:1-94:7
BE		*		*		*	0.71	0.24	1.97	84:1-94:7
CA	*	*(ws)	*	*	*		0.82	0.23	2.16	84:1-94:7
FR	*	*		*		*	0.45	0.13	1.99	84:1-94:7
DE		*		*	*		0.51	0.11	2.14	84:1-94:7
IT	*	*		*		*	0.77	0.16	2.10	84:10-94:6
JP		*			*		0.62	0.09	2.15	85:10-94:7
NL	*		*	*	*	*	0.80	0.15	1.97	84:1-94:7
ES			*			*	0.36	0.28	2.23	84:6-94:7
SE (1)		*				*	0.86	0.42	2.03	86:IV-92:II(Q)
(2)		*				*	0.96	0.39	1.95	89:II-94:II(Q)
UK	*	*		*	*		0.99	0.07	2.16	84:1-94:7
US (1)		*	*		*(ws)	*	0.76	0.13	2.09	84:1-94:7
(2)		*				*	0.78	0.42	1.87	84:I-94:I(Q)

* The estimation period is that shown in Table 1.

Table 4 describes the response of the loan rate to a simultaneous 100 basis point rise in *all* the rates that appear as relevant in the regression. It considers, that is, loan rate setting behaviour abstracting from cross-country differences in the relationship between policy and market rates. In order to capture different aspects of stickiness, the responses are shown both in absolute terms and as a percentage of the long-run adjustment. Plots of the response paths together with the corresponding confidence bands can be found in Annex I (Graph AI.3).

The point estimates of the long-run responses generally range between 0.80 and 1.10. They are considerably lower in France and considerably higher (suspiciously so) only in Italy, Belgium and Spain. Although formal tests indicate that a long-run response of equal size to the shock can be statistically rejected at traditional confidence levels in most countries, it is not with respect to long-run responses that cross-country differences are most apparent.

Differences are more pronounced with respect to the pattern of responses over time. In a first group of countries, comprising all those where policy rates are especially relevant (the United Kingdom, Canada[41] and the Netherlands) as well as Belgium, by the end of the first quarter the loan rate has already responded by around 100 basis points. Indeed, in the Netherlands and the United Kingdom a similar adjustment takes place within the first month. The finding is especially significant for the United Kingdom, given the large share of short-term lending in total lending and the large fraction of small borrowers' financing that is related to the loan rate chosen. It is less so for the Netherlands, given that the rate applies to large businesses. In a second group, comprising the remaining continental European countries and Japan, adjustment appears to be considerably slower, ranging from around 20% to no more than 70% within the first quarter. Finally, the United States and Australia seem to fall in between. Once the nature of the rates chosen is taken into account, however, the United States is probably better classified in the fast-adjustment group, while responses in Australia are more similar to those in some continental European countries (Box 2). In particular, for the United States, the rate based on survey evidence, covering only the business sector and including

41 The present estimates for Canada are considerably lower than those presented by Clinton and Howard (1994) based on *weekly* data, where adjustment is virtually complete within the first month. Moreover, they argue that their own estimates probably understate the true speed.

Table 4

Loan rate response to a simultaneous change in policy and money market rates (whole period)[1]

	Absolute change (in percentage points)						2 x SE	P-value[2] %	As % of long-run response				
	1 month	1 quarter	2 quarters	1 year	2 years	Long-run			1 month	1 quarter	2 quarters	1 year	2 years
AU	0.40	0.78	0.86	0.86	0.86	0.86	0.97	0.2***	46	90	99	100	100
BE	0.61	0.99	0.97	1.05	1.17	1.27	1.05	3.8**	47	76	74	80	90
CA	0.74	0.92	0.97	1.00	1.00	1.00	0.70	93.2	74	92	97	99	100
FR	0.43	0.45	0.51	0.60	0.69	0.74	0.69	2.0**	59	61	69	81	93
DE	0.11	0.45	0.61	0.82	0.99	1.05	0.53	32.3	10	42	58	78	94
IT	0.26	0.69	0.84	1.00	1.15	1.22	1.45	30.2	21	57	69	82	94
JP	0.32	0.53	0.63	0.74	0.82	0.84	0.58	7.5*	39	63	76	88	97
NL	1.08	0.96	1.04	1.08	1.08	1.08	0.39	0.8***	100	89	96	99	100
ES	0.0	0.30	0.51	0.80	1.06	1.17	1.48	41.0	0	25	43	67	90
SE (1)	-	0.74	0.86	0.92	0.92	0.92	1.45	41.4	-	80	93	99	100
(2)	-	0.61	0.76	0.79	0.80	0.80	1.10	0.1***	-	77	95	100	100
UK	1.00	1.01	1.01	1.01	1.01	1.01	0.14	1.7***	99	100	100	100	100
US (1)	0.43	0.75	0.80	0.85	0.88	0.88	0.47	0.0***	49	86	92	97	100
(2)	-	0.84	1.03	1.01	1.09	1.09	0.96	4.8**	-	77	95	93	100

[1] Time path of the response of the loan rate to a simulated 100 basis point change in both policy and money market rates. [2] Marginal significance level for the F-test that the long-run response of the loan rate is equal to 100 basis points.

Table 5

Loan rate response to a change in the policy rate (whole period)[1]

	Absolute change (in percentage points)						As % of long-run response				
	1 month	**1 quarter**	**2 quarters**	**1 year**	**2 years**	**Long-run**	**1 month**	**1 quarter**	**2 quarters**	**1 year**	**2 years**
AU	0.34	0.77	0.86	0.86	0.86	0.86	39	89	99	100	100
BE[2]	-	-	-	-	-	-	-	-	-	-	-
CA	0.73	0.93	0.97	1.00	1.00	1.00	73	93	97	99	100
FR	0.45	0.46	0.52	0.60	0.67	0.70	64	65	75	85	95
DE	0.11	0.50	0.61	0.81	0.99	1.05	11	48	58	77	94
IT	0.22	0.53	0.66	0.69	0.70	0.71	31	75	93	97	100
JP	0.00	0.24	0.48	0.64	0.74	0.76	0	31	63	84	97
NL	1.08	0.97	1.00	1.03	1.03	1.03	105	94	97	100	100
ES	0.00	0.31	0.51	0.76	0.97	1.06	0	29	48	71	91
SE (1)	-	0.59	0.81	0.89	0.90	0.90	-	66	90	99	100
(2)	-	0.50	0.69	0.77	0.78	0.78	-	65	89	99	100
UK	1.00	1.01	1.01	1.01	1.01	1.01	99	100	100	100	100
US (1)	0.34	0.74	0.78	0.79	0.79	0.79	44	94	99	101	100
(2)	-	0.91	1.03	0.99	1.06	1.06	-	86	97	94	100

[1] Time path of the response of the loan rate to a simulated 100 basis point change in the policy rate; the response of the money market rate is endogenised on the basis of the regressions shown in Annex I. [2] At least until the implementation of new operating procedures in January 1991, the response to changes in the interbank rate shown in Table 4 can be taken as a very good approximation to the response to changes in the policy rates.

loans related to market rates, adjusts faster than the prime, nowadays mainly representative of the retail segment. For Australia, independent evidence indicates that the adjustment of other rates is generally slower than the one chosen here (Lowe and Rohling (1992) and Lowe (1994)). In all countries the pass-through is virtually complete within two years, at least equal to some 90% of the long-run response.[42]

If the confidence bands around the point estimates are taken into account, cross-country differences are obviously not as sharp. In particular, the margin of doubt is comparatively large in the case of some of the slowest-adjusting countries, notably Spain and Italy, and in Belgium. It is, of course, also considerable in the case of those relationships estimated on quarterly data. Nevertheless, the broad picture is probably not misleading. Moreover, for the countries in which rates adjust fastest, the United Kingdom and the Netherlands, the confidence bands are especially narrow, highlighting their differences from the rest.

These conclusions regarding the broad pattern of responses are largely unchanged once the relationship between money market and policy rates is explicitly considered (See Table 5 and Annex I for detailed econometric results and plots of responses). The relatively close correlation between three-month money market and policy rates in conjunction with the direct link between policy and loan rates combine to produce this result.[43] The main exception is Japan, where no significant response can now be detected during the first month.

2. Minimum specification: stability over sub-periods

There are several reasons for believing that the relationships captured in the previous specifications may not have remained invariant over time; these are listed in Box 5 together with the countries affected and the periods concerned. The list includes: the temporary imposition or lifting of direct controls on banks' balance sheets, most notably on lending rates and credit extension (Australia, Italy and France); exchange rate crises (Canada and a number of European countries); changes in operating procedures (Australia, United States, Japan, Belgium, Spain and Italy); specific macroeconomic developments, such as widespread balance-sheet restructurings (several Anglo-Saxon countries, Sweden and Japan) or, in the case of Germany, the economic shock of reunification; and the broader process of financial liberalisation and heightening of competitive pressures in the financial industry. In order to analyse the impact of these events on the previous findings, stability tests were carried out (Table 6) and, where appropriate, the regressions were re-estimated over the most recent period.

The evidence indicates that the impact of the identified direct controls on banks' portfolio decisions is not important. Their effect either cannot be traced (Australia) or, when present, is not such as to affect the remaining properties of the regressions (Italy). In France, a significant break is detected following the lifting of the "encadrement du crédit"; the test, however, may also be capturing the effect of the 1992 ERM crisis.

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42 In order to assess the robustness of the findings, in the case of France and Germany two alternative rates were used: the rate on overdrafts (France; quarterly only) and the lower bound of the sample of rates used to construct the loan rate series (Germany). In neither case did the results alter the basic conclusions regarding the international ranking of the two countries. The new German rate adjusts somewhat faster in the first month (coefficient = 0.22) but its response is otherwise very similar. For France the rate on overdrafts actually responds less vigorously after one quarter (0.27) but more strongly thereafter (0.80 and 1.06 after one and two years respectively). This narrows the gap between France and most other countries over the longer horizons.

43 Note, however, that the link between policy and money market rates is not uniform across countries, nor, just as importantly, is the *uncertainty* surrounding point estimates of the relationship. To the extent that this uncertainty reflects the unpredictability of the response of market rates to policy actions rather than shortcomings in the estimation, it is clearly of significance for policy.

Box 5: Main reasons for possible changes in the average relationship

Australia:	*Operating procedures:*	January 1990	Announcement of standards for overnight rate.
	Macro events:	around 1989	Widespread balance-sheet restructuring.
Belgium:	*Operating procedures:*	January 1991	Fixing of one, two and three-month Treasury certificate rates discontinued.
Canada:	*Financial industry:*	1990	Pronounced heightening of competition in the loan market.
	Exchange rate:	September 1992	Exchange rate turbulence.
France:	*Loan rate setting:*	January 1987	Phasing out of the ceiling on bank lending (encadrement du crédit).
	Exchange rate	around September 1992	Exchange rate turbulence.
Germany:	*Macro events:*	late 1989 - mid-1990	Reunification.
Italy:	*Operating procedures:*	October 1990	Part of compulsory reserve holdings allowed to be used for settlement purposes. Final step in a series of changes starting in late 1988, beginning of the phasing out of the practice of setting a minimum price at Treasury bill auctions.
	Direct controls:	January-June 1986 September 1987 - March 1988	Temporary imposition of restrictions on lending.
Japan:	*Operating procedures:*	November 1988	Broad reform, including notably a shortening of the maturity of open market operations and a large increase in their frequency.
	Financial industry:	January 1989	Prime rate introduced; revised when the weighted average of the CD and other short-term market rates has changed by more than 0.25% since the previous change in the prime rate.
	Macro events:	late 1990	Widespread balance-sheet restructuring.
Spain:	*Operating procedures:*	January 1989 - May 1990	Reform of operating procedures, notably with greater emphasis on interest rate objectives.
	Financial industry:	around 1990	Pronounced heightening of competition in the loan market.
	Exchange rate:	around September 1992	Exchange rate turbulence.

Box 5: Main reasons for possible changes in the average relationship (cont.)			
Sweden:	*Macro events:*	around 1991	Widespread banking problems.
	Exchange rate:	September 1992	Exchange rate turbulence.
United Kingdom:	*Macro events:*	around 1990	Widespread balance-sheet restructuring.
	Exchange rate:	September 1992	ERM exchange rate turbulence.
United States:	*Operating procedures:*	about June 1989	Use of more explicit operating objectives for the overnight rate.
	Macro events:	around 1990	Widespread balance-sheet restructuring.

Table 6

Statistical evidence of structural breaks

	Reason[1]	**Date**[2]	**RL Equation**		**RM Equation**	
			Chow p-value (%)	**Dummy (coefficient)**	**Chow p-value (%)**	**Dummy (coefficient)**
AU	DC	85:4	n.s.	-	-	-
	OP/Macro	90:3	0.0***	-	0.0***	-
BE	OP	91:4	1.1**	-	-	-
CA	ER	92:9	-	n.s.	-	2.49***
	FI	90:1	0.1***	-	-	-
FR	DC	88:1	3.1**[3]	-	4.7**[3]	-
	ER	92:5-93:3	-	- 0.13***	-	1.23***
DE	Macro	90:1	n.s.	-	n.s.	-
IT	DC	86:1-86:6	-	0.13*	-	-
		87:9-88:3	-	n.s.	-	-
JP	OP/FI/Macro	90:5	0.0***	-	0.0***	-
NL	-	90:1	0.0***	-	n.s.	-
ES	OP/FI	90:7	0.0***	-	4.9**	-
	ER	92:9-93:4	-	n.s.	-	0.80***
SE[4]	ER	92:III (Q)	n.s.	n.s.	-	- 14.7***
UK	Macro	90:1	4.4**	-	1.2**	-
	ER	92:9	n.s.	-	n.s.	-
US (1)	OP/Macro	90:1	0.0***	-	n.s.	-
(2)		90:I (Q)	n.s.	-	n.s.	-

Key: n.s. = not significant; DC = direct controls; OP = operating procedures; Macro = macroeconomic events; ER = exchange rate; FI = financial industry.

[1] See Box 5 for details. [2] Dates for which the corresponding test was carried out. In the case of changes in operating procedures, a lag was generally allowed for so as not to contaminate the results of the tests. [3] Owing to multicollinearity, the equations had to be re-estimated without dummies. [4] Too few observations for a test on macroeconomic conditions.

Indeed, the effects of policies designed to contain downward exchange rate pressures are very different across countries. In France, loan rates remain appreciably below what would have been predicted by the observed levels of other rates: the additive dummy included in the regression is statistically significant.[44] In other countries, notably the United Kingdom, Canada and Sweden, the normal link between the loan rate and its proximate determinants is not severely disrupted; the use of quarterly data, though, calls for caution in interpreting the result for Sweden (see also Graph AI.1, Annex I). This suggests that in certain countries the authorities have greater room for manoeuvre when fighting speculative pressures.

The tests for the remaining factors that may have led to changes in the average relationship generally indicate that a closer look at the more recent period is warranted.[45] This should also help to clarify the nature and economic import of the statistical breaks identified, particularly in those cases where several influences may be at work at the same time. Sweden, of course, is not considered in what follows: the data are only quarterly and, in one case, already refer only to the last few years. The same is true for the quarterly US loan rate based on survey data.

In most countries, the basic pattern of results as regards the proximate determinants of the loan rate changes little in comparison with that over the whole period (Table 7).[46] One notable exception is Italy, where now the explanatory power of the new policy rate (the tender rate) is such that the Treasury bill rate (the proxy for the money market rate) drops out. This probably mainly reflects the fact that since the introduction of the new operating procedures the tender and three-month money market rates have moved quite closely together while the interbank market has gained in importance in loan pricing decisions.[47] Another possible exception is the United States, where now the contemporaneous change in the policy rate becomes significant alongside the money market rates. This is not inconsistent with the adoption of new operating procedures, which are likely to have reduced the "noise" in the policy rate. In the United Kingdom, the policy rate consolidates its importance: the loan rate appears to be practically indexed to it.

The broad picture regarding the response of the loan rate is also largely unaffected (Tables 8 and 9). Although some noticeable changes appear to have taken place in certain countries, the overall pattern of international differences is basically the same.

Indeed, in several countries the adjustment path is essentially unchanged. In the case of the United Kingdom it is apparent that the statistical evidence of instability mainly reflected the comparatively high precision of the estimates: adjustment remains immediate. For Canada, the simulations are unable to capture the relatively faster speed of adjustment to changes in the Bank Rate in the wake of heightened competitive pressures revealed by earlier work (e.g. Clinton and Howard (1994)): perhaps this change is diluted by the extension of the estimation period and masked by the relatively low frequency of the observations (monthly).[48] The rate remains quite sticky in France, especially in the long run.

In most of the remaining countries the changes are comparatively minor. In Italy and Belgium they are mainly concentrated at longer horizons (beyond one year): the long-run responses are more in line with theoretical priors (closer to unity). In Germany there are some weak signs of a somewhat slower response, especially at the one-month horizon: the impact effect is no longer

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44 Indeed, the dummy had to be included in the previous regression in order to obtain sensible results.

45 The Chow tests for Germany, however, do not reveal any statistically significant instability.

46 See Tables AI.3 and AI.4 in Annex I.

47 There was in fact little to choose between the equation reported here and one where the tender and three-month interbank rate were included.

48 The authors report that the beginning of the recent rising phase in market rates heralded the end of the period of more aggressive prime rate adjustments.

Table 7

Determination of the loan rate: basic pattern of results (recent period)[1]

	Short-run				**Long-run**		$\overline{R}^2$	**SEE**	**DW**	**Sample period**
	Δ_t		Δ_{t-i}		**RP**	**RM**				
	RP	**RM**	**RP**	**RM**						
AU ..	*					*[2]	0.82	0.15	1.99	90:3-94:7
BE ...		*		*		*	0.89	0.18	2.01	91:4-94:7
CA ..	*		*	*	*		0.82	0.27	1.90	90:1-94:7
FR ...	*	*				*	0.53	0.13	2.12	88:1-94:7
DE ..				*	*		0.51	0.12	2.03	90:1-94:7
IT	*		*		*		0.92	0.13	1.86	91:3-94:6
JP		*				*	0.68	0.09	1.81	90:5-94:7
NL ..	*				*	*	0.74	0.11	1.98	90:1-94:7
ES ...				*	*		0.57	0.26	2.27	90:7-94:7
UK ..	*						1.00	0.02	2.01	90:1-94:7
US ...	*	*			* (ws)	*	0.71	0.11	1.71	90:1-94:7

[1] The estimation period is that shown in Table 1. [2] But practically indistinguishable from policy rate.

significant.[49] This is probably the result of the relatively slow response of German loan rates in periods of falling market rates (see below). Some reduction also takes place in the case of the Netherlands at the one-month horizon. By contrast, a somewhat faster response within the first month can be detected in Australia. This may be due to the adoption of the new operating procedures: the standard errors in both the loan and money market regressions are considerably lower and the pass-through between policy and market rates seemingly faster. A similar, but smaller, increase in the one-month response can be detected for the United States; the reasons behind it may be analogous to those in Australia.

The two countries for which a marked change is most apparent are Japan and Spain:[50] in both cases the response is raised over the whole horizon, especially within a year. The change is particularly large in Spain: although no significant adjustment appears in the first month, the response is already a full one after one quarter. This finding is in line with the heightening of competitive pressures in the financial industry. In Japan, the adoption of the new procedures for setting loan rates (the "prime" rate) appears to have had a noticeable effect (Box 5).[51] Despite the higher response, however, at least Japan is still best classified among those countries in which loan rates appear to be comparatively sticky.

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49 Since the loan rate for Germany is sampled at mid-month while the policy and money market rates are end-of-month observations (see Boxes 1, 3 and 4), in principle the speed of adjustment could be somewhat understated in the first month. However, monthly-average and end-of-month series relating to the money market rate are extremely close. Similarly, when both observations are available, the corresponding policy rate series virtually coincide. The bias, therefore, is unlikely to be quantitatively significant.

50 Owing to difficulties in the estimation, the sample period for Spain was extended to January 1989, when the change in operating procedures took effect.

51 The result may also in part reflect the fact that since 1990:4 the series used relates exclusively to short-term loans.. Because of the specific characteristics of the Japanese market, however, this factor need not be very significant, especially prior to 1990.

Table 8

Loan rate response to a simultaneous change in policy and market rates (recent period)[1]

	Absolute change (in percentage points)						2 x SE	P-value[2] %	As % of long-run response				
	1 month	1 quarter	2 quarters	1 year	2 years	Long-run			1 month	1 quarter	2 quarters	1 year	2 years
AU	0.83[3]	0.74	0.79	0.85	0.87	0.87	0.43	0.0***	95[3]	85	91	98	100
BE	0.63	0.95	0.93	0.93	0.93	0.93	0.48	0.1***	68	102	100	100	100
CA	0.77	0.86	0.95	0.99	1.00	1.00	0.77	93.2	77	86	95	99	100
FR	0.51	0.53	0.55	0.58	0.59	0.59	0.55	0.0***	86	89	93	97	100
DE	0.00	0.36	0.53	0.74	0.91	0.98	0.57	89.6	0	37	54	76	94
IT	0.19	0.72	0.97	1.06	1.07	1.07	0.82	59.0	18	67	91	99	100
JP	0.45	0.63	0.77	0.86	0.89	0.89	0.30	0.2***	51	70	86	97	100
NL	0.71	0.95	1.02	1.03	1.03	1.03	0.30	27.0	69	92	99	100	100
ES	0.00	1.00	1.04	1.05	1.05	1.05	0.75	22.8	0	95	99	100	100
UK	1.00	1.00	1.00	1.00	1.00	1.00	0.25	-	100	100	100	100	100
US (1)	0.70	0.77	0.83	0.85	0.86	0.86	0.33	0.0***	81	90	96	99	100

[1] Time path of the response of the loan rate to a simulated 100 basis point change in both policy and money market rates. [2] Marginal significance level for the F-test that the long-run response of the loan rate is equal to 100 basis points. [3] Overshooting, down to 0.65 in the second month (74% of long-run response).

Table 9

Loan rate response to a change in the policy rate (recent period)[1]

	Absolute change (in percentage points)						As % of long-run response				
	1 month	1 quarter	2 quarters	1 year	2 years	Long-run	1 month	1 quarter	2 quarters	1 year	2 years
AU	0.83[2]	0.67	0.71	0.78	0.80	0.80	95[2]	84	89	97	100
BE	0.61	0.82	0.85	0.85	0.85	0.85	72	96	100	100	100
CA	0.77	0.88	0.95	0.99	1.00	1.00	77	88	95	99	100
FR	0.53	0.56	0.58	0.59	0.60	0.60	89	94	96	98	100
DE	0.00	0.32	0.50	0.73	0.91	0.97	0	33	52	75	93
IT	0.19	0.72	0.97	1.06	1.07	1.07	18	67	91	99	100
JP	0.30	0.57	0.71	0.78	0.80	0.80	38	72	88	98	100
NL	0.71	0.90	0.95	0.95	0.95	0.95	74	95	99	100	100
ES	0.00	0.95	1.02	1.05	1.05	1.05	0	91	97	100	100
UK	1.00	1.00	1.00	1.00	1.00	1.00	100	100	100	100	100
US (1)	0.62	0.79	0.84	0.81	0.81	0.81	76	97	103	100	100

[1] Time path of the response of the loan rate to a simulated 100 basis point change in the policy rate; the response of the money market rate is endogenised on the basis of the regressions shown in Annex I. [2] Overshooting, down to 0.59 in the second month (73% of long-run response).

VI. SELECTED SPECIFIC ISSUES

The above results are based on the minimum specification of the loan rate equations. There are, however, at least three additional questions that merit particular attention. First, is there any evidence that loan rates respond asymmetrically to increases and decreases in interest rates? Second, do revisions of infrequently changed rates on official standing facilities speed up the adjustment of loan rates? Finally, does the average, as opposed to marginal, cost of funding help to determine the loan rate?

1. Asymmetric response of the loan rate

The existence of asymmetric responses of the loan rate to increases and reductions in the opportunity cost rates was tested by allowing two coefficients to be estimated separately for observations in which those rates were rising/falling. Tests were carried out for asymmetric responses in both first-difference and level coefficients: although in principle one might expect only the short-run response to differ, it may in practice be difficult to distinguish between the two given the elusive nature of the hypothesis examined. For similar reasons, in order to maximise the degrees of freedom and hence the power of the analysis, the tests were executed over the long sample.

The tests in general fail to detect much evidence of asymmetries: in most cases the hypothesis that the response is symmetric cannot be rejected at the standard significance levels (Table 10). The only exceptions are Germany and Japan; for the United Kingdom, the evidence is statistically very weak and the difference is negligible in economic terms. Consistent with theoretical priors, where asymmetries appear to be present the response is faster with respect to *increases* in rates. The effect, however, is primarily captured by the level terms in the equation, implying that the long-run response is also affected. This may be due to the limited period covered by the observations, which makes it difficult to distinguish short from long-run effects.

Table 10

Tests of asymmetric responses

	Δ	Levels	Joint	Difference*	
				Levels	Long-run
Australia	84.4	63.2	49.7	-	-
Belgium	77.2	48.1	90.0	-	-
Canada	62.9	94.0	59.2	-	-
France	33.7	-	-	-	-
Germany	18.3	2.3**	4.7**	+ 0.01	+ 0.11
Italy	47.2	19.5	52.4	-	-
Japan	80.2	1.5**	5.0*	+ 0.01	+ 0.25
Netherlands	29.6	79.2	21.8	-	-
Spain	68.2	97.1	91.8	-	-
Sweden (1)	25.7	17.3	37.9	-	-
(2)	82.5	80.4	96.7	-	-
United Kingdom	57.2	9.5*	42.6	+ 0.01	+ 0.01
United States (1)	13.0	47.0	22.3	-	-
(2)	29.0	16.4	37.0	-	-

* A positive number means that upward adjustments are larger/faster than downward adjustments.

It is hard to say precisely what lies behind this finding. Inspection of the graphs (Annex I) appears to indicate that the recent sizable widening of spreads plays a crucial role in the case of Japan: the spread did not narrow much as interest rates were rising between 1988-90. A similar pattern emerges in the case of Germany. In fact, when the estimation period in Germany is extended to the beginning of the 1980s or the 1970s to cover more interest rate cycles, the pattern disappears. Reunification may have played a role in the more recent period.

Also of some interest is the failure to uncover any evidence of asymmetries in the case of the United States. Not only have spreads widened markedly in the recent recession amid widespread balance-sheet restructuring among financial and non-financial agents; in addition, some empirical work, following a similar methodology, had found evidence of asymmetries in the early 1980s (Arak et al. (1983)). One possible interpretation is that a further heightening of structural competitive pressures during the period has reduced the scope for delayed adjustments. More specific testing, however, would be necessary to assess this hypothesis.

2. Role of infrequently changed rates on official standing facilities

As argued above, changes in the rates on official standing facilities may be relevant in determining loan rates for a number of related reasons. They may reinforce signals about the direction of policy, helping to crystallise expectations about future interest rates or to underline the persistence of a specific policy move. They may be used as key reference rates for loan rates, especially in oligopolistic structures. Finally, they may actually represent the marginal funding cost of banks; this justification, however, has lost much of its significance in recent years.

The hypothesis was tested by adding a rate on official standing facilities to the standard specification adopted in Section III. The rate was included in first differences. In order to highlight possible changes in the role of the rate over time, the equations were estimated over the whole sample and the more recent period.

The rates chosen were discount rates in virtually all instances.[52] For France, the five to ten-day "pension" (repurchase agreement) rate was used: the facility is available to banks on demand and the interest rate on the transactions moves less frequently than that on discretionary open market interventions. Owing to the specificity of operating procedures, in a few countries there was no rate corresponding to the required characteristics (Australia, Spain and Canada). The availability of only quarterly data precludes a meaningful test in the case of Sweden. A similar problem exists for the United Kingdom. Although the Minimum Lending Rate facility was discontinued in 1981, it has been reactivated for very short periods since then. In addition, "14:30 lending" has been used on a number of occasions to provide markets with a clear signal of policy intentions. However, since such lending is effective for one day at a time, it is more difficult to model.

Remarkably, when the regressions are estimated over the whole period, discount rates are highly significant in all the countries covered; in all cases they are associated with a stronger response of the loan rate, at least in the short run (Table 11). The additional explanatory power of the official rate generally survives with little change in recent years; the only exceptions are Belgium and France, where no significant correlation can be detected.

In the case of the Netherlands the result no doubt reflects the formula used by banks to set the loan rate used, which until the end of 1993 was actually tied to the discount rate through a variable, but administered, mark-up.[53] For the remaining countries it is not clear how best to interpret the result. The fact that the effect is generally limited to the first month is consistent with the signalling hypothesis, at least in the more recent period; indeed, this role has been explicitly recognised in the cases of Italy (e.g. Bank of Italy (1988)) and Japan (Okina and Sakuraba (1994)).

52 For Germany, the lombard rate could alternatively have been tried.

53 Since then the rate has been linked to the rate on central bank advances.

Table 11

The role of infrequently changed official rates

	Behaviour of rate			Regression results						Estimation period
	$\Delta R0 = 0$ (% obs.)	$\Delta R0 = 0$		R0 coefficient		Comparison with standard specification				
		1980s[1]	1990s[1]	Δ_t	Δ_{t-i}	Δ impact coefficient[2]	Δ_{t-1} coefficient[2]	Δ long-run coefficient	$\Delta \bar{R}^2$	
BE (a)	65	63	67	0.13**	-	+ 0.06	-	0.0	+ 0.01	84:1-94:7
(b)				-	-	-	-	-	-	91:4-94:7
FR (a)	70	74	65	0.04**	-	+ 0.02	-	- 0.02	+ 0.01	84:1-94:7
(b)				-	-	-	-	-	-	88:1-94:7
DE (a)	80	85	75	0.17**	0.27***	+ 0.12	+ 0.20	+ 0.05	+ 0.14	84:1-94:7
(b)				0.10**	0.38***	+ 0.10	+ 0.30	- 0.22	+ 0.28	90:1-94:7
IT (a)	76	83	67	0.13***	-	+ 0.06	-	+ 0.06	+ 0.02	84:1-94:7
(b)				0.13*	-	+ 0.07	-	0.0	+ 0.01	91:3-94:6
JP (a)	87	89	84	0.12***	0.28***[3]	+ 0.02	+ 0.04	+ 0.08	+ 0.06	84:1-94:7
(b)				-	0.13**	-	+ 0.13	0.0	+ 0.03	90:5-94:7
NL[4]	78	82	71	0.19**	-	+ 0.16	-	0.0	+ 0.01	84:1-93:12
US (a)[5]	85	85	85	0.21**	0.22**	+ 0.13	+ 0.15	- 0.02	+ 0.03	84:1-94:7
(b)				-	0.27***	- 0.09	+ 0.27	0.0	+ 0.07	90:1-94:7

[1] For Italy, Belgium, the United States and Japan, dates corresponding to changes in operating procedures. [2] Calculated as the sum of the effects of all relevant interest rates in the regressions. [3] Sum of coefficients lagged one to three periods. [4] Estimated to end-1993. [5] Prime rate.

However, the fact that lagged changes are also present raises doubts about this interpretation for Germany (one lag) and Japan (two lags). One possibility is that the slowly moving discount rate may act as a proxy for sticky administered deposit rates which are an element in the loan pricing decision.[54]

3. Marginal versus average cost of funds

It was argued in Section II that, if banks behave according to profit maximisation or similar objectives, it is the *marginal* opportunity cost of funds which is relevant. By contrast, in the presence of full-cost pricing or, more generally, "satisfying" behaviour, the average cost of funds may be more directly relevant. Such behaviour would help to explain stickiness in the loan rate with respect to policy and market rates: deposit rates, especially those for retail customers, have comparatively low reaction speeds.

Unfortunately, the data to test this hypothesis are generally not available. Exceptions are Germany, Italy and Spain, for which weighted averages of the cost of domestic currency deposits exist, even at monthly frequencies. The strategy followed was to test for their statistical significance in the benchmark regressions containing policy and/or money market rates and, where appropriate, to re-estimate the "best" specification.

Table 12

Marginal vs. average funding costs: summary of results

	Germany	Italy	Spain
RD coefficients			
ΔRD_t	0.55***	0.30**	0.41**
ΔRD_{t-1}	-	-	0.32*
RD_{t-1}	-	0.12***	-
Joint p-value (%)[1]	0.1***	0.04***	0.8***
Comparison with standard specification			
Δ impact[2]	+ 0.54	+ 0.26	+ 0.41
Δ long-run	+ 0.01	+ 0.01	- 0.27
$\Delta\bar{R}^2$	+ 0.04	+ 0.01	+ 0.04
Estimation period	1984:1-1994:7	1984:9-1994:6	1984:6-1994:7

[1] Marginal significance level of the null hypothesis that the RD coefficients are jointly zero. [2] Sum of the contemporaneous coefficients on all rates.

The results are broadly consistent with the relevance of average funding costs (Table 12): in all regressions the weighted average cost of deposits is statistically highly significant. For Germany and Spain, however, only changes are significant. For Italy, the influence of the variable is considerably starker: a clear effect can be traced in both the short and the long run. These results confirm previous findings (e.g. Bank of Italy (1988) and García et al. (1994)): both central banks include average funding costs in their standard specifications. The reason why the present evidence is less strong in the case of Germany and Spain probably has to do with the choice of loan rate, viz. a narrow one (current account credits) compared with that in country-specific work (an average rate on

54 In the case of Germany, another plausible reason is the fact that the loan rate is sampled at around mid-month while the discount rate relates to the end of the month. This explanation appears to be the relevant one for the United States, where one lag is also present: if month-end observations for the loan rate are used, only the contemporaneous change is significant; while concentrated in one month, the overall size of the effect remains unaltered.

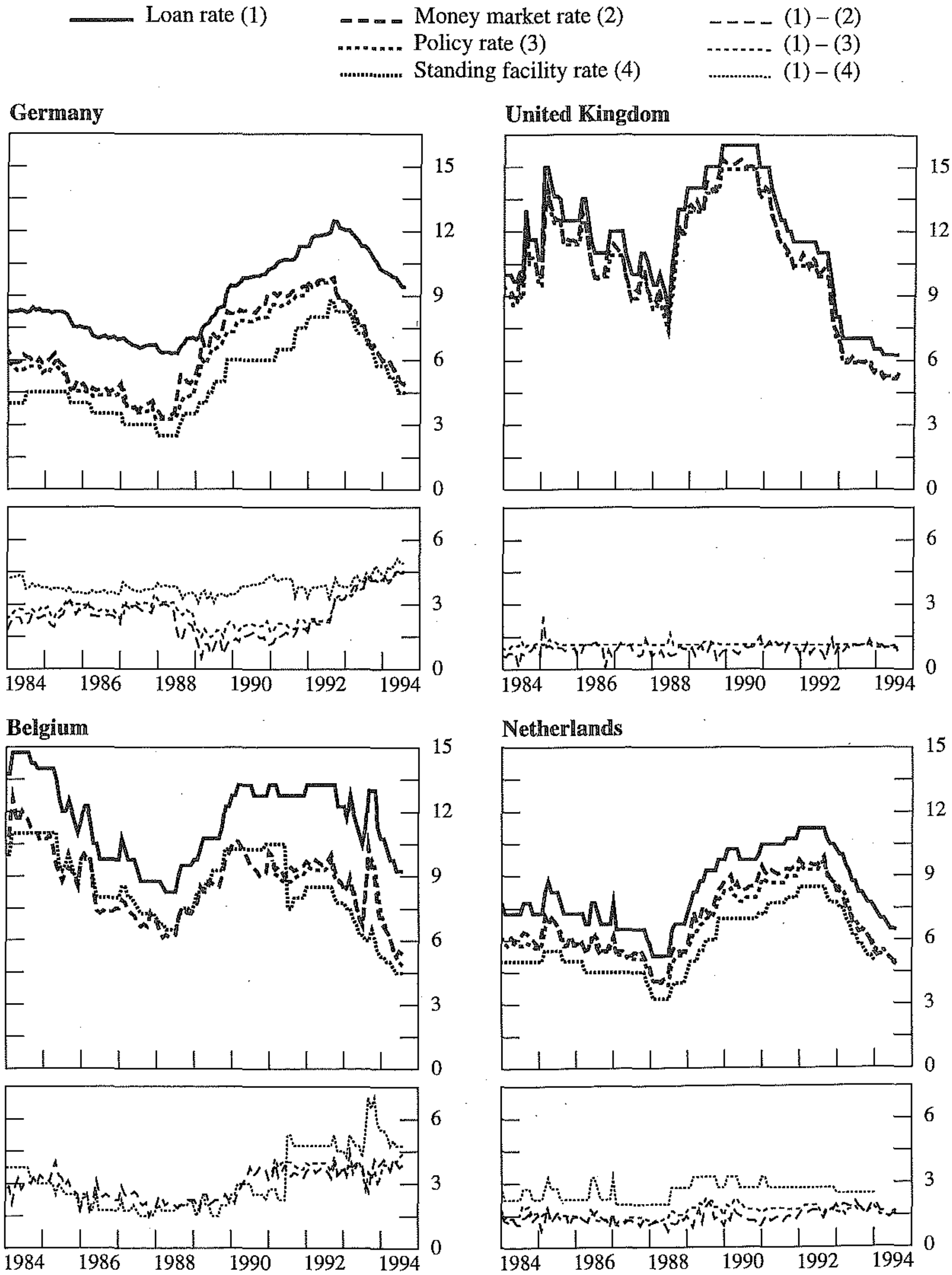
all new loans), the same rate used for Italy. These findings suggest that it would be useful to consider average deposit rates also in the other countries covered, especially where loan rates appear comparatively sticky.

ANNEX I

Detailed statistical and econometric information

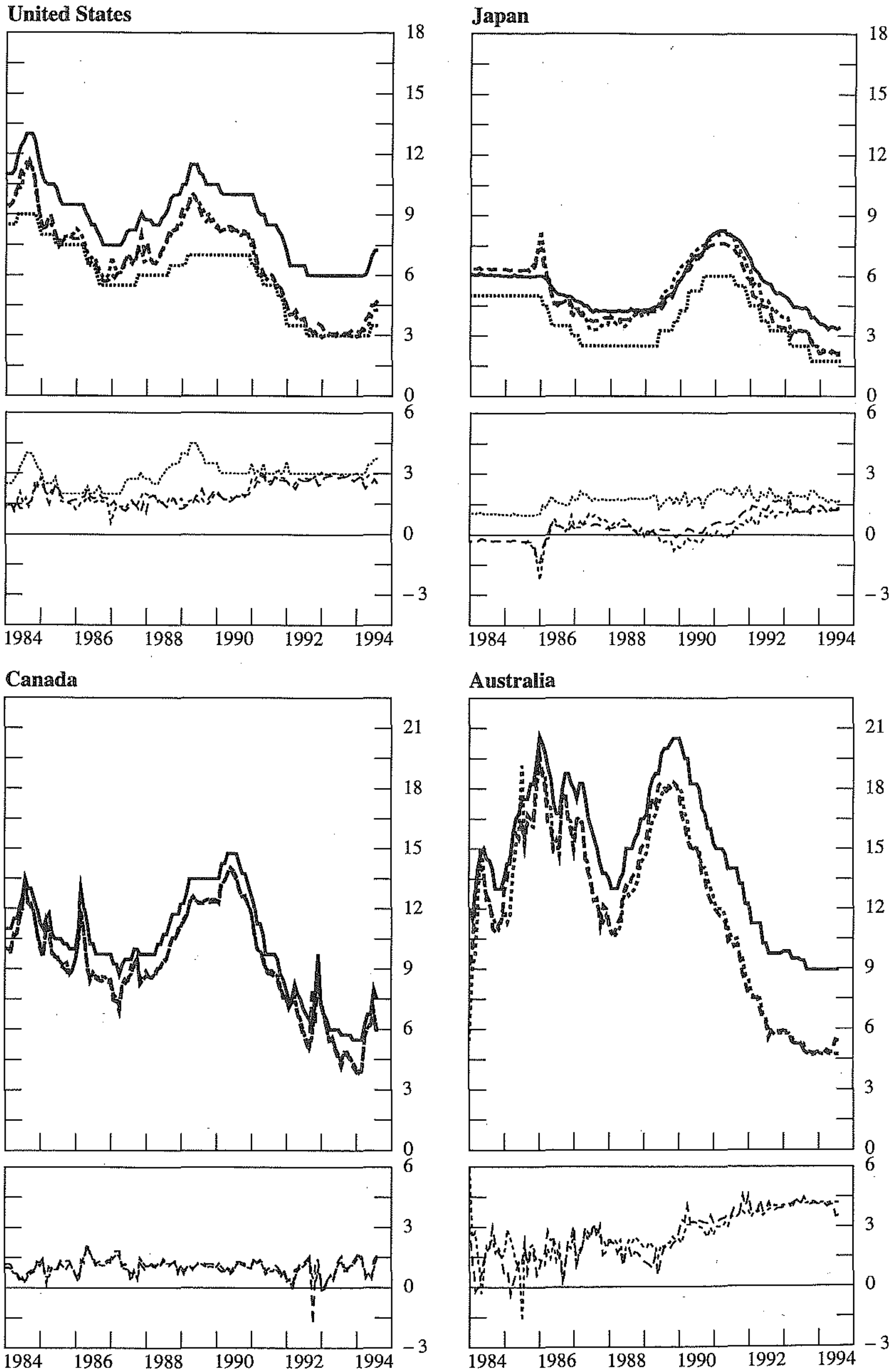
Graph AI.1

Interest rate series and spreads *



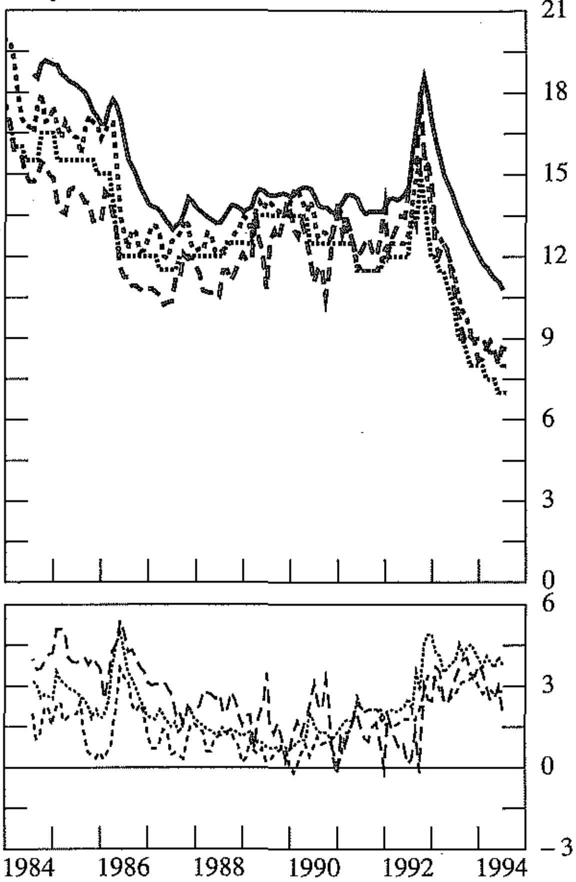
* For a definition of the rates, see Boxes 1 – 4.

Graph AI.1 (cont.)

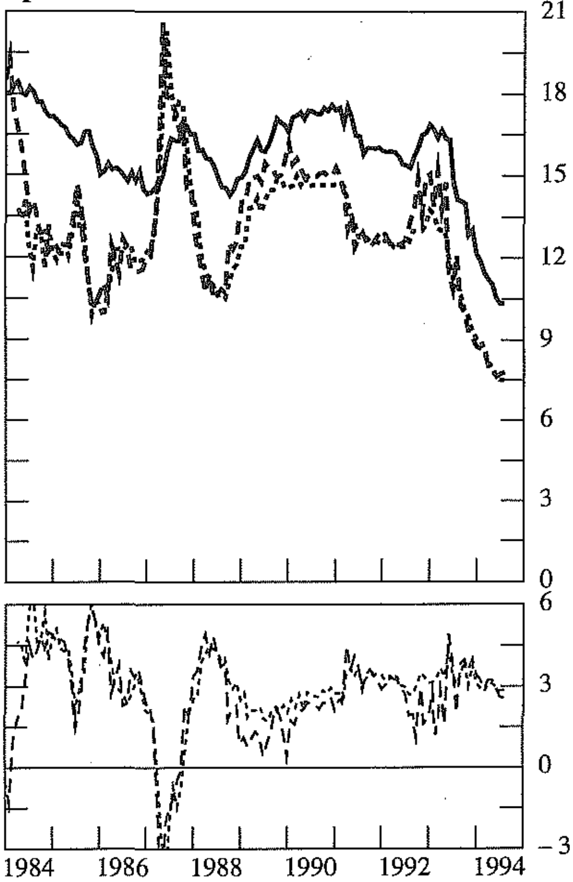


Graph AI.1 (cont.)

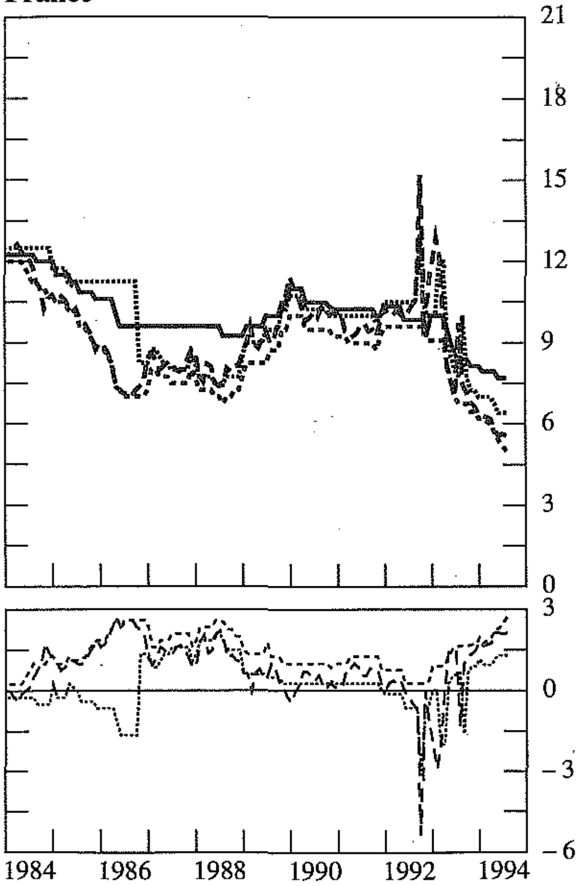
Italy



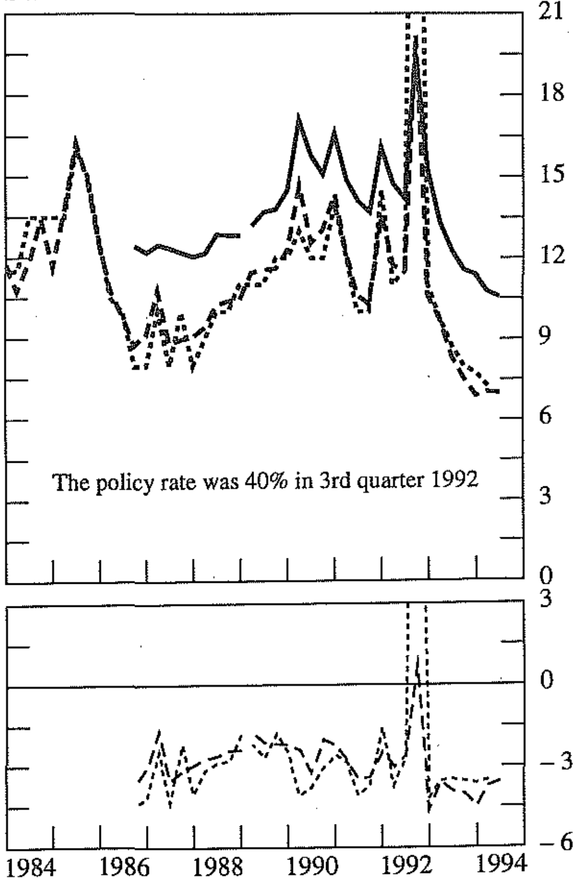
Spain



France

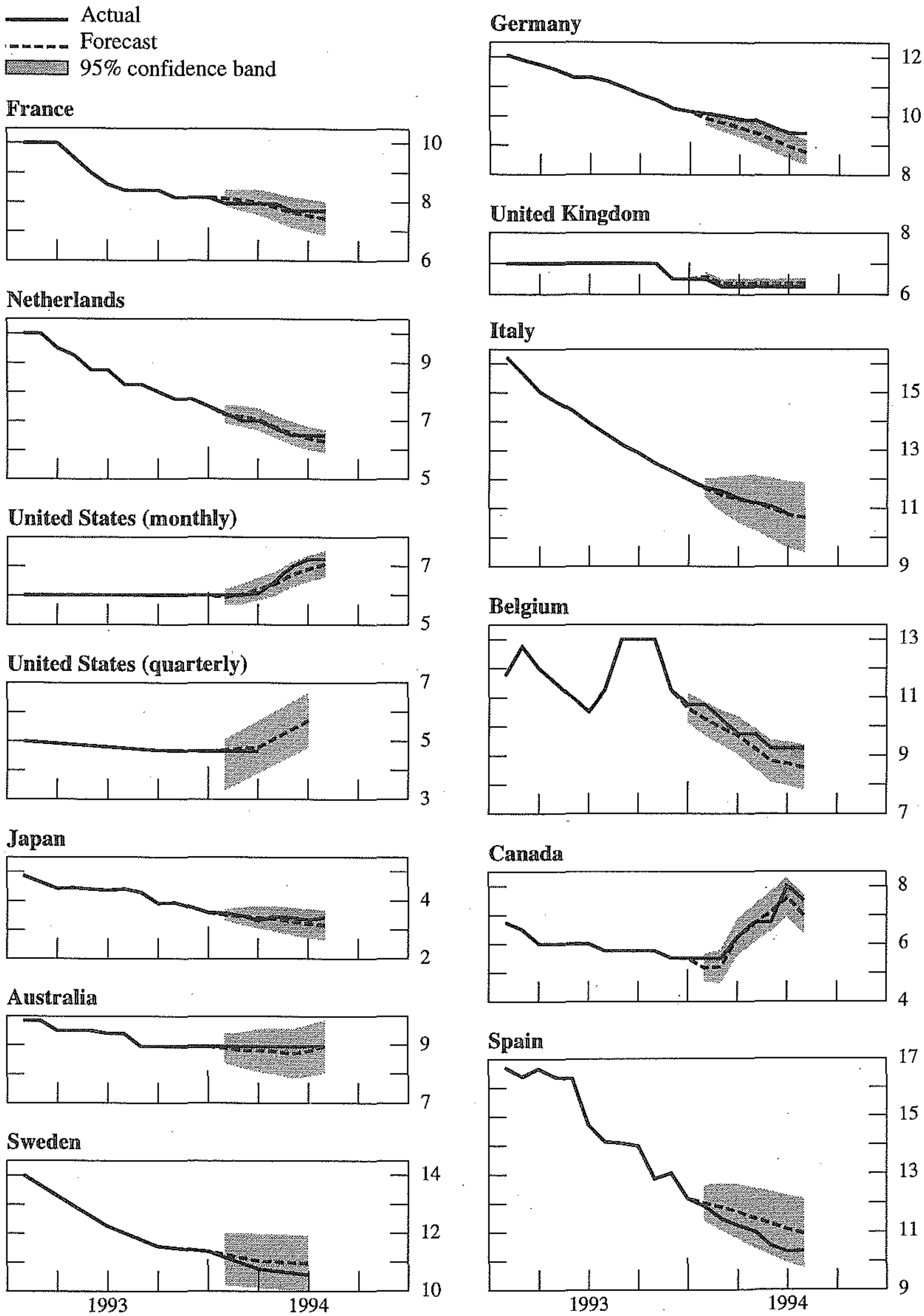


Sweden



Graph AI.2

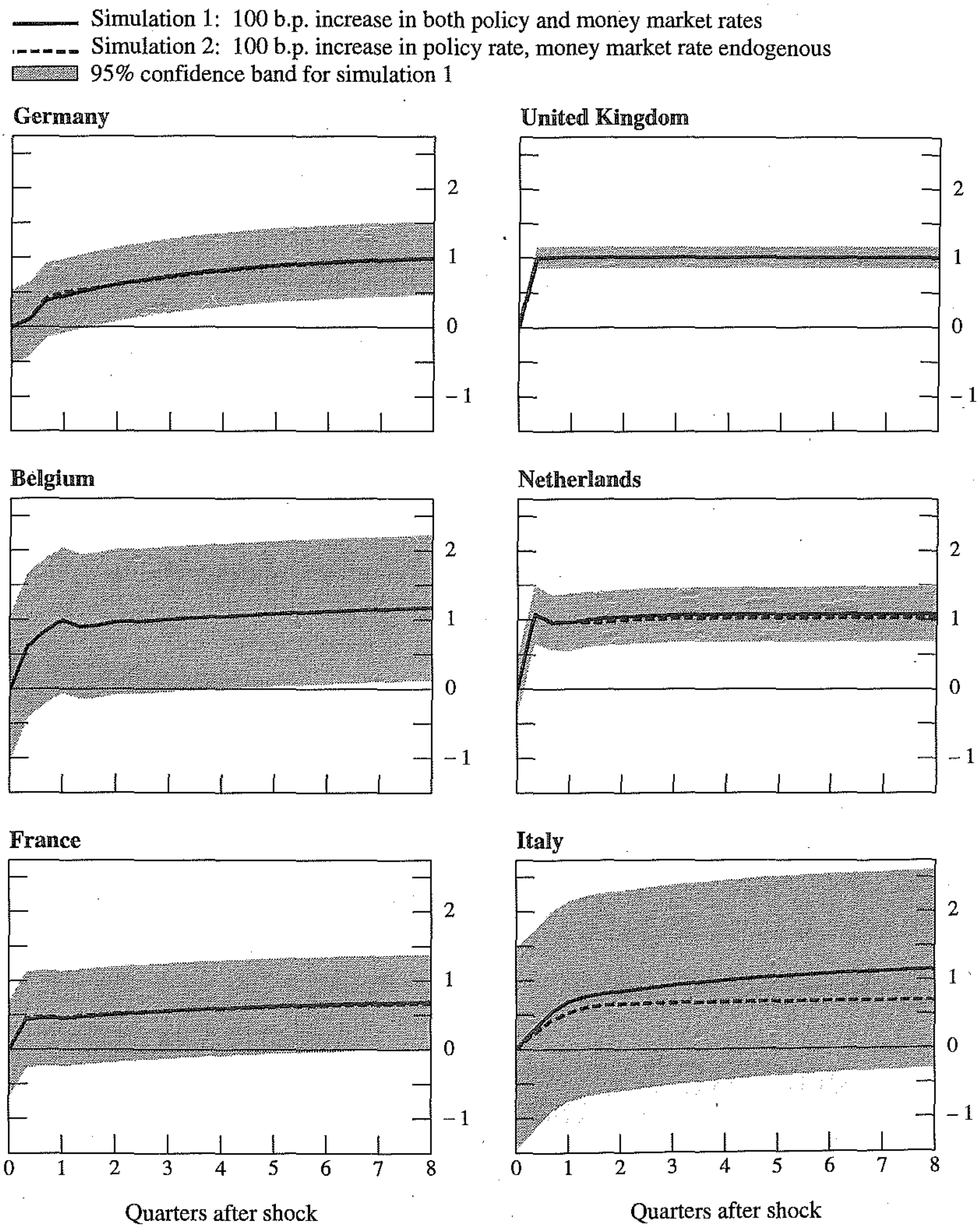
Out-of-sample forecast performance *



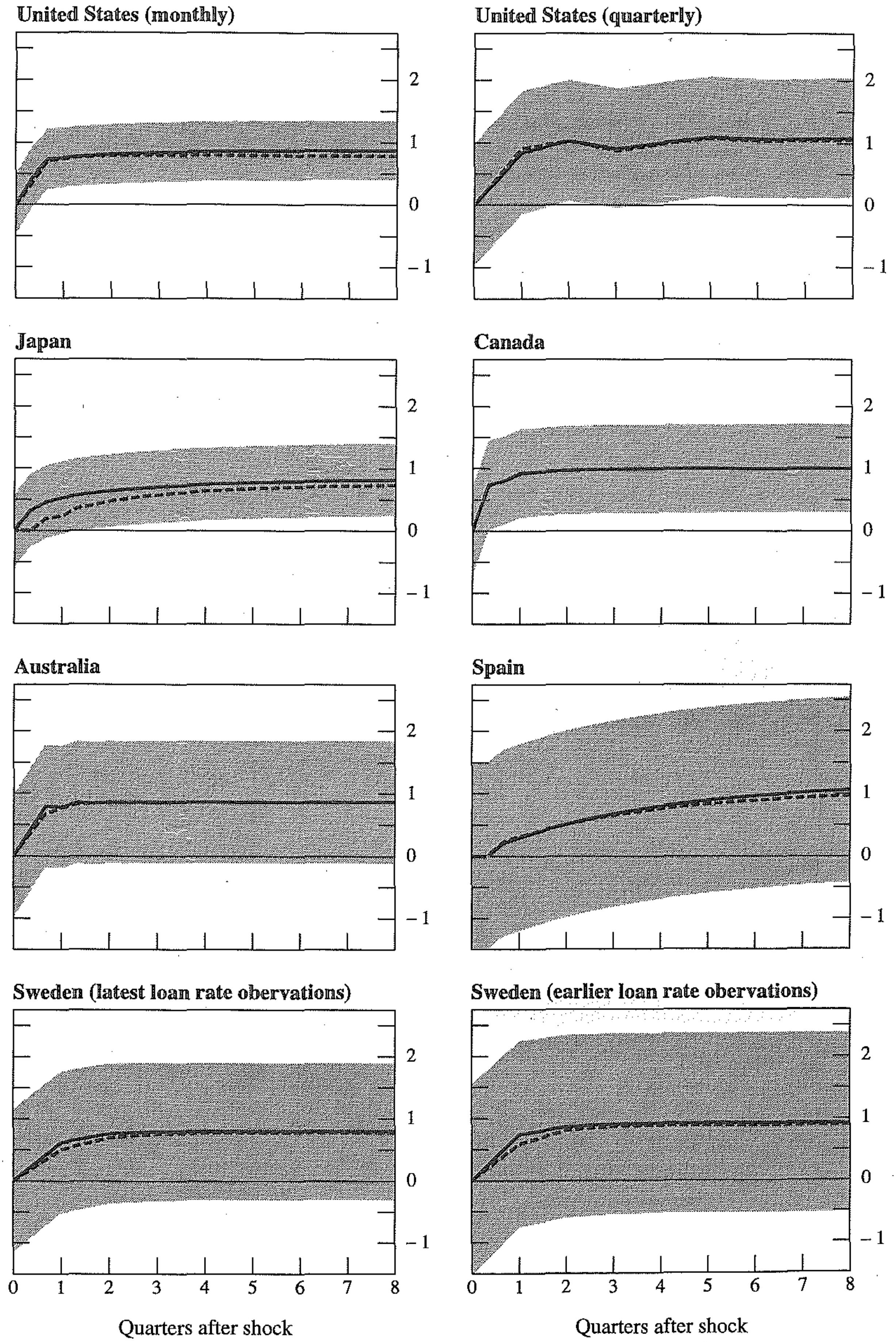
* Minimum specification, whole sample.

Graph AI.3

Simulations of loan rate responses (whole period)

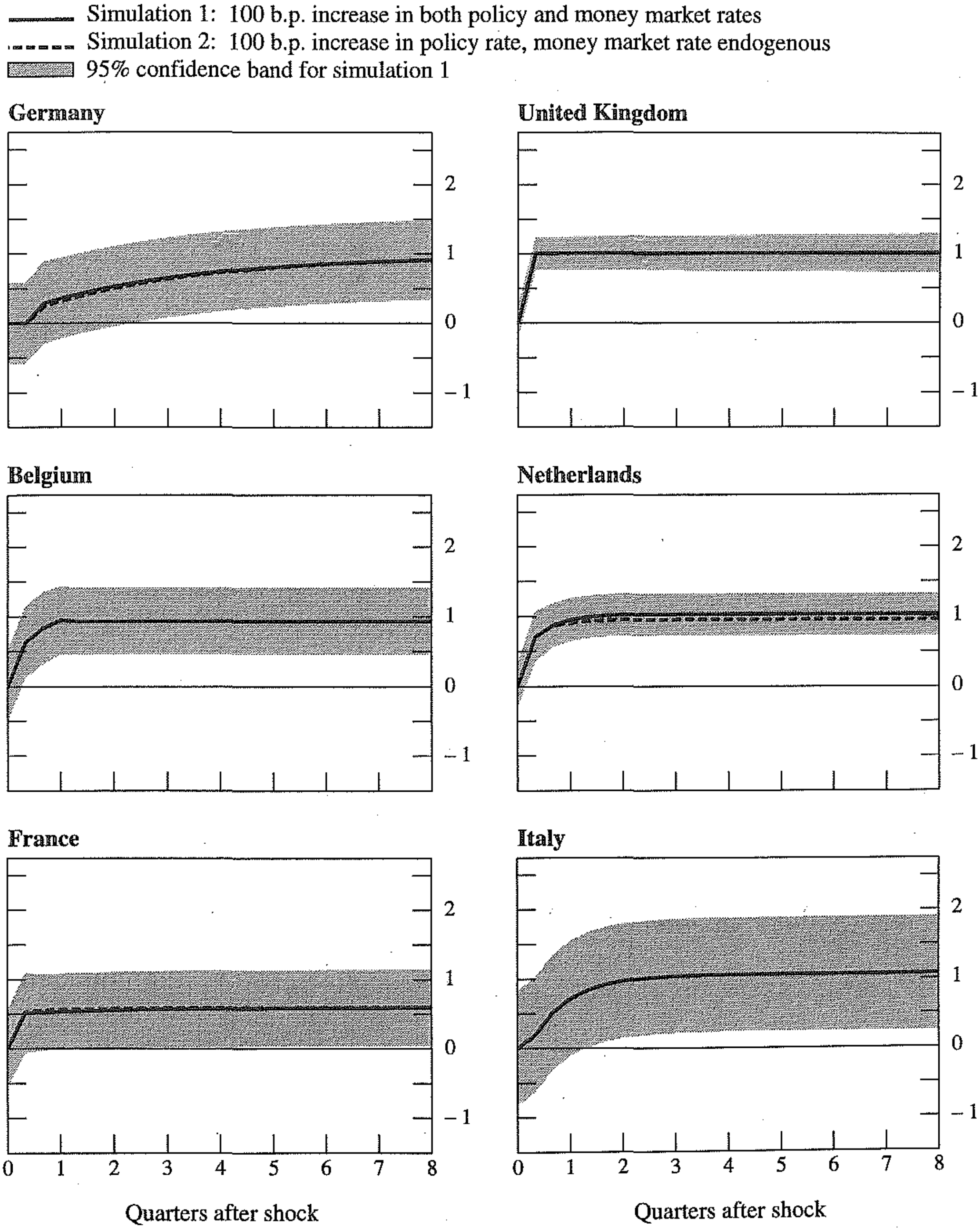


Graph AI.3 (cont.)



Graph AI.4

Simulations of loan rate responses (recent period)



Graph AI.4 (cont.)

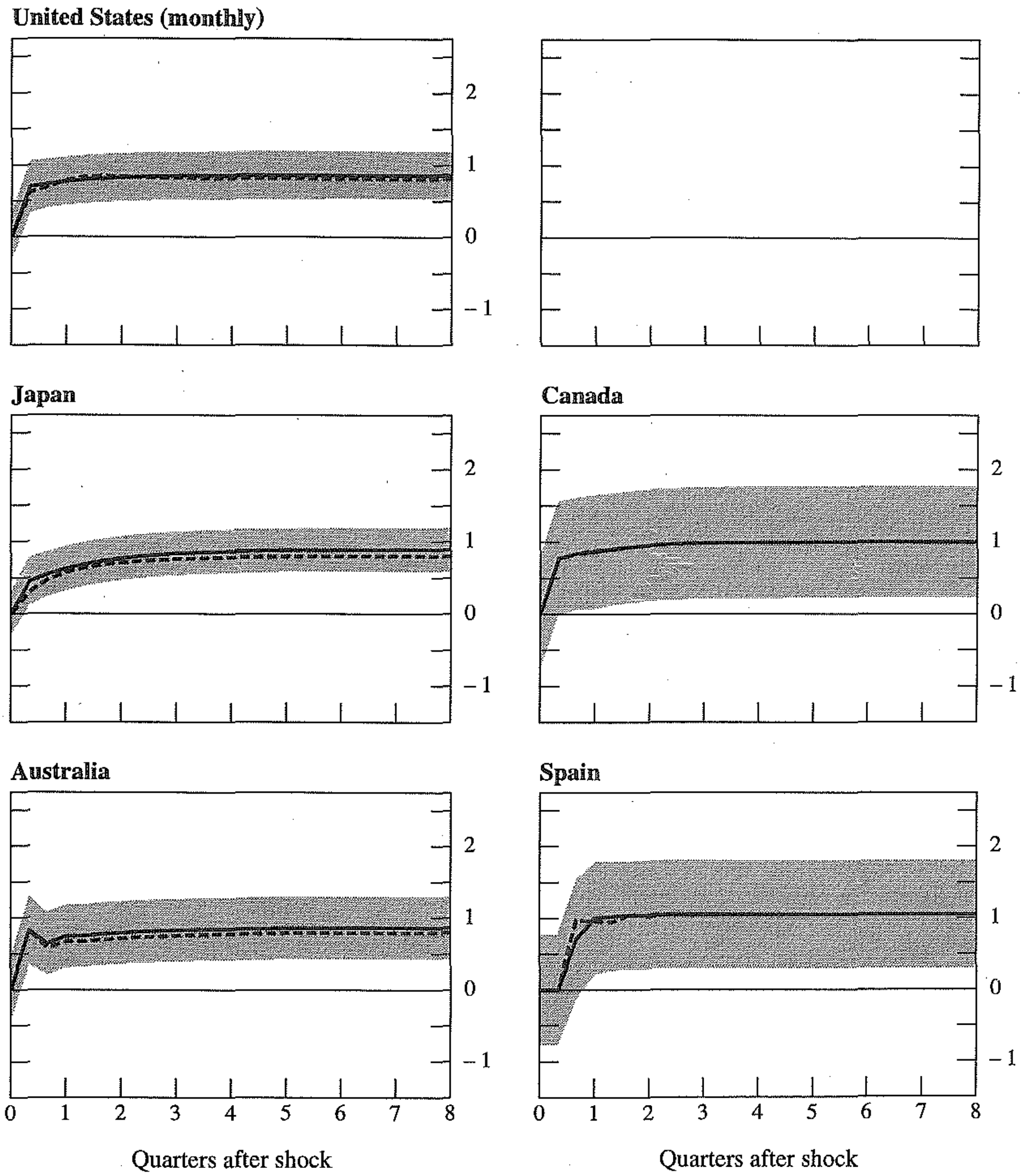


Table AI.1

Loan rate regressions: standard specification (whole period)[1]

	AU	BE	CA	FR	DE	IT	JP	NL	ES	SE(1)	SE(2)	UK	US(1)	US(2)
ΔRM_t	0.20***	0.61***	- 0.14***	0.04**	0.11***	0.09***	0.32***	-	-	0.74***	0.61***	0.06***	0.43***	0.84***
	(4.65)	(14.07)	(2.83)	(2.37)	(2.71)	(3.99)	(7.40)			(10.29)	(19.79)	(2.92)	(10.84)	(8.24)
ΔRM_{t-1}	0.42***	0.39***	-	-	0.18***	0.07***	-	-	-	-	-	0.04**	-	-
	(10.22)	(5.64)			(4.32)	(2.94)						(2.12)		
ΔRM_{t-2}	-	0.38***	0.26***	- 0.03**	-	-	-	0.16**	-	-	-	-	-	-
		(5.34)	(4.85)	(2.25)				(2.23)						
ΔRP_t	0.20***	-	0.88***	0.40***	-	0.17***	-	1.08***	-	-	-	0.94***	-	-
	(5.24)		(16.08)	(753)		(4.77)		(17.60)				(49.14)		
ΔRP_{t-1}	-	-	-	-	-	-	-	-	0.11***	-	-	-	0.23***	-
									(2.80)				(4.97)	
ΔRP_{t-2}	-	-	- 0.20***	-	-	-	-	- 0.21***	-	-	-	-	-	-
			(3.50)					(2.66)						
ΔRL_{t-1}	- 0.22***	- 0.37***	-	-	-	0.61***	0.30***	- 0.12**	-	-	-	- 0.04**	-	-
	(3.86)	(4.60)				(8.86)	(3.97)	(2.39)				(2.00)		
ΔRL_{t-2}	0.17***	- 0.28***	-	-	-	- 0.16**	-	-	-	-	-	-	-	- 0.20**
	(3.61)	(3.91)				(2.34)								(2.57)
RL_{t-1}	- 0.13***	- 0.07*	- 0.27***	- 0.08***	- 0.10***	- 0.04***	- 0.08**	- 0.33***	- 0.09***	- 0.67***	- 0.79***	- 0.63***	- 0.16***	- 0.77***
	(3.18)	(1.94)	(4.23)	(3.19)	(5.65)	(3.01)	(3.52)	(4.59)	(3.57)	(3.66)	(5.31)	(7.39)	(4.54)	(5.14)
RM_{t-1}	-	0.10**	-	0.06***	-	0.05***	-	0.14**	0.10***	0.62***	0.63***	-	0.36***	0.84***
		(2.21)		(3.46)		(3.02)		(2.15)	(6.06)	(3.89)	(6.10)		(6.99)	(5.43)
RP_{t-1}	0.11***	-	0.27***	-	0.11***	-	0.07***	0.22**	-	-	-	0.63***	- 0.22***	-
	(3.35)		(4.17)		(6.47)		(3.74)	(2.29)				(7.39)	(4.98)	
$\overline{R}^2$	0.80	0.71	0.82	0.45	0.51	0.77	0.62	0.80	0.36	0.86	0.96	0.99	0.76	0.78
SEE	0.24	0.24	0.23	0.13	0.11	0.16	0.09	0.15	0.28	0.42	0.39	0.07	0.13	0.42
DW	2.15	1.97	2.16	1.99	2.14	2.10	2.15	1.97	2.23	2.03	1.95	2.16	2.09	1.87

[1] For the dummies included in order to take into account the 1992 ERM turbulence, see Table 6.

Table AI.2

Money market rate regressions (whole period)[1]

	AU	BE[2]	CA	FR	DE	IT	JP	NL	ES	SE	UK	US(1)	US(2)
ΔRP_t	0.72***	-	1.04***	1.46***	1.06***	0.54***	0.58***	1.05***	0.86***	0.80***	0.95***	0.80***	1.08***
	(10.03)		(23.22)	(6.21)	(11.23)	(4.71)	(12.93)	(14.53)	(7.45)	(8.79)	(24.81)	(12.07)	(17.5)
ΔRP_{t-1}	-	-	-	-	0.22**	-	-	0.35***	-	-	-	0.21***	-
					(2.51)			(3.13)				(3.28)	
ΔRP_{t-2}	-	-	-	-	-	0.25**	0.13***	-	-	-	-	-	-
						(2.21)	(2.94)						
ΔRM_{t-1}	0.16**	-	-	-	-	-	-	- 0.42***	-	-	-	-	-
	(2.37)							(4.41)					
ΔRM_{t-2}	-	-	-	-	-	-	-	- 0.19***	-	-	-	-	-
								(2.96)					
RP_{t-1}	0.28***	-	1.24***	0.82***	0.33***	0.12**	0.11**	-	0.58***	0.90***	0.71***	0.33***	0.90***
	(2.96)		(13.05)	(8.69)	(4.30)	(2.59)	(2.20)		(5.47)	(4.00)	(7.61)	(4.80)	(5.32)
RM_{t-1}	- 0.29***	-	- 1.23***	- 0.85***	- 0.34***	- 0.21***	- 0.13**	-	- 0.60***	- 0.93***	- 0.71***	- 0.34***	- 0.93***
	(3.08)		(13.16)	(9.59)	(4.45)	(3.74)	(2.33)		(6.14)	(4.24)	(7.66)	(4.94)	(5.42)
$\bar{R}^2$	0.54	-	0.82	0.44	0.53	0.20	0.64	0.64	0.33	0.82	0.83	0.65	0.89
SEE	0.51	-	0.27	0.62	0.19	0.64	0.14	0.18	0.78	0.60	0.28	0.20	0.24
DW	1.96	-	2.03	2.11	2.05	2.19	1.90	2.10	2.20	1.91	2.03	1.92	1.99

[1] For the dummies included in order to take into account the 1992 ERM turbulence, see Table 6. [2] The three-month interbank rate moves closely in line with the rate on three-month Treasury certificates, the best indicator of a policy rate until the reforms in January 1991.

Table AI.3

Loan rate regressions: standard specification (recent period)[1]

	AU	BE	CA	FR	DE	IT	JP	NL	ES	UK	US (1)
ΔRM_t	-	0.63***	-	0.05**	-	-	0.45***	-	-	-	0.37***
		(11.98)		(2.57)			(6.46)				(3.24)
ΔRM_{t-1}	-	- 0.15**	-	-	0.19**	-	-	-	0.19***	-	-
		(2.09)			(2.04)				(3.46)		
ΔRM_{t-2}	-	-	0.31***	-	-	-	-	-	0.13***	-	-
			(4.19)						(2.39)		
ΔRP_t	0.83***	-	0.77***	0.46***	-	0.19***	-	0.71***	-	1.00***	0.33**
	(9.61)		(11.1)	(7.17)		(8.55)		(8.46)		(151.4)	(2.53)
ΔRP_{t-1}	-	-	-	-	-	0.15***	-	-	-	-	-
						(3.81)					
ΔRP_{t-2}	-	-	- 0.34***	-	-	-	-	-	-	-	-
			(4.09)								
ΔRL_{t-1}	- 0.23***	-	-	-	-	0.43***	-	-	-	-	-
	(3.63)					(4.69)					
ΔRL_{t-2}	-	-	-	-	-	-	-	-	-	-	-
RL_{t-1}	- 0.25**	- 1.18***	- 0.30***	- 0.14***	- 0.10***	- 0.11**	- 0.22***	- 0.51***	- 0.48***	-	- 0.28***
	(2.46)	(7.37)	(2.95)	(3.41)	(3.53)	(2.08)	(4.35)	(4.90)	(4.25)		(3.58)
RM_{t-1}	0.22**	1.10***	-	0.08***	-	-	0.20***	0.20***	-	-	0.48***
	(2.36)	(7.44)		(3.33)			(4.67)	(2.96)			(4.26)
RP_{t-1}	-	-	0.30***	-	0.10***	0.11**	-	0.32***	0.51***	-	- 0.24**
			(2.88)		(4.68)	(2.27)		(2.71)	(4.46)		(2.34)
$\bar{R}^2$	0.82	0.89	0.82	0.53	0.51	0.92	0.68	0.74	0.57	1.00	0.71
SEE	0.15	0.18	0.27	0.13	0.12	0.13	0.09	0.11	0.26	0.02	0.11
DW	1.99	2.01	1.90	2.12	2.03	1.86	1.80	1.98	2.27	2.01	1.71

[1] For the dummies included in order to take into account the 1992 ERM turbulence, see Table 6.

Table AI.4

Money market rate regressions (recent period)[1]

	AU	BE	CA	FR	DE	IT[2]	JP	NL	ES	UK[2]	US (1)
ΔRP_t	0.73***	0.97***	1.06***	1.48***	0.73***	-	0.68***	0.98***	2.39***	-	0.80***
	(4.41)	(8.16)	(11.47)	(4.30)	(6.61)		(8.24)	(10.20)	(8.22)		(8.22)
ΔRP_{t-1}	-	0.81***	-	-	0.28**	-	-	-	-	-	-
		(4.19)			(2.10)						
ΔRP_{t-2}	-	-	-	-	-	-	-	-	-	-	-
ΔRM_{t-1}	-	- 0.50***	-	-	- 0.31**	-	0.25***	- 0.21**	- 0.78***	-	0.26***
		(3.86)			(2.13)		(2.76)	(2.47)	(7.28)		(3.04)
ΔRM_{t-2}	-	- 0.44***	-	-	-	-	-	-	- 0.21**	-	-
		(4.66)							(2.14)		
RP_{t-1}	0.43**	-	1.28***	0.96***	-	-	0.22**	-	-	-	0.47***
	(2.38)		(8.66)	(7.02)			(2.35)				(4.34)
RM_{t-1}	- 0.46**	-	- 1.28***	- 0.96***	-	-	- 0.25**	-	-	-	- 0.48***
	(2.51)		(8.76)	(8.27)			(2.40)				(4.36)
$\bar{R}^2$.................	0.42	0.77	0.74	0.48	0.49	-	0.62	0.66	0.63	-	0.70
SEE	0.25	0.28	0.37	0.75	0.15	-	0.13	0.14	0.50	-	0.13
DW	1.97	2.36	2.07	2.07	1.95	-	2.09	2.39	2.43	-	1.89

[1] For the dummies included in order to take into account the 1992 ERM turbulence, see Table 6. [2] Not relevant since no money market rate enters the loan rate equation.

List of symbols used in the tables

Δ	change (first difference)	AU	Australia
SD	standard deviation	BE	Belgium
$\overline{R}^2$	adjusted R^2	CA	Canada
SEE	standard error of the equation	FR	France
DW	Durbin Watson statistic	DE	Germany
CH (x)	Chow test (p-value); x is the year that splits the sample	IT	Italy
		JP	Japan
*	significant at the 10% level	NL	Netherlands
**	significant at the 5% level	ES	Spain
***	significant at the 1% level	SE	Sweden
(.)	figures in brackets under coefficient estimates are t-statistics	UK	United Kingdom
		US	United States
–	not applicable/not statistically significant		
n.a.	not available		
RL	lending rate		
RM	money market rate		
RP	policy rate		
RD	(average) cost of deposits		
RC	opportunity cost rate		
R0	standing facility rate		

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Is there a credit channel in the transmission of monetary policy? Evidence from four countries

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I. INTRODUCTION[1]

The mechanism by which changes in the market for liquid reserves engineered by the monetary authorities affect the level of economic activity has always been a topic of great interest to academic economists and policy-makers alike. Research in this general area has focused lately on the particular role played by the assets side of the banking sector's[2] balance sheet in this transmission mechanism and, more specifically, on the question of whether bank loans play a special and independent role that is not captured by conventional analysis.

The standard IS-LM type analysis assumes that there is imperfect substitutability between money and other financial assets grouped under the category "bonds". Moreover, the quantity of money is dependent on the availability of liquid reserves. The monetary authorities, by controlling the amount and/or price of these reserves, can influence the ability of the banking system to attract deposits. When a central bank drains reserves from the system, the resulting "liquidity squeeze" drives up interest rates and affects negatively all interest rate sensitive expenditure. This ability of monetary policy to influence aggregate demand hinges on three assumptions:[3] (1) that the central bank can control the quantity of banking system reserves, (2) that there are no close substitutes for bank deposits, and (3) that some sort of nominal rigidity in the system does not allow nominal magnitudes to adjust fully and instantaneously to the level of reserves, therefore necessitating certain quantity adjustments. This is what has been (somewhat loosely) referred to as the "money view" of the transmission of monetary policy.

The IS-LM model maintains a feature of the Arrow-Debreu framework, viz. that informational imperfections are absent, which renders all debt instruments perfect substitutes. The analysis can thus be based on a well-defined and well-behaving demand schedule for interest rate elastic components of aggregate expenditure. The "credit view" of the transmission mechanism relaxes this assumption and also moves away from the Modigliani-Miller theorem. It introduces the concept of agency costs in the interaction of borrowers and lenders and underlines the importance of the borrower's liabilities structure in determining the terms on which credit can be obtained. An important result of this analysis is that financial intermediation can play a major role in mitigating these costs either by avoiding redundant duplication of borrower evaluation and monitoring by a group of lenders,[4] or by providing a platform permitting longer-term relationships to be established that, in turn, reduce the scope for informational asymmetries and thus agency costs.[5] These arguments suggest that intermediated loans are different in nature from other types of market credit such as bonds or commercial paper. When a central bank reduces the amount of reserves in the system it is not only bank liabilities that are affected but also bank assets. A reduction in the quantity of bank

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1 This paper has benefited from the comments of Dr. Horst Bockelmann.

2 Throughout the paper I use the term "bank" to denote deposit-taking financial intermediaries.

3 None of these three assumptions are part of the Arrow-Debreu setting.

4 See for example Diamond (1984).

5 Two examples of such models are Sharpe (1992) and Gertler (1992).

loans supplied, because of the absence of close substitutes, will be reflected in a *quantity* constraint on *intermediated* credit to bank customers. A reduction in the total supply of external funds will have negative effects on their activity level. It is important to note here that although this mechanism works parallel to the conventional one stipulated by the "money view", it represents a distinct channel because it entails a shift in the supply of bank credit in addition to any movements along the demand curve for loans induced by the higher level of interest rates.

The empirical investigation of the importance of this "bank loan channel", as it is otherwise known, has focused mainly on the United States. Although results compatible with the theory have been presented, the evidence is far from being compelling and unambiguously in favour of the "credit view". The present study investigates the issue from a cross-country perspective, to examine whether one can exploit the fact that alternative arrangements regarding the financial structure should, in theory, emphasise to a different degree the effects of the credit channel. In other words, the idea is to use the institutional differences as an "instrument" (loosely speaking) that could help us to disentangle the responses of the two sides of banks' balance sheets after a monetary policy tightening.

Of the countries included in this study, the United States and the United Kingdom may be thought of as being the representatives of the "Anglo-Saxon"[6] model, where the relationships between borrowers and banks are more arm's-length and deposit-taking institutions are not permitted to develop ownership and control relationships with their corporate customers. The situation in Japan and Germany, on the other hand, is quite different. Banks in these countries not only supply the majority of external funds to the non-financial sector, as their capital markets tend to be quite "thin", but they also play a very important role in corporate governance through their close ties to industry, which frequently take the form of substantial equity holdings and participation in companies' boards. Relationships of this type should help reduce agency costs and thus make bank credit more "special". One might then expect the bank lending channel to be stronger under these conditions than in the more "market-oriented" Anglo-Saxon countries.

The second part of the paper explains the methodological approach adopted, usually referred to as the "narrative method", which provides the main results of this study, and those financial market characteristics of the four countries examined that are relevant to the analysis of the transmission mechanism. Section III presents the results of a series of tests that try to gauge the predictive ability of different financial variables for various real activity measures. Section IV studies the behaviour of money, bank loans and output following episodes of monetary policy tightening, and Section V contains the conclusions.

II. METHODOLOGY AND THE SAMPLE OF COUNTRIES

A crucial first step in any analysis of the effects of monetary policy on economic activity is the definition of the term "monetary policy" itself. The macroeconometric literature abounds with studies that have proposed, and used, different identification methods in order to distil from the data a measure of monetary policy "purged" of the impact of other economic developments beyond the control of the monetary authorities. Although it is not the purpose of this paper to provide a detailed critical review of these alternative methodologies, it is still instructive to make some broad comparisons between the main strands in the literature in order to clarify the merits and limitations of the particular scheme used.

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6 Even though the term "Anglo-Saxon" fails to capture the essence of the distinguishing characteristics in the financial structure of these countries, it has been used in the literature extensively. Although I am aware of its shortcomings, for lack of a better term I shall use it throughout the paper simply as an identifier for the United States and the United Kingdom.

It is possible to classify the different identification methods into two major categories. The first approach amounts to "declaring" a particular variable as representing the monetary policy stance. Various monetary aggregates (or growth rates of aggregates) were the natural candidates which suggested themselves first for the role but it was soon realised that their use was subject to serious endogeneity problems. In recent years many researchers (focusing mainly on the US economy) have proposed particular interest rates, interest rate spreads or narrow definitions of the monetary base as being good representatives of the policy stance.[7] Movements in these variables, the authors argue, are influenced mainly by policy actions, and the feedback from the underlying level of economic activity is relatively unimportant. Although these arguments are quite persuasive, the choice of variables is heavily influenced by the particular institutional environment present in each country, and this makes international comparisons difficult.

The second method uses the framework of a statistical model for the economy and employs coefficient and/or error covariance restrictions in order to identify the impact of monetary policy.[8] This statistical approach has the advantage of providing a platform that can accommodate international comparison but has been a source of endless controversy, as the results of the analysis depend heavily on the restrictions imposed. Alternative economic theories typically imply quite different sets of restrictions. Moreover, to the extent that some of these restrictions are not overidentifying, they cannot be subjected to statistical verification.

In this paper I have used yet a third method, that has frequently been referred to as "the narrative approach".[9] Its has its intellectual roots in the seminal work of Friedman and Schwartz (1963), which used the historical record to provide evidence of the importance of money in determining the level of economic activity in pre-World War II United States. In keeping with this approach Romer and Romer (1989) used the policy records of the Federal Reserve to identify a number of dates during the post-war period when monetary policy was tightened in order to reduce inflation. Equivalent dates have been identified for Japan by Ueda (1993) and Fernandez (1994), and for the United Kingdom and Germany by myself.

Even though the motivation of the narrative and the statistical methods is the same, the philosophy that governs the choice of dates is rather different from the econometric identification techniques. Rather than representing the error term in the authorities' policy reaction function, which is orthogonal to the other sources of random disturbances of the system, these dates represent major shifts in the policy stance, aimed explicitly at reducing aggregate demand. This difference in the way "shocks" are defined in each method seems to have produced a great deal of confusion and controversy. Since the narrative approach is used in this paper it would be useful to attempt to clarify the matter in this section.

It is true that the purpose of this particular scheme, like any other identification scheme, is to isolate the effects of monetary policy actions on financial variables and to filter out the influence that the underlying level of economic activity has on them. This is especially important when one's final objective is to analyse the impact of monetary policy on real activity. What is *not* true about these dates is that they represent monetary policy shocks that are entirely *independent* of, and *not explainable* by, other macroeconomic variables or events. Such actions may reflect a dramatic change in the way policy-makers view the economy (e.g. a new model, a new attitude towards deviations of various objectives from their target values), or in some cases the simple realisation that the current situation had not been dealt with appropriately within the existing policy framework (correction of policy mistakes). In fact, for each one of these episodes there was a single (but not always the same) concern that clearly determined the monetary authorities' strategy and rendered the particular policy response necessary. So in this sense the policy shifts are not exogenous, since they have well-defined

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7 A small sample of recent papers includes Bernanke and Blinder (1992), Stock and Watson (1989), Friedman and Kuttner (1992) and Estrella and Hardouvelis (1991).

8 See, for instance, Gerlach and Smets (this volume).

9 The term was coined by the Romers in their first paper on the subject (Romer and Romer (1989)).

causes. These causes, however, have always been nominal disturbances, and the policy-maker's response was explicitly aimed at reducing aggregate demand in order to restore a more favourable macroeconomic equilibrium.

A defining characteristic of these "policy shifts" is that they represent unambiguous[10] changes in attitude, major corrections (if not complete reversals) of the path followed up to that point, towards a more restrictive policy. Apart from being by their very nature big headline events, they were also documented, and the rationale behind the decision was clearly explained in official sources published contemporaneously with each episode.[11] In a way, they can be interpreted as being the closest real-world approximation to a leftward shift of the LM curve as it is interpreted in a standard macroeconomics textbook.

Another characteristic that distinguishes a policy tightening episode from the "normal operation" of monetary policy is that it is, in a sense, backward rather than forward-looking. By this I mean that the policy-maker intended to correct the current problem (that problem being what was perceived as excessive inflation or an exchange rate crisis) by actually inducing a recession. Pre-emptive strikes in anticipation of future inflation, of the type announced early in 1994 by the Federal Reserve in the United States, for example, are *not* included in the list of episodes.[12]

As a general approach this method of identification is subjective by its very nature. Not only does it rely on the policy-maker's published account of his own actions, but there is a potential problem of the analyst interpreting this record with the benefit of hindsight since he will know what happened after the policy action. Unfortunately there is not much that the researcher can offer in his defence, since there are no quick verification tests. Also, from a more practical point of view, there are some other obvious limitations of the narrative method, which one should be fully aware of in order to be able to evaluate the results correctly. The dates identified represent discrete episodes that mark only the beginning of a policy-tightening period. Therefore, the statistical analysis that uses them as reference points has to take account of the fact that the period of restrictive policy extends over several months after a particular date, and that the policy effects are typically felt over even longer periods subsequently. It is also important to note that there is an asymmetry in the treatment of policy actions, because only tightenings are identified. This is not intentional but a necessary consequence of the way policy is made and documented, as it seems that the monetary authorities have a bias towards acting (or at least appearing to be acting) on the restrictive side. Monetary policy easing is much more gradual and tentative and is typically accompanied by relatively cautious language, warning of the risks of excessive relaxation. It is much easier to isolate policy measures with a clear contractionary objective than to identify exactly when the monetary authorities were actively seeking to reflate the economy.[13] Another dimension of policy-making not captured by these "dates" is the intensity of the policy tightening. Although this is a clear limitation of the method, one could argue that because the identified policy shifts have all been quite severe, they can be grouped together and their effects analysed in an average sense.

On the other hand, this methodology has some advantages. Instead of letting "the data decide" when there was a policy shock, the researcher plays an active role in choosing the dates. This

10 To the extent that the term can be used when referring to economic policy actions.

11 The Romers used the FOMC minutes and the Record of Policy Actions of the Board of Governors. Ueda used the dates of increases in the discount rate in Japan on institutional grounds and his results have been confirmed and documented by Fernandez. For the United Kingdom and Germany I have used the discussion of current economic conditions in the Quarterly Bulletins of the Bank of England and Monthly Reports of the Bundesbank respectively.

12 Other examples of apparent policy tightenings that do not qualify as "dates" are the 1966 "credit crunch" in the United States, and the interest rate increases in the latter part of the 1980s in Germany. In all of those episodes the intent of the policy-makers (at least the one publicly declared) was to merely anticipate overheating of the economy and prevent pressures on price level from building up and feeding the wage-price spiral.

13 In fact, the only deliberate monetary policy easing that I found easy to identify is the monetary expansion that accompanied the "Barber boom" in the United Kingdom in 1971-72.

way the interpretation is more straightforward and closer to what seems to be a typical episode of monetary policy tightening that economic commentators (and many economists) refer to in more casual discussion. The strongest argument in favour of the narrative approach is its usefulness in comparative analysis. The episodes in question are entirely comparable across different countries and can serve as points of reference for an event-based analysis similar to that undertaken in this paper. Finally, this methodology should be viewed as complementary to, rather than competing against, other techniques, and as such can offer additional insights in the analysis of monetary policy effects.

The episodes of monetary policy shifts in the United States,[14] as identified by Romer and Romer (1989, 1994), are: December 1968, April 1974, August 1978, October 1979 and April 1988. For Japan, Ueda (1993) identified policy shifts with the first date of a discount rate increase by the Bank of Japan: July 1961, March 1963, September 1967, September 1969, April 1973, April 1974 and May 1989. Mechanistic as this approach may seem, the results were confirmed by Fernandez (1994), with one exception (September 1969), when the latter author felt that the increase in the discount rate was not an independent tightening but rather a continuation of the previous episode (September 1967). The five periods that I have identified as policy shifts by the Bundesbank are: February 1960, January 1966, September 1969, May 1973 and February 1981. There have also been five monetary policy tightening episodes since 1963 in the United Kingdom: October 1964, November 1967, July 1973, November 1978 and August 1988.

1. Individual country characteristics

The four countries included in this study, besides being the ones for which sets of policy shifts have been identified, are of interest because they represent a diversified group in terms of the structure of their respective financial systems, and the manner in which domestic monetary policy is conducted. In the remaining part of this section I shall briefly review some of these characteristics. My objective is to underscore the contrasting features among them that may help in identifying the channels of the transmission mechanism.

It has become commonplace to distinguish between those countries whose financial structure follows the so-called "Anglo-Saxon" model and those whose financial structure more closely resembles the "continental" one. The United States and the United Kingdom are frequently put forth as the two major representatives of the former category, while Germany and several other mainland European economies are thought of as representing the latter. Japan is another example of the "continental" system.

The major difference between the two systems is the role that banks are allowed to play. The Anglo-Saxon system is rather restrictive with respect to the activities that banks are permitted to undertake. There is a separation between investment and commercial banking activities, which generally may not be conducted by the same entity, and more importantly there are limits on a bank's ability to hold substantial equity stakes in non-financial companies. The "continental" system not only allows banks to supply directly a wider array of services but also to some extent encourages the active participation of financial intermediaries in the governance of big corporations and makes them partners in the decision-making process.[15] The "Hausbank" institution in Germany and the "keiretsu" groups of industrial and financial firms in Japan are very clear illustrations of this philosophy. Also regulatory and institutional arrangements in these countries not only favour intermediated credit but

14 I am including only episodes falling within the sample period used in the paper for each country (1959-93 for the United States, 1961-93 for Japan, 1957-90 for Germany and 1963-93 for the United Kingdom).

15 The term "continental" should not be interpreted as encompassing all the countries of mainland Europe. Italy, for instance, has been an exception in terms of the direct role that banks are permitted to play in corporate governance.

have in the past discouraged, to varying degrees, the development of alternative, market-oriented forms of finance such as commercial paper.[16]

It is not easy to quantify the effect of credit market structure and the degree of dependence of the non-financial sector on bank loans. Some descriptive evidence is provided in the following table, which summarises the composition of non-financial corporations' balance sheets. The data are from Borio (1990), where the interested reader can find a more detailed analysis. The first four rows represent the percentage of total credit market debt attributed to banks, other financial intermediaries and private securities issues. The last row shows the ratio of debt to total assets (at market value).

Composition of external finance for non-financial corporations, 1985

(numbers in percentages)

	United States	United Kingdom	Japan	Germany
Domestic banks	32	62	53	73
Other domestic institutions	9	6	38	5
Securities	56	19	8	4
Other	4	13	2	17
Debt/Asset ratio	0.50	0.52	0.73	0.71

N.B.: The data are not fully comparable. See Borio (1990), Tables 2 and 14, for exact definitions.

The effects of the institutional arrangements I referred to in the previous paragraph are clearly demonstrated in terms of the lower corporate leverage ratios of US and UK companies.[17] The comparison of the relative contribution of different sources of external finance shows that corporations in Germany and Japan rely more heavily on intermediated credit, especially bank loans, for external funding. In the other two countries, capital markets play a much more important role. It is a well-known problem with these figures that they are not fully comparable across countries because of differences in the respective agencies' data collection "philosophies", and in accounting practices. However, the differences are clear enough to suggest that any corrective adjustments for these discrepancies should not substantially alter the main picture.

The greater dependence of non-financial firms on bank-intermediated credit in Germany and Japan and the active involvement of banks in the governance of corporations are factors that mitigate the agency costs of financial relationships in these countries. The strengthened role of the banking system should theoretically enhance the attractiveness of bank loans as sources of credit and reduce the degree to which they can be substituted by other forms of external finance. In other words, bank loans are relatively "more special" in these countries and the credit channel of monetary policy transmission could therefore be expected to be, if anything, stronger.

The structure of credit markets is not the only differentiating characteristic of these economies that might have some influence on the transmission of monetary policy. There are, and have been in the past, substantial differences in the conduct of monetary policy, as well as in the particular methods and instruments used by the monetary authorities in their effort to achieve their objectives. In this respect the United States and Germany could be grouped together as two countries

16 See Prowse (1994) for a good discussion of such regulatory practices and how they have influenced the development of capital markets in Japan and Germany.

17 These differences are even more dramatic if one compares net debt to the level of real assets.

with independent central banks that rely almost exclusively on money market forces in the operation of monetary policy. In the United Kingdom and Japan, on the other hand, the monetary authorities have, at times, made extensive use of the informal but well-established channels of direct communication with the banks in order to achieve their purpose through moral suasion. In the United Kingdom this has taken the form of the letters from the Governor of the Bank of England to the banking community informing it as to what the desired credit policy would be from the central bank's point of view.[18] In Japan, several authors refer to the central bank's previous policy of "window guidance" by which banks were instructed during their frequent individual contacts with the Bank of Japan on the way in which the authorities would prefer to see their balance sheets adjusted. The tightly controlled system of interest rates, on both bank liabilities and loans extended, increased the leverage that the Japanese monetary authorities had on the banking system.[19]

There have been large-scale changes in the way in which monetary policy operates in all four countries. An event which affected everybody was the collapse of the Bretton Woods system and the subsequent emergence of the floating exchange rate regime.[20] Another was the switch to a strategy of monetary aggregate targeting sometime in the second half of the same decade. But more relevant for this study is the radical transformation in the way in which monetary policy is conducted in Japan and the United Kingdom. With the liberalisation of the money market and the creation of a secondary market for government and commercial securities the Bank of Japan lost (or rather relinquished) its ability to tightly control bank balance-sheet movements. In the United Kingdom, the long process that started with the introduction of Competition and Credit Control in 1971 and continued for about ten years, resulted in the abolition of the London clearers' cartel and transformed existing monetary policy into one that tried to achieve its goals through manipulation of the short-run interest rates rather than by relying on explicit quantity controls. In both these countries the contrast between the earlier years and the period after 1980 is potentially instructive, as it will reflect any differences in the relative strength of the transmission channels that can be attributed to the instruments used in the conduct of monetary policy rather than differences in the structure of their credit markets.

III. PREDICTION TESTS

A method that has been frequently used in assessing the importance of financial variables in the determination of real economic activity is to evaluate their predictive ability with regard to various measures of economic activity. This "horse race" approach is related to the concept of Granger causality, although it typically omits the second part of the Granger test. More specifically the variable X is said to "Granger-cause" a variable Y if two conditions hold: first, that X contains information about future movements of Y beyond that already included in the latter's past history; second, that the converse is not true, and lagged values of Y cannot improve over the history of X in predicting future values of X. The standard tests performed in this literature only run the first type of prediction equation (of Y on past Ys and past Xs) and compare the performance of various explanatory variables. These tests are sensitive to the specification of the forecasting equations,[21] so

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18 Many of these letters have subsequently been published in various issues of the Bank of England's Quarterly Bulletin.

19 For a discussion of the conduct of monetary policy in Japan, see Suzuki (1987, 1984a, 1984b) and Ueda (1993). It is actually quite interesting to note that a tightening of monetary policy in Japan during the 1960s amounted to an increase in the official discount rate of only 25 basis points, another illustration that small price movements were enough to produce the desired effect as the quantities were also being directly influenced separately.

20 Although Germany has been part of the quasi fixed rate system in Europe since the mid-1970s, by having assumed the role of the system's de facto anchor, it has been relatively free to adjust the value of its currency vis-à-vis the rest of the world.

21 Whether one uses log levels or growth rates, whether a trend is included, and especially to the lag length of the r.h.s. variables.

one should not attach too much importance to their outcome. They are useful, however, as a means of determining the correlations between the various variables.

Tables 1a to 1d contain the results of such tests for each country conducted for the entire period and a smaller sub-period. This sub-period has been chosen to reflect what can be thought of as a period when the institutional framework and/or general economic environment within which monetary policy was operating had been significantly altered. The rationale for the particular choice of sample for each country has been discussed above, at the end of Section II.

The first set of tests comes from "bivariate" forecasting equations that have as dependent variable the measure of economic activity listed at the top of the column, and as regressors a constant term, six lags of the same variable, six lags of the financial variable listed in the first column and six lags of the price index. Output, production, employment and financial aggregates are all in growth rates, while interest rates, unemployment rates and interest rate spreads are in levels. There are four groups of financial variables used: monetary aggregates, interest rates, interest rate spreads and bank loans to the private sector. The inclusion of interest rate spreads is an attempt to evaluate the extent to which one can generalise the results of several studies that have found that these spreads are robust predictors of economic activity in the United States. The two spreads used are the term spread, the difference between comparable government security yields of different maturity (long minus short), and the quality spread, the difference between a commercial and a government security of the same (or similar) maturity. The term spread captures the idea that monetary authorities operate on the short end of the term structure and therefore movements in this spread should reflect the policy stance. The quality spread attempts to evaluate the extent to which a restrictive monetary policy that reduces the supply of loans from banks shifts credit demand towards other sources of funding and thus drives up their price. The top figure in each cell is the p-value for the joint significance test for all the lags of the financial variable, and the bottom number is the test statistic for the null hypothesis that the sum of its coefficients is equal to zero. A variable is a good predictor of the corresponding activity measure if the top value is below 0.05000 (5% significance level) and the direction of its influence significantly positive (negative) if the bottom figure is larger (smaller) than 1.960 (-1.960).

Tables 2a to 2d run the same type of prediction equation, augmented by the inclusion of six lags of a short-term money market rate. This interest rate is included as a monetary policy proxy variable. The choice of the particular rate for each country was based on institutional grounds or the results of previous studies that established its significance. The variable used is the federal funds rate in the United States, the day-to-day money market rate in Germany, the call rate in Japan and the local authorities' three-month rate for the United Kingdom.[22] The idea is that this latter set of tests will show how much of the predictive ability of the financial variables is not attributable to their contemporaneous correlation with monetary policy actions. In other words, it will indicate the extent to which these variables play an independent role in determining the level of real economic activity.

The overall picture is not very clear, and few generalisations can be drawn with confidence from these tables. Probably the most surprising result is the limited success of the federal funds rate in forecasting economic activity in the United States. On the other hand, M_2 seems to perform quite well in all samples, whether the prediction equation includes the federal funds rate or not. The clear winners of the contest, however, are the two spreads, which consistently outperform the other variables.[23]

In Germany the interest rates perform very well in both samples, but it appears that their predictive ability is linked to their relationship with the policy variable. The two spreads also do not seem to survive the inclusion of the day-to-day rate in the equation, despite their reasonable

22 The last rate was chosen because it moves very closely in line with the Minimum Lending Rate (previously called Bank Rate) but, being a market rate, it does not have the stepwise path of the official rate that tends to remain fixed for relatively long periods of time.

23 The robustness of the spreads' predictive ability confirms the results of Friedman and Kuttner (1992) and Estrella and Hardouvelis (1991).

performance in the unconditional prediction tests. Monetary aggregates are not very successful, and their performance is again influenced by whether or not the monetary policy proxy is included. Loans, on the other hand, although marginally better performers, seem to be unaffected by the presence of the policy interest rate.

The good performance of the monetary aggregates in Japan is quite robust across samples and different equation specifications. On the other hand, interest rates are not very successful, with the exception of the commercial bill rate in the earlier period and the spread between the long-term commercial bond yield and the ten-year government equivalent for the same sample.

Little of the predictive ability of UK interest rates seems to remain after the inclusion of the policy proxy. The spreads, however, seem to fare better in the later sample and their performance is not affected so much when controlled for the policy stance. Monetary aggregates are quite successful in all four settings, as are loans, which seem to fare better when the short-term rate is included, especially in the later part of the sample.

The more robust conclusion reached as a result of this exercise points to the generally good forecasting ability of the spreads and some of the monetary aggregates in all countries except Germany. These variables seem to perform well even after a monetary policy proxy has been added to the right-hand side variables. By contrast, the performance of all the financial variables as predictors of the economic activity in Germany seems to be related to their co-movement with the short-run interest rate, indicating their limited independent influence on economic activity.

The inability to draw other strong conclusions from these numbers reflects the fact that such exercises are quite sensitive to the exact specification of the test and therefore not very helpful in international comparisons, since it is difficult to find a single common framework for all countries. Nevertheless, as already mentioned above, they set the scene for the discussion of the results of the analysis of movements of the financial variables at times of monetary policy shifts.

IV. THE POLICY EPISODES

In this section I shall examine the behaviour of money and loans immediately after an episode of monetary policy tightening in the four countries. To the extent that the response of monetary aggregates differs from that of bank credit, one can afford to make some inferences about their relative role in the propagation of the policy "shock" through the banking sector's balance sheet. Two different techniques will be used: a "limited information" methodology, where I look at the prediction errors of single forecasting equations for a period following an episode, and a "full information" methodology, where I estimate a VAR system that includes all three variables and then look at their responses to a policy tightening. The results of the two exercises, combined with the evidence from the statistical tests presented in the previous section, can provide some insights into the channels that the monetary transmission follows.

Before presenting the analysis in greater detail it should be underlined once more that the reader should apply considerably more caution than the proverbial "grain of salt" in interpreting the actual numbers in Figures 1a-1d and 2a-2d. As mentioned previously, the nature of any exercise using the episodes of policy tightening as discrete events necessarily removes one dimension from the information the data can possibly supply, viz. the intensity of the tightening. The analysis, therefore, has to be interpreted in an "average" sense over several episodes, and the numbers provide a measure of the order of magnitude of the policy effect rather than a precise estimate of a specific variable's elasticity in response to policy actions.

1. Forecasting equations

The aim of this exercise is to examine to what extent money, bank credit and output deviate from what can be called their "normal cyclical behaviour" in response to monetary policy tightening. This "normal" path is estimated using univariate forecasting equations of the following type:

$$\Delta\ln(X_t) = c + t + \sum_{i=1}^{n} \Delta\ln(X_{t-i}) + \sum_{i=1}^{p} S_i + \varepsilon_i$$

where X_t is the variable of interest (in turn the measure of economic activity chosen, a monetary aggregate or bank loans), S_i are seasonal dummies that are included when necessary, c a constant and t is a linear trend. A full year of lags (i.e. n=12 for monthly and n=4 for quarterly data) were included on the right-hand side of the equations, but the results are quite robust to the use of a greater lag length. I have then used the coefficient estimates from these equations and actual data up to the date of each tightening episode to produce dynamic forecasts for the growth rate of the variable in question. Forecast errors are then calculated as the difference between the actual and the predicted growth rates of the variable for three years following the policy shift date. Average forecast errors are subsequently calculated by averaging across all the episodes for each country. The top panels of Figures 1a to 1d plot for each country separately the *accumulated* average forecast errors of output, money and bank loans for three years after the policy shock. Since these are cumulative forecast errors for the *growth rates*, they represent the percentage deviation of the variable *level* from its predicted path.

As expected, all three variables eventually fall below their "normal" path, as the negative forecast errors imply. There are, however, a few interesting differences between countries. Economic activity shows a faster response to a policy shift in Germany and the United States, where the deviations become negative within the second six-month period after the episode, while it takes more than a year for output to decline in Japan and the United Kingdom. Moreover, the extent of the output decline is quite similar in Japan, Germany and the United States, with an average fall of 6-7% twenty-four months after the policy tightening, while the corresponding figure for the United Kingdom is about half that amount.[24] It is also interesting to note the very quick response of M_1 in Germany, which drops immediately after the policy shift, to reach a trough twelve months later. In the other three countries the response of the monetary aggregate is weaker, its pace much more gradual, and it does not show any tendency to return to "baseline" within the three-year period. Another important feature is the behaviour of loans: in Germany and the United States bank lending seems to lag behind industrial production,[25] suggesting that a probable cause of its decline can be found in the reduced demand for loans because of the poorer economic prospects. In the other two countries, bank loans not only seem to lead output but their deviation from their respective forecasts is greater than that of the monetary aggregates.

In an effort to further investigate the extent to which the deviations of the two financial variables from their predicted path can be attributed to the underlying level of economic activity, I have repeated the same exercise after augmenting the forecasting equation by adding half a year of leads and lags of the output measure as explanatory variable. The new equation thus takes the form:

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24 It is of course, possible that this difference is (at least partly) due to the fact that I have used quarterly GDP data for the United Kingdom as a measure of economic activity, while monthly industrial production is the corresponding variable for the other countries.

25 In the case of the United States the loan lag is quite substantial, as can be seen from Figure 1d. This is something that has been observed in several studies, including Bernanke and Blinder (1992), Romer and Romer (1990) and Gertler and Gilchrist (1993).

$$\Delta\ln(X_t) = c + t + \sum_{i=1}^{n} \Delta\ln(X_{t-i}) + \sum_{i=-\frac{n}{2}}^{\frac{n}{2}} \Delta\ln(Y_{t-i}) + \sum_{i=1}^{p} S_i + \varepsilon_i$$

where Y_t is industrial production for Germany, Japan and the United States and GDP for the United Kingdom. The leads are added to the usual specification that includes only lags in order to account for the possible effects that present expectations about future developments might have on the decision-making of economic agents. The lower panels of Figures 1a to 1d plot the percentage deviations of money and bank loans from their predicted path for the three years following a policy shift. The responses are again averages across all the episodes for each country. To facilitate the comparison with the upper panels, the response of the output measure is also included in the graphs.[26]

A few aspects of these graphs are well worth highlighting. As expected, the forecast errors are smaller than the univariate equation ones. The reduction in the size of these errors, however, is not uniform either across series or across countries. In particular, the contrast between Germany and Japan is rather sharp. In Germany, the inclusion of industrial production as a predictor does not seem to improve upon the univariate equation for the monetary aggregate, while the average forecast error of bank loans is almost 80% smaller two years after the policy shock. This appears to imply that most of the deviation in the level of bank lending could be attributed to a decreased demand for credit because of the decline in output. In the case of Japan the picture seems to be the reverse. While loans appear to be almost unaffected, the forecast errors for the monetary aggregate are virtually zero for the whole period, after the forecasts are made conditional on the path of output.

For the two Anglo-Saxon countries the results are less clear-cut. For the United States, the prediction errors of the bank loan equation are eliminated after the inclusion of industrial production as an additional explanatory variable, suggesting a strong demand-driven reaction of bank credit to a monetary policy tightening. On the other hand, the response of M_1 is also affected by this addition, (albeit to a lesser extent) and, given that it was not too large in the first place, one might be sceptical as to what degree a clear distinction can be made between the behaviour of the two financial variables. The situation is even more ambiguous in the case of the United Kingdom. Here we started with a loan response that was similar in pattern but greater in magnitude compared to that of M_4.[27] After the movements in output were taken into account, the relative position of the two variables was unchanged, only the percentage deviations from their "normal" path were now reduced proportionately. Thus it seems safe to assert that whatever the relationship between money and loans may be in the United Kingdom, it is not greatly affected by the position of the economy in the cycle.

There are a few conclusions that can be drawn from this exercise, some with greater confidence than others. First, it is quite clear that both the financial variables and output decline following a monetary policy tightening, i.e. monetary policy "matters", and it affects real as well as financial variables. The timing of the responses is not identical, however, and we can probably identify two general patterns that can be associated with the two sides of the money vs. credit debate. The clearest example of a transmission pattern implied by the "money view" is presented by Germany, and the case closest to the "credit channel view" is that of Japan.

In Germany M_1 declines immediately and at a rapid pace for about one year following the shock, reverting to its "normal" level for the next twenty-four months. This pattern is to a large degree independent of the movements in economic activity. Loans, on the other hand, not only lag behind output but most of the prediction error disappears when the forecasts are made conditional

26 This is of course identical to the one from the univariate forecasting equation.

27 Because of frequent changes in the definition of the monetary aggregates in the United Kingdom during the sample period, there are no series for M_1 extending from 1963-93. The M_2 series that exists includes several discontinuities owing to revisions and, even though some of them can be dealt with by using the published M_2 changes, some jumps remain. That is why I used M4 in this part of the analysis. When I experimented with M_2 the results were virtually the same.

upon industrial production. These patterns suggest that there is no independent role played by bank lending in the transmission of monetary policy shocks.[28]

In Japan the movement of the monetary aggregate is very little affected by the policy tightening and seems to follow the developments in output. In fact, its deviations from the benchmark value are entirely explained by output movements. On the other hand, loans lead output movements and are not explained by them. This evidence is consistent with the view that bank credit plays a special and independent role in the transmission of monetary policy shocks.

The other two countries can be classified along the same lines, but not with the same degree of confidence. The United States shares a lot of common features with Germany in terms of the general responses pattern of money and loans but the results are less pronounced. The United Kingdom bears some resemblance to the Japanese case but here the common features are even weaker.

2. Vector auto-regressions

In the previous sub-section single-equation methods were used to gauge the effect of policy tightening on money, loans and output. These methods are susceptible to the obvious criticism that they do not allow for a two-way interaction among the endogenous variables and impose explicit and sometimes questionable restrictions in order to identify the system statistically. This sub-section presents the results from the estimation of systems of equations where the endogenous variables are output, money and bank loans and the policy tightenings are included as exogenous events. More specifically, for each country a binary variable is created, which is equal to one on the dates of policy tightening episodes and zero otherwise. Three years of lags of this dummy variable are then included as exogenous components in a three-equation VAR system which also includes six months of lags[29] of the growth rates of money, bank loans and output, a vector of constants and linear trends. These systems are estimated over the entire sample period and include seasonal dummies where necessary. The following exercise is then performed: a one-period, unit shock is applied to the current period policy dummy, and the impulse responses of the endogenous variables are subsequently graphed for three years into the future. These responses are the sum of two parts: one component is the dynamics contained in the normal interaction of the endogenous variables and is captured by the matrix of coefficients of these variables; the second component is due to the effect of the monetary policy tightening and is captured in the coefficients of the dummy variable lags. The impulse responses to the policy variable "shock" therefore provide a more complete picture of the three-variables reaction compared to the single-equation methodology, as they allow their internal dynamics to be demonstrated.

Figures 2a to 2d contain the accumulated impulse responses of the endogenous variables' growth rates.[30] For each country three graphs were produced: one that contains the results of the estimation over the entire sample period (top panel), one which uses only the sub-sample up to the first oil shock[31] (bottom panel) and one for the later period (middle panel). The results of the different sub-samples allow one to examine the extent to which shifts in the structure of the financial environment that have occurred over the last twenty or so years have substantially changed the

28 Or at least not one that is detectable by this aggregate data analysis.

29 For the United Kingdom, where only quarterly data are available for the entire period, I have included three quarters of lags for the endogenous variables to allow for richer dynamics. The results are not very sensitive to small changes in the lag length.

30 Thus they can be interpreted as representing the deviations of the corresponding variable's log level.

31 The choice of this break point is not completely arbitrary. Besides splitting the sample more or less evenly, it represents a turning-point in the long-run growth rate for most of the industrialised world (productivity slowdown). It also roughly coincides with the beginning of the floating exchange rate period and the introduction of monetary targeting policy regimes in the sample countries.

responses of money and bank loans to a policy tightening. In what follows I shall discuss the plots for each country separately and attempt a synthesis at the end of the section.

For Germany, the impulse responses from the VAR are strikingly similar to the plots of the average forecast errors of the same variables after a policy shock (Figure 1a). Not only does the general shape of the responses conform to that of the earlier graphs, but also the magnitude of the deviations is quite similar. Again a pattern emerges in which money seems to lead both industrial production and bank loans, while the two latter variables move closer together. It is also interesting to observe some differences between the early and late sample results. For the period before the oil shocks loans appeared to be lagging substantially behind the decline in industrial production and their deviation from "baseline" was considerably less pronounced than in the period after 1973. It appears that German banks were able to maintain high levels of lending despite the fact that they were facing constraints in expanding their liabilities during the periods of monetary restraint. This is a finding consistent with the view that bank lending is the major source of finance for the German economy, but at the same time the banking system has the flexibility to adjust its balance-sheet composition so as to insulate to a considerable degree the supply of loans from the direct impact of restrictive monetary policy.

For the other countries the results are less transparent. While the general pattern of the endogenous variables responses for Japan is similar to those from the single-equation estimation, the size of these deviations from baseline is quite different. We can see that money lagged behind output and loans in the early sample period but it hardly moves away from zero in the full sample. It is interesting to observe that following a policy tightening in the period after 1973 money actually remained *above* its predicted level given the movements of the other two variables, suggesting that monetary tightenings have little effect on the path of bank liabilities. The deviations of loans from their baseline are less pronounced than in the single-equation case, while the opposite is true for industrial production. Moreover, industrial production seems to have been more responsive to policy tightenings in the 1960s.

For the United States, the VAR results are generally in line with the single-equation ones, with one notable exception; viz. the period from the 1960s up to the first oil shock. The relative behaviour of money in the bottom panel is rather uncharacteristic, given all the results for this country shown so far. It is almost as if M_1 does not deviate at all from its baseline compared with the quite large deviation of output and loans. It is not altogether obvious how to interpret this effect other than to attribute it to the fact that there was only one tightening episode in this sample period, i.e. December 1968. Following this particular episode the deviation of M_1 from its baseline was rather weak, as documented by the Romers.[32] A further indication that this might actually be the case is the fact that the results for the entire period resemble more closely those for the post-1973 sample. There one can see the same pattern of money leading and loans lagging output more clearly than in the single-equation graphs, suggesting that the timing of relationships is consistent with the money view of the transmission mechanism.

The same phenomenon of a variable's uncharacteristically large reaction to a policy tightening that was observed with industrial production in Japan surfaces again in the UK results for the 1963-73 sample. The impulse responses for loans and the monetary aggregate show a decline of 40% and 30% respectively three years after the policy tightening, while the GDP decline is of the order of 6-8% (which is about double the corresponding error from the forecasting equations). The explanation for this deviation could be the fact that the two monetary policy shifts of 1964 and 1967 marked the beginning of prolonged periods of tightening aimed at correcting the United Kingdom's persistent balance-of-payments problems, which led to the 1967 devaluation and the eventual floating of the pound in 1972. Another possible factor, closely related to the monetary policy transmission channels, is the fact that during this period the Bank of England made extensive use of moral suasion in order to influence bank lending decisions. Frequently, credit letters addressed to the clearing banks

32 Romer and Romer (1990) present the cumulative deviations of M_1 from its forecast path when industrial production was included as one of the explanatory variables; see loc. cit., Table 4, p. 173.

and other financial intermediaries contained suggestions regarding their lending policies.[33] The picture is quite different for the later sample after the changes in policy that took effect with the introduction of Competition and Credit Control in May 1971. In this period one can see that the behaviour of the financial variables significantly lagged that of output and was less pronounced (in fact money remained virtually unaffected for most of the three-year period after the shock). This suggests that there have been substantial differences in the monetary policy transmission channels between the two periods of different monetary policy regimes in the United Kingdom.

The VAR impulse responses, therefore, generally confirm the results from the single-equation forecast error analysis. The few exceptions concern mainly the size of the reaction of some of the variables in Japan and the United Kingdom. It may tentatively be concluded that following a monetary tightening the response of financial aggregates differs not only from one country to another, but also over different time periods for the same country. For Germany, the results of the two tests are consistent in their rejection of the hypothesis that bank loans provide a distinct and independent channel in the monetary policy transmission. There is no evidence that German banks restrict the supply of credit to their customers after a tightening by the Bundesbank any more than might be expected because of the higher level of interest rates. On the contrary, in the early sample, when the credit channel might reasonably have been expected to be stronger, it was observed that bank lending was very little affected. The results for Japan, on the other hand, provide support for the credit view hypothesis that monetary policy tightening does have a negative effect on the supply of bank loans. This evidence is not, however, as strong and clear-cut as in the German case. Moreover, it is also sensitive to the sample period used in the analysis. The results for the United States and the United Kingdom are less conclusive. The best one can do is to cautiously classify the United States together with the countries where the money channel is stronger, and the United Kingdom (with even greater caution) together with the countries that show some evidence of bank loans playing an independent role in the transmission of monetary policy. In fact, as mentioned earlier, the UK results appear to reflect the earlier period of strong controls imposed informally but firmly by the Bank of England on British deposit-taking institutions.

V. CONCLUSIONS

The comparative analysis of monetary policy transmission channels in the four countries studied has yielded few strong conclusions. This confirms the difficulties faced by empirical analysis in producing results that distinguish sharply between the two competing hypotheses when relying exclusively on aggregate data. With the exception of Germany (and to a lesser extent Japan), where the same picture consistently emerges from the various tests and the results appear quite robust with respect to specification changes, definitive statements about the relative importance of the bank lending channel in the monetary transmission mechanism cannot be made with any great degree of confidence.

As mentioned above, monetary policy in Germany seems to work mainly through the conventional "money" channel. The timing of the money and loan responses following monetary policy tightening is not consistent with a theory that attributes most of the slowdown in economic activity to a fall in the supply of bank credit. This result is very robust, as the comparison of the single-equation forecast errors and the impulse responses from the VAR specification show. The large share of external finance supplied by banks and the prediction equation tests testify to the importance of bank credit in the functioning of the German economy. On the other hand, however, if one concentrates on the periods that immediately follow a severe monetary policy tightening, this variable does not appear to play an independent role in the transmission of the policy shock to the real sector. In fact, the impulse response functions for the sample before 1973, when arguably fewer substitutes

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33 These letters actually went so far as to contain explicit quantitative targets for loans in periods when that was judged to be necessary.

for domestic bank credit were available, suggest that banks were quite successful in shielding the supply of loans to their clients from the adverse influence of restrictive monetary policy.

The results for Japan point in the opposite direction, offering evidence supportive of bank credit's primary role in the transmission mechanism. The timing of money and loans is almost the reverse of that in Germany, and monetary aggregates seem hardly to deviate from their "baseline" values following a tightening episode. This finding contrasts with the good performance of M_2+CD in the prediction equations in the presence of a monetary policy proxy, but it is consistent with the successful showing of the quality spread and the robust performance of bank loans in the same tests. This contradiction is quite persistent with Japanese money data, whether the monetary aggregates are included in real or in nominal terms. In fact, even though the use of deflated series has somewhat similar effects on the US and UK impulse responses, these are not nearly as important as in the case of Japan.[34] I have chosen to work with nominal variables to keep this study in line with the practice followed by other researchers.[35] It might actually be quite informative to investigate this apparent puzzle in greater depth in future research.

The results for the United Kingdom and the United States are quite mixed. The United Kingdom shows weak evidence consistent with the existence of a credit channel, as the analysis of the financial aggregates' behaviour after a policy shock suggests. But these results are far from conclusive and seem to be determined by the earlier part of the sample. They are also in conflict with the prediction equation tests that show bank loan growth as performing better as an independent predictor of future output growth in the 1980s. Finally, the United States could be weakly classified in the same group as Germany, where the transmission mechanism appears to work primarily through the liabilities side of the banking system's balance sheet. Money seems to move ahead of loans and output, at least in the later part of the sample, a finding consistent with the prediction equation results, where M_2 appears to be a better activity predictor than loans, especially when the federal funds rate is included as an additional explanatory variable.

If one accepts the validity of this empirical classification of the four countries as either "money channel" or "loan channel" countries, then a contradiction becomes apparent with a reasonable alternative classification which, based on theoretical arguments, emphasises the characteristics of their respective financial structure. On these grounds, one would have expected Germany and Japan to present stronger evidence in favour of the operation of a bank loan channel than the two representatives of the "Anglo-Saxon" model, because of the importance of bank financing in the former two economies. Instead, the empirical analysis seems to group together countries that share common features in the operational practices of their monetary authorities. The countries that show signs of bank loans having a strong leading role in the transmission of monetary policy are those in which monetary policy has in the past relied more heavily on directly influencing the quantity of bank credit. This was especially true of Japan and the United Kingdom prior to the reforms of the early 1980s, when quantitative controls, moral suasion and other direct methods were heavily employed by the two central banks in achieving their policy objectives. This is less true of Germany and the United States, where throughout the sample period monetary authorities have relied more on reserve management techniques and the manipulation of the short-term money market rates in order to indirectly exert influence on the quantity of bank credit in the economy.

So are the operational procedures of the monetary authorities responsible for the "bank loan" channel in the transmission process? The answer to this question is no. At least not in the sense that these procedures create the informational and incentive asymmetries that lie at the root of the credit view of the transmission mechanism. These procedures, however, impose additional constraints on the operation of the banking system, especially in the form of the adjustment of banks' balance sheets to monetary policy tightening. In countries where direct quantitative controls are present, the banking system does not have the option of rebalancing the composition of its assets by altering the

34 The German results are virtually identical whether one uses nominal or real money and loans series.

35 Romer and Romer (1990) and Ueda (1993).

relative shares of loans and other marketable securities as the liabilities side of the balance sheet shrinks after an episode of restrictive monetary policy. It is in this sense that monetary policy becomes to a large extent a "credit availability" policy, hence the leading role of bank loans in shaping the slowdown in real economic activity. Loan levels above "baseline" in Germany for significant periods after a policy episode testify to the fact that banks tend to behave consistently with the theories that describe financial intermediaries as an efficient mechanism to address the agency problems in the market for credit.

Despite the fact that one might express reservations about the empirical methodology used, which is just one among several alternatives, each with its own particular strengths and weaknesses, this study provides some insight into the workings of the monetary policy transmission mechanism and the way it interacts with the financial structure. Even if in certain cases the analysis does not yield clear-cut conclusions, the fact remains that where the results are the strongest (the rejection of the idea of a credit channel in Germany and the evidence in its favour in Japan) they point to the implementation of monetary policy as a determining factor in the operation of the transmission channel that works through bank credit, rather than the characteristics of an economy's financial structure.

Table 1a

Prediction equation results

Germany

1957-90	Ind. prod.	Sales	Orders	Empl.	Unempl.
M_1	0.13444 *0.827*	0.44738 *2.263*	0.15632 *1.394*	0.60214 *1.447*	0.06017 *- 2.566*
M_2	0.23572 *1.110*	0.34913 *0.326*	0.95647 *0.413*	0.68205 *1.566*	0.29993 *- 1.017*
Day-to-day	0.00051 *- 4.666*	0.74299 *- 1.1148*	0.00140 *- 3.958*	0.00003 *- 4.689*	0.00169 *3.935*
Fibor	0.00020 *- 4.551*	0.01440 *- 0.657*	0.00087 *- 3.452*	0.00001 *- 4.515*	0.00100 *3.582*
Government bonds	0.00102 *- 3.637*	0.40961 *- 0.939*	0.00117 *- 3.417*	0.00408 *- 3.977*	0.00968 *3.016*
Term spread	0.03605 *- 3.057*	0.55035 *- 0.195*	0.02169 *- 3.633*	0.00373 *- 2.669*	0.34921 *2.434*
Quality spread	0.05411 *- 2.656*	0.00718 *- 1.000*	0.32161 *- 1.525*	0.40882 *- 2.147*	0.63540 *0.054*
Bank loans	0.02508 *0.577*	0.02938 *2.398*	0.09314 *- 0.194*	0.19096 *1.792*	0.80943 *- 0.904*

1974-90	Ind. prod.	Sales	Orders	Empl.	Unempl.
M_1	0.05156 *0.193*	0.03902 *1.225*	0.43761 *1.599*	0.26614 *0.682*	0.28966 *- 1.732*
M_2	0.79620 *0.356*	0.01332 *- 0.104*	0.77208 *- 0.148*	0.33557 *0.979*	0.52445 *0.507*
Day-to-day	0.00641 *- 3.755*	0.35145 *- 1.003*	0.00202 *- 4.223*	0.00002 *- 4.582*	0.00859 *3.604*
Fibor	0.00907 *- 2.914*	0.02091 *- 1.110*	0.00003 *- 3.363*	0.00001 *- 4.025*	0.03556 *2.694*
Government bonds	0.00011 *- 1.890*	0.92107 *- 0.087*	0.00979 *- 2.917*	0.16224 *- 2.641*	0.01600 *1.918*
Term spread	0.01151 *- 3.123*	0.51598 *- 0.487*	0.02765 *- 3.430*	0.00025 *- 3.852*	0.38442 *2.063*
Quality spread	0.32604 *- 1.371*	0.14861 *- 2.047*	0.07490 *- 1.344*	0.03371 *- 2.586*	0.90810 *1.030*
Bank loans	0.04898 *1.534*	0.29529 *0.751*	0.02765 *0.446*	0.11713 *2.529*	0.56096 *- 0.481*

Table 1b

Prediction equation results

Japan

1961-93	Ind. prod.	Sales	Stocks	Empl.	Unempl.
M_1	0.00000 *2.144*	0.85128 *- 1.253*	0.00997 *- 1.862*	0.20108 *0.005*	0.49676 *- 0.879*
M_2+CD	0.00000 *3.538*	0.89392 *0.470*	0.01118 *- 2.838*	0.30477 *0.957*	0.20438 *- 0.999*
Call rate	0.39923 *- 2.063*	0.92198 *0.115*	0.05857 *0.990*	0.12621 *- 1.861*	0.15609 *0.219*
Government paper (two months)	0.99399 *- 0.451*	0.01339 *0.195*	0.82810 *0.014*	0.02856 *- 2.130*	0.01186 *0.121*
Commercial bills	0.07530 *- 1.898*	0.06825 *0.530*	0.00000 *- 1.160*	0.00007 *- 2.127*	0.00126 *1.377*
Term spread	0.21222 *2.711*	0.28649 *- 0.165*	0.27672 *- 2.482*	0.00000 *- 2.320*	0.02952 *1.875*
Quality spread (long)	0.00031 *0.853*	0.05836 *- 0.449*	0.01172 *2.445*	0.02681 *0.868*	0.61786 *- 0.591*
Bank loans	0.46831 *1.958*	0.00308 *- 0.604*	0.65484 *- 0.652*	0.96885 *0.686*	0.66735 *- 0.471*

1980-93	Ind. prod.	Sales	Stocks	Empl.	Unempl.
M_1	0.00159 *1.295*	0.51875 *- 1.568*	0.12323 *- 0.031*	0.05665 *1.437*	0.11716 *- 1.100*
M_2+CD	0.00002 *3.947*	0.14977 *2.430*	0.65832 *- 0.261*	0.01246 *2.170*	0.00012 *- 2.831*
Call rate	0.96081 *0.045*	0.01087 *1.749*	0.58410 *0.157*	0.34004 *0.300*	0.23880 *- 1.495*
Government paper (two months)	0.83071 *- 0.284*	0.00871 *0.906*	0.99632 *0.212*	0.69564 *- 0.207*	0.19931 *- 1.777*
Commercial bills	0.62214 *- 0.745*	0.12093 *0.798*	0.56765 *- 0.076*	0.31352 *0.434*	0.01131 *- 0.801*
Term spread	0.34655 *2.015*	0.03618 *0.555*	0.92236 *- 0.581*	0.82130 *0.133*	0.54020 *1.495*
Quality spread (long)	0.08302 *- 1.343*	0.13036 *- 1.026*	0.12122 *- 0.072*	0.78252 *- 0.283*	0.05151 *1.985*
Bank loans	0.10363 *2.449*	0.00055 *2.522*	0.63278 *0.928*	0.72695 *1.534*	0.65466 *- 1.774*

Table 1c

Prediction equation results
United Kingdom

1963-93	GDP	Cons.	Invest.	Sales	Stocks	Unempl.
M2	- 0.17693 *2.048*	0.06662 *2.481*	0.91664 *0.626*	0.00835 *3.123*	0.02175 *2.835*	0.00000 *- 2.643*
M4	0.39913 *1.320*	0.00930 *0.949*	0.55388 *- 0.158*	0.07918 *1.958*	0.03466 *2.087*	0.47289 *- 1.540*
Minimum lending rate	0.00919 *- 3.011*	0.02333 *- 2.291*	0.10672 *- 2.087*	0.43767 *0.687*	0.03484 *- 0.901*	0.00012 *3.073*
Treasury bill (three months)	0.02850 *- 3.131*	0.01314 *- 2.455*	0.12668 *- 1.721*	0.93056 *0.390*	0.08001 *- 0.708*	0.00005 *2.973*
Government bonds (ten years)	0.25513 *- 1.147*	0.02829 *- 0.971*	0.01000 *- 0.705*	0.01085 *2.874*	0.66281 *0.147*	0.00087 *2.038*
Term spread	0.09469 *2.118*	0.15264 *1.971*	0.20941 *1.741*	0.00710 *2.782*	0.12866 *0.856*	0.22256 *- 1.400*
Quality spread	0.07147 *- 2.416*	0.43239 *- 0.677*	0.29544 *- 1.694*	0.12909 *0.459*	0.30602 *- 1.283*	0.15756 *0.304*
Bank loans	0.43239 *1.500*	0.00403 *0.954*	0.85522 *0.822*	0.01048 *1.611*	0.07891 *2.455*	0.41054 *- 1.512*

1979-93	GDP	Cons.	Invest.	Sales	Stocks	Unempl.
M2	0.29562 *1.722*	0.41821 *1.411*	0.35329 *0.463*	0.05633 *2.412*	0.00003 *3.017*	0.00115 *- 1.055*
M4	0.01459 *0.744*	0.00443 *0.209*	0.16804 *0.274*	0.45837 *- 0.341*	0.09831 *1.606*	0.66071 *- 0.708*
Minimum lending rate	0.01127 *- 3.165*	0.00323 *- 3.439*	0.00131 *- 3.809*	0.02031 *- 2.698*	0.00004 *- 2.750*	0.00996 *3.073*
Treasury bill (three months)	0.02548 *- 2.976*	0.00523 *- 3.118*	0.01729 *- 3.025*	0.02658 *- 2.789*	0.00142 *- 2.280*	0.01817 *2.611*
Government bonds (ten years)	0.14281 *- 1.841*	0.02223 *- 2.261*	0.00626 *- 1.516*	0.00024 *- 3.394*	0.30578 *- 1.719*	0.11354 *1.744*
Term spread	0.03751 *2.373*	0.01330 *2.960*	0.00196 *2.338*	0.28155 *0.791*	0.00030 *0.782*	0.14381 *- 1.527*
Quality spread	0.99634 *- 0.003*	0.38297 *0.546*	0.12355 *- 1.722*	0.08461 *- 2.074*	0.00006 *- 4.683*	0.10606 *1.264*
Bank loans	0.23114 *0.564*	0.79171 *0.236*	0.21728 *1.145*	0.53664 *- 0.337*	0.07347 *1.434*	0.89041 *- 0.606*

Table 1d

Prediction equation results

United States

1959-93	Ind. prod.	Sales	Durables	Empl.	Unempl.
M_1	0.02888 *2.830*	0.29984 *1.633*	0.02695 *3.465*	0.02989 *2.918*	0.20993 *- 1.367*
M_2	0.00019 *3.976*	0.00011 *4.306*	0.00021 *4.533*	0.00160 *3.818*	0.09170 *- 2.051*
Federal funds	0.11965 *- 0.526*	0.43202 *0.930*	0.12841 *0.084*	0.45252 *0.549*	0.21796 *1.678*
Treasury bill (three months)	0.07255 *- 1.835*	0.89832 *- 0.751*	0.56312 *- 1.397*	0.14452 *- 1.046*	0.34161 *1.738*
Government bonds (ten years)	0.03097 *- 2.768*	0.00385 *- 1.328*	0.11386 *- 1.911*	0.25169 *- 2.064*	0.22524 *2.463*
Term spread	0.00079 *- 4.368*	0.00169 *- 2.003*	0.03111 *- 2.680*	0.01183 *- 3.337*	0.00041 *3.457*
Quality spread	0.00000 *- 4.682*	0.33199 *- 1.811*	0.00016 *- 3.785*	0.00001 *- 3.375*	0.00216 *2.746*
Bank loans	0.55010 *1.453*	0.15668 *0.654*	0.50991 *1.218*	0.16375 *2.210*	0.04870 *- 1.032*

1973-93	Ind. prod.	Sales	Durables	Empl.	Unempl.
M_1	0.07210 *2.377*	0.25585 *0.608*	0.21602 *1.911*	0.12129 *1.274*	0.31480 *- 0.836*
M_2	0.08405 *2.844*	0.00321 *2.693*	0.42621 *1.621*	0.04759 *1.929*	0.22820 *- 1.726*
Federal funds	0.01091 *- 0.465*	0.73871 *0.583*	0.19213 *- 0.868*	0.12810 *- 0.299*	0.06740 *2.009*
Treasury bill (three months)	0.10560 *- 1.279*	0.89213 *- 0.783*	0.46071 *- 1.754*	0.11726 *- 1.316*	0.18773 *1.966*
Government bonds (ten years)	0.06558 *- 2.093*	0.00781 *- 1.528*	0.12308 *- 2.310*	0.30975 *- 2.243*	0.27376 *2.514*
Term spread	0.00240 *- 3.736*	0.00010 *- 2.782*	0.02749 *- 3.150*	0.00217 *- 3.348*	0.00318 *3.182*
Quality spread	0.00058 *- 3.172*	0.75015 *- 1.381*	0.03041 *- 2.772*	0.00660 *- 1.835*	0.00110 *1.473*
Bank loans	0.22318 *- 0.467*	0.22945 *- 0.503*	0.30276 *- 0.260*	0.00140 *0.213*	0.60474 *0.319*

Table 2a

Prediction equation results conditional on policy proxy
Germany

1957-90	Ind. prod.	Sales	Orders	Empl.	Unempl.
M_1	0.77554 *- 0.753*	0.52913 *2.063*	0.09625 *- 0.952*	0.77869 *0.091*	0.70237 *- 1.120*
M_2	0.25409 *1.320*	0.36672 *0.221*	0.67930 *1.054*	0.50517 *1.659*	0.40793 *- 1.140*
Day-to-day	n.a.	n.a.	n.a.	n.a.	n.a.
Fibor	0.48719 *- 0.643*	0.00567 *- 0.538*	0.14860 *1.250*	0.06569 *0.720*	0.66389 *0.998*
Government bonds	0.09782 *- 1.043*	0.54400 *- 0.326*	0.13687 *- 0.293*	0.30131 *- 1.035*	0.05777 *0.952*
Term spread	0.42492 *1.349*	0.21051 *1.887*	0.83575 *0.093*	0.18987 *1.687*	0.96749 *- 0.812*
Quality spread	0.64863 *0.118*	0.00241 *- 0.398*	0.28335 *0.972*	0.19977 *0.134*	0.99819 *- 0.142*
Bank loans	0.04418 *0.298*	0.02594 *2.351*	0.16387 *- 0.236*	0.27509 *1.226*	0.82143 *- 0.577*

1974-90	Ind. prod.	Sales	Orders	Empl.	Unempl.
M_1	0.05798 *- 0.775*	0.05763 *0.588*	0.32427 *- 0.071*	0.66355 *- 0.043*	0.79299 *- 0.265*
M_2	0.85801 *0.960*	0.01861 *0.232*	0.45565 *0.812*	0.06952 *2.188*	0.61642 *0.365*
Day-to-day	n.a.	n.a.	n.a.	n.a.	n.a.
Fibor	0.25003 *1.951*	0.17391 *0.378*	0.00245 *0.766*	0.06450 *1.321*	0.01297 *- 1.647*
Government bonds	0.00024 *0.782*	0.86529 *0.643*	0.26840 *- 0.110*	0.32187 *1.044*	0.06770 *- 1.225*
Term spread	0.32447 *0.085*	0.44281 *0.858*	0.24263 *0.293*	0.31344 *- 0.501*	0.87479 *- 0.192*
Quality spread	0.17547 *- 0.336*	0.72078 *- 1.076*	0.02424 *0.381*	0.16753 *- 0.407*	0.62585 *0.598*
Bank loans	0.15811 *1.265*	0.26737 *1.186*	0.04423 *0.878*	0.47205 *1.968*	0.67868 *- 0.404*

Table 2b

Prediction equation results conditional on policy proxy
Japan

1961-90	Ind. prod.	Sales	Stocks	Empl.	Unempl.
M_1	0.00000 *1.677*	0.81677 *- 1.319*	0.01002 *- 1.592*	0.18276 *- 0.394*	0.38833 *- 0.962*
M_2+CD	0.00000 *3.349*	0.88222 *0.593*	0.00405 *- 3.059*	0.44380 *0.756*	0.12415 *- 1.168*
Call rate	n.a.	n.a.	n.a.	n.a.	n.a.
Government paper (two months)	0.39642 *2.108*	0.01596 *0.213*	0.16949 *- 0.182*	0.15674 *0.081*	0.03698 *- 0.497*
Commercial bills	0.18129 *- 0.544*	0.09559 *1.681*	0.00000 *- 1.793*	0.00009 *- 1.376*	0.00153 *0.688*
Term spread	0.74116 *1.590*	0.34609 *- 0.053*	0.02493 *- 2.220*	0.24649 *- 0.026*	0.10825 *1.658*
Quality spread (long)	0.00207 *- 3.135*	0.01381 *- 1.049*	0.00919 *2.762*	0.00000 *- 2.137*	0.03488 *1.897*
Bank loans	0.41354 *2.040*	0.00067 *- 0.603*	0.77015 *- 0.871*	0.83052 *0.510*	0.52976 *- 0.522*

1980-93	Ind. prod.	Sales	Stocks	Empl.	Unempl.
M_1	0.00132 *1.231*	0.72017 *- 1.400*	0.04867 *- 0.244*	0.05596 *1.289*	0.09777 *- 1.012*
M_2+CD	0.00001 *4.348*	0.10613 *2.469*	0.68282 *- 0.410*	0.01561 *2.197*	0.00008 *- 2.595*
Call rate	n.a.	n.a.	n.a.	n.a.	n.a.
Government paper (two months)	0.31045 *- 0.375*	0.01425 *- 0.713*	0.91869 *0.169*	0.66370 *- 0.582*	0.01212 *- 1.583*
Commercial bills	0.45003 *0.148*	0.21979 *- 0.736*	0.14851 *0.243*	0.20492 *0.846*	0.00319 *- 1.285*
Term spread	0.14400 *2.414*	0.01642 *1.870*	0.98722 *- 0.530*	0.79527 *0.300*	0.70860 *1.129*
Quality spread (long)	0.05752 *- 1.441*	0.13817 *- 0.859*	0.12949 *- 0.281*	0.80829 *- 0.460*	0.04217 *2.210*
Bank loans	0.03637 *3.092*	0.00062 *2.418*	0.65447 *0.960*	0.57399 *1.935*	0.67474 *- 1.469*

Table 2c

Prediction equation results conditional on policy proxy

United Kingdom

1963-93	GDP	Cons.	Invest.	Sales	Stocks	Unempl.
M_2	0.37383 *1.507*	0.14510 *2.121*	0.98751 *0.245*	0.00367 *3.422*	0.02055 *2.874*	0.00000 *- 2.345*
M_4	0.09309 *2.104*	0.01638 *2.149*	0.26891 *0.764*	0.04573 *- 0.428*	0.04354 *2.059*	0.15608 *- 2.136*
Minimum lending rate	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Treasury bill .... (three months)	0.20995 *1.373*	0.37306 *0.679*	0.04823 *2.442*	0.70266 *- 1.164*	0.71673 *0.398*	0.06896 *0.409*
Government bonds .... (ten years)	0.33941 *1.505*	0.59262 *1.001*	0.28986 *0.944*	0.00086 *3.457*	0.63728 *1.207*	0.11496 *0.168*
Term spread	0.30755 *0.977*	0.43382 *0.767*	0.08307 *0.526*	0.00030 *3.999*	0.73865 *0.801*	0.90793 *- 0.377*
Quality spread	0.25460 *- 1.521*	0.30215 *0.816*	0.58629 *- 1.146*	0.04685 *0.520*	0.74508 *- 0.859*	0.05932 *- 1.119*
Bank loans	0.11401 *2.390*	0.00024 *3.024*	0.22841 *2.004*	0.01242 *1.651*	0.08371 *2.321*	0.06135 *- 2.607*

1979-93	GDP	Cons.	Invest.	Sales	Stocks	Unempl.
M_2	0.34874 *1.642*	0.48449 *1.375*	0.38878 *0.417*	0.29885 *1.433*	0.00001 *1.660*	0.00275 *- 0.778*
M_4	0.00225 *3.403*	.00717 *1.994*	0.00297 *1.783*	0.84421 *- 0.034*	0.00381 *2.968*	0.00036 *- 3.131*
Minimum lending rate	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Treasury bill .... (three months)	0.41845 *1.540*	0.32521 *1.031*	0.00000 *5.205*	0.34995 *1.156*	0.02784 *2.963*	0.12186 *- 1.260*
Government bonds .... (ten years)	0.23980 *- 0.720*	0.14169 *- 0.899*	0.05773 *0.370*	0.07400 *- 2.594*	0.27862 *- 1.020*	0.66733 *0.788*
Term spread	0.11500 *- 1.215*	0.33972 *- 1.399*	0.03327 *- 0.691*	0.00595 *- 2.961*	0.04589 *- 1.708*	0.54523 *1.376*
Quality spread	0.96987 *0.323*	0.47421 *- 0.899*	0.00944 *- 3.006*	0.44215 *- 0.780*	0.00114 *- 3.823*	0.10327 *0.745*
Bank loans	0.00387 *3.157*	0.32893 *1.705*	0.00024 *3.155*	0.82513 *- 0.312*	0.00013 *2.794*	0.01434 *- 3.166*

Table 2d

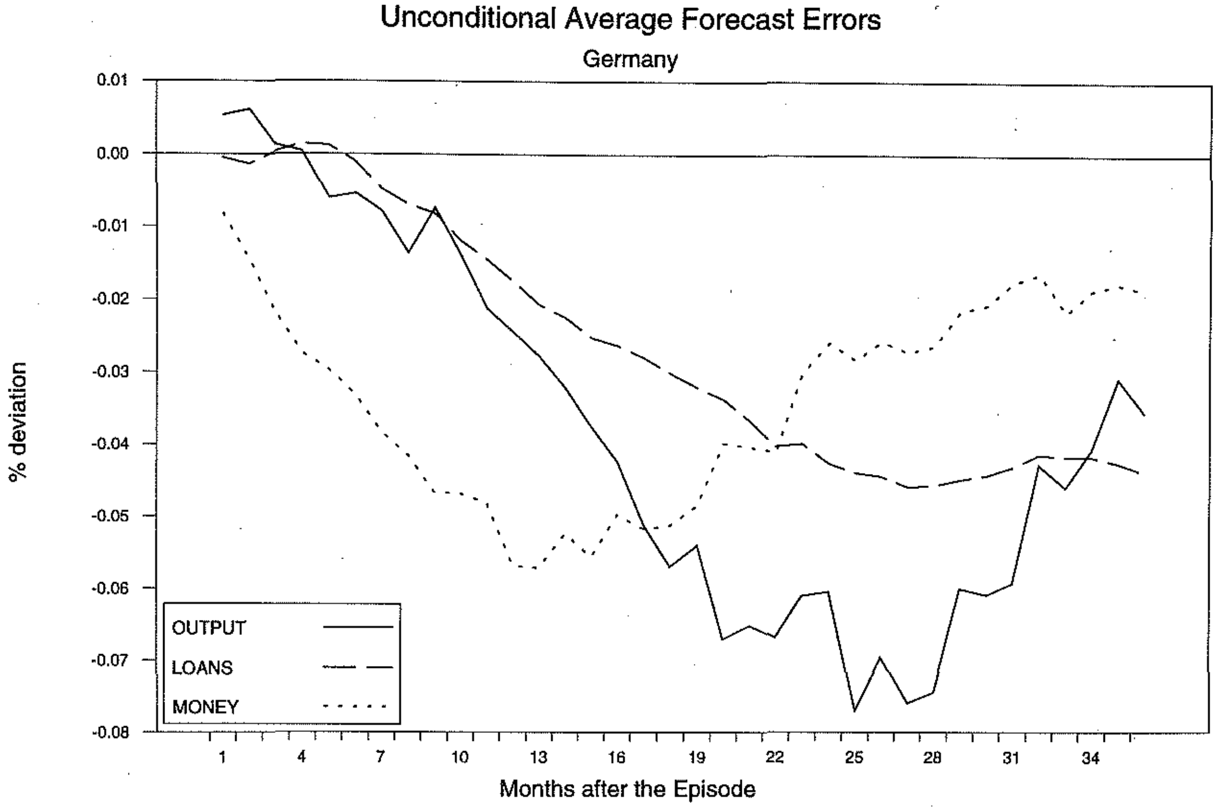
Prediction equation results conditional on policy proxy

United States

1959-93	Ind. prod.	Sales	Durables	Empl.	Unempl.
M_1	0.03982 *2.855*	0.33480 *1.464*	0.05465 *3.269*	0.04320 *2.804*	0.13352 *- 1.089*
M_2	0.00000 *5.263*	0.00047 *3.977*	0.00001 *4.885*	0.00037 *4.202*	0.03081 *- 2.315*
Federal funds	n.a.	n.a.	n.a.	n.a.	n.a.
Treasury bill .... (three months)	0.01832 *- 3.441*	0.06026 *- 3.057*	0.02733 *0.004*	0.00881 *- 3.367*	0.51937 *0.357*
Government bonds .... (ten years)	0.00026 *- 4.361*	0.00008 *- 3.199*	0.00168 *- 3.222*	0.00587 *- 3.913*	0.35590 *1.716*
Term spread	0.00030 *- 4.701*	0.00024 *- 2.850*	0.00168 *- 3.222*	0.00904 *- 3.651*	0.00321 *3.103*
Quality spread	0.00000 *- 4.565*	0.31315 *- 1.938*	0.00142 *- 3.789*	0.00002 *- 3.362*	0.00909 *2.382*
Bank loans	0.61643 *1.394*	0.19139 *0.659*	0.45086 *1.323*	0.34173 *1.927*	0.02836 *- 1.462*

1973-93	Ind. prod.	Sales	Durables	Empl.	Unempl.
M_1	0.28362 *1.933*	0.32415 *0.589*	0.37118 *1.748*	0.36335 *0.999*	0.17646 *0.033*
M_2	0.00190 *4.293*	0.00226 *2.545*	0.05240 *2.322*	0.00417 *2.892*	0.10247 *- 2.086*
Federal funds	n.a.	n.a.	n.a.	n.a.	n.a.
Treasury bill .... (three months)	0.07822 *- 1.998*	0.17212 *- 2.479*	0.37924 *- 1.825*	0.08110 *- 2.397*	0.30088 *0.120*
Government bonds .... (ten years)	0.00836 *- 2.803*	0.00056 *- 2.887*	0.09273 *- 2.456*	0.11930 *- 2.860*	0.72423 *1.208*
Term spread	0.00630 *- 3.828*	0.00002 *- 3.361*	0.02265 *- 3.035*	0.02270 *- 3.177*	0.05565 *2.562*
Quality spread	0.00161 *- 3.163*	0.61720 *- 1.481*	0.04465 *- 3.028*	0.01287 *- 1.954*	0.00316 *1.176*
Bank loans	0.24860 *- 0.607*	0.30730 *- 0.418*	0.29043 *- 0.055*	0.00513 *0.111*	0.55944 *- 0.414*

Figure 1a


Unconditional Average Forecast Errors
Germany
% deviation
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
OUTPUT
LOANS
MONEY
1
4
7
10
13
16
19
22
25
28
31
34
Months after the Episode

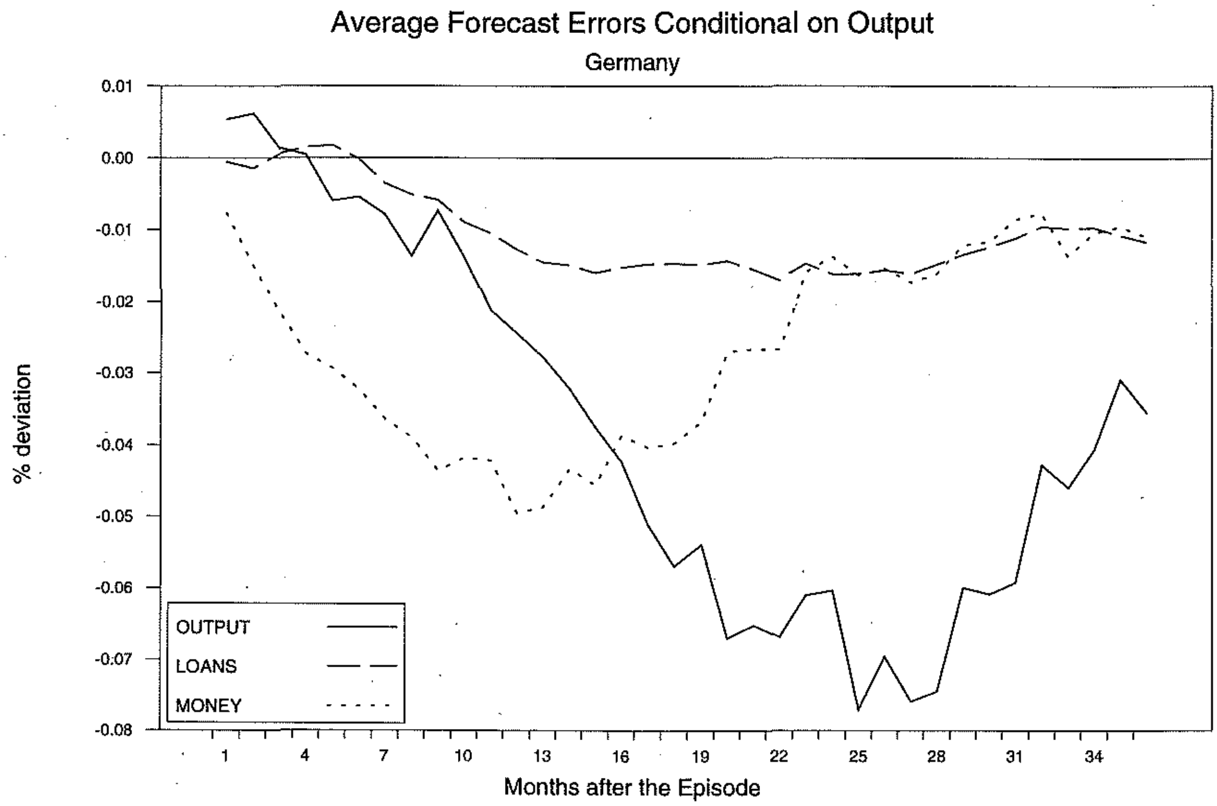
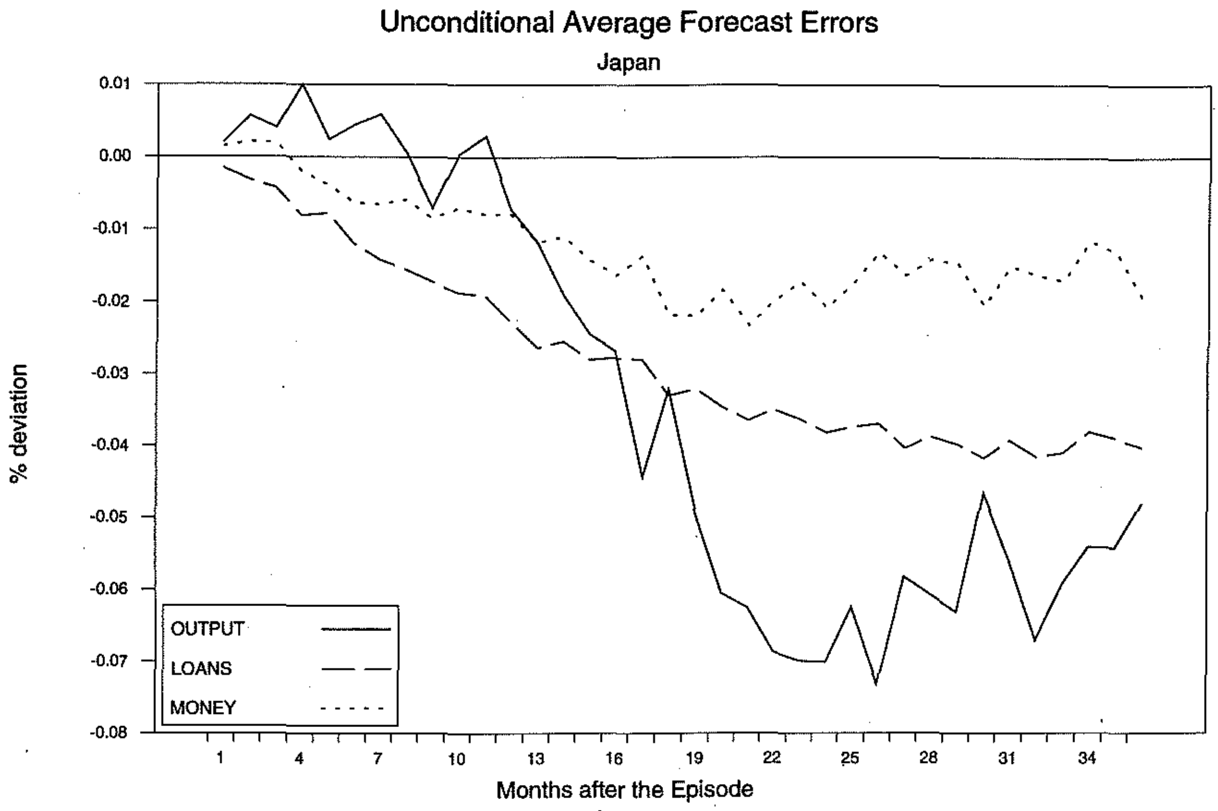
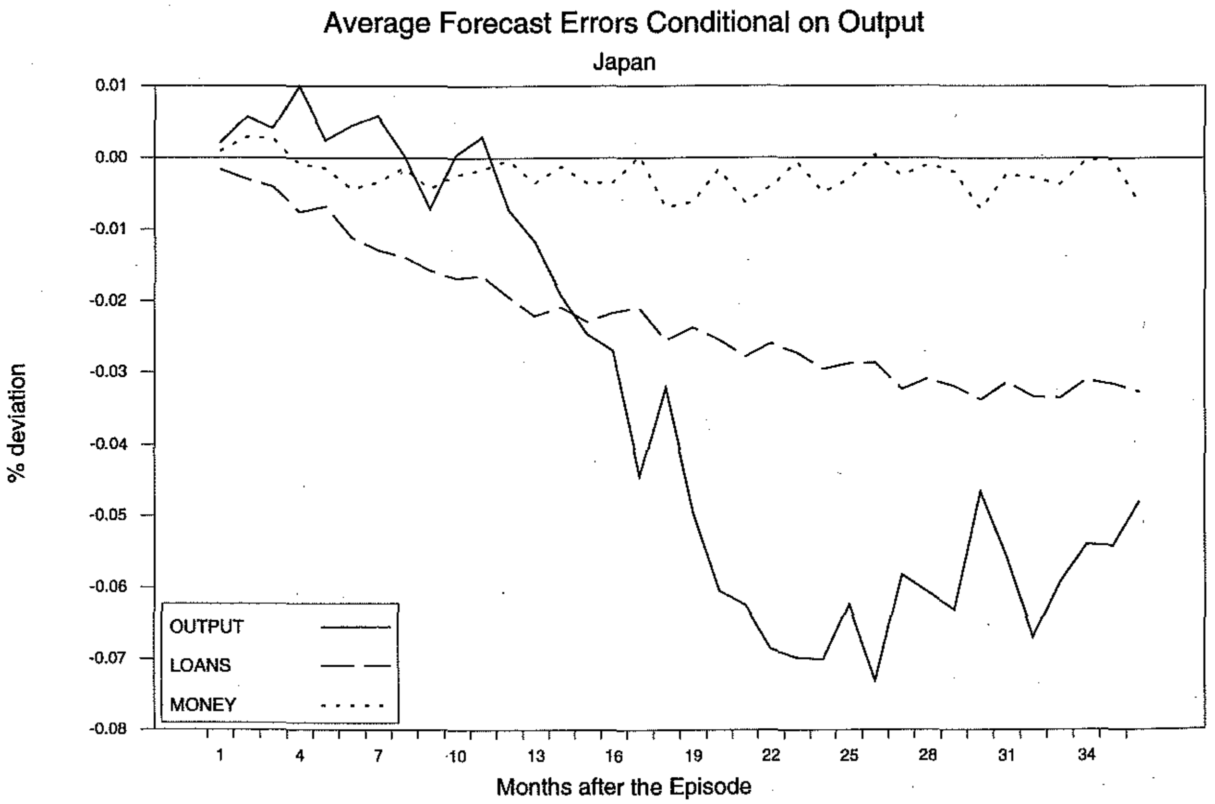

Average Forecast Errors Conditional on Output
Germany
% deviation
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
OUTPUT
LOANS
MONEY
1
4
7
10
13
16
19
22
25
28
31
34
Months after the Episode

Figure 1b

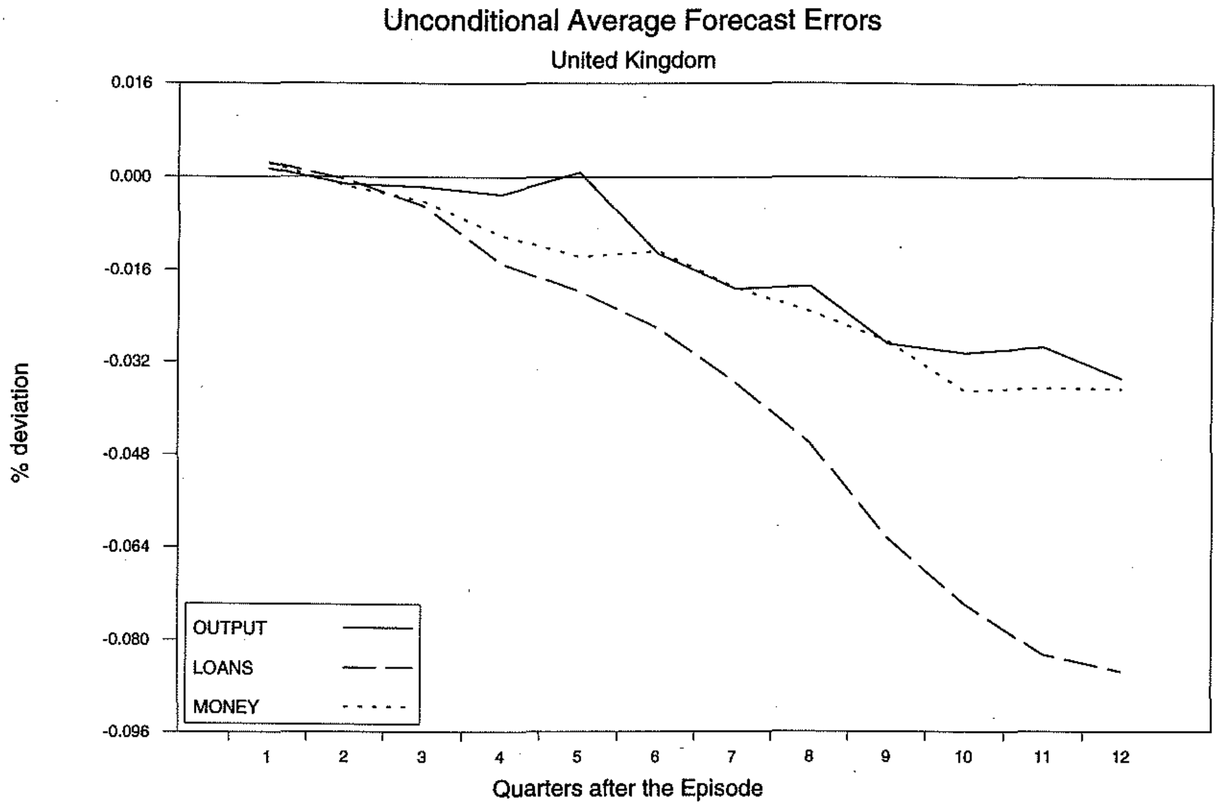


Unconditional Average Forecast Errors
Japan
% deviation
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
OUTPUT
LOANS
MONEY
1
4
7
10
13
16
19
22
25
28
31
34
Months after the Episode



Average Forecast Errors Conditional on Output
Japan
% deviation
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
OUTPUT
LOANS
MONEY
1
4
7
10
13
16
19
22
25
28
31
34
Months after the Episode

Figure 1c


Unconditional Average Forecast Errors
United Kingdom
% deviation
0.016
0.000
-0.016
-0.032
-0.048
-0.064
-0.080
-0.096
OUTPUT
LOANS
MONEY
1
2
3
4
5
6
7
8
9
10
11
12
Quarters after the Episode

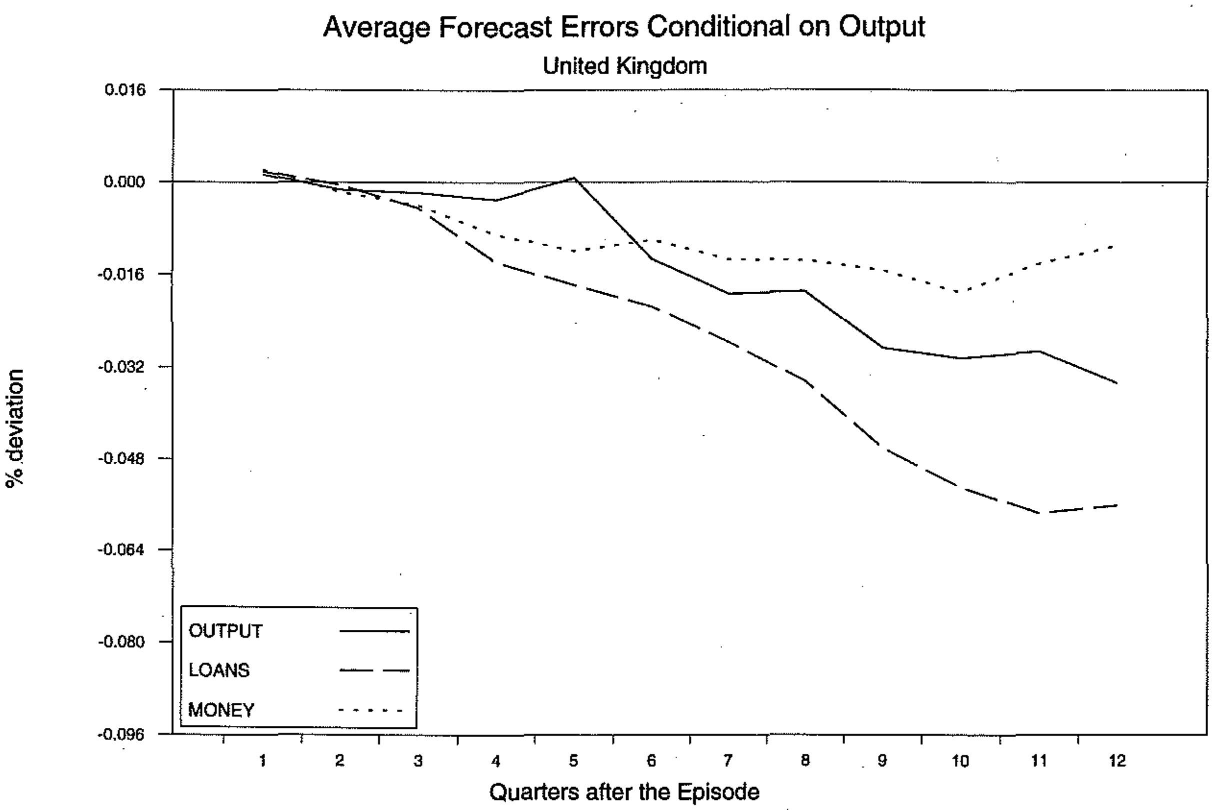
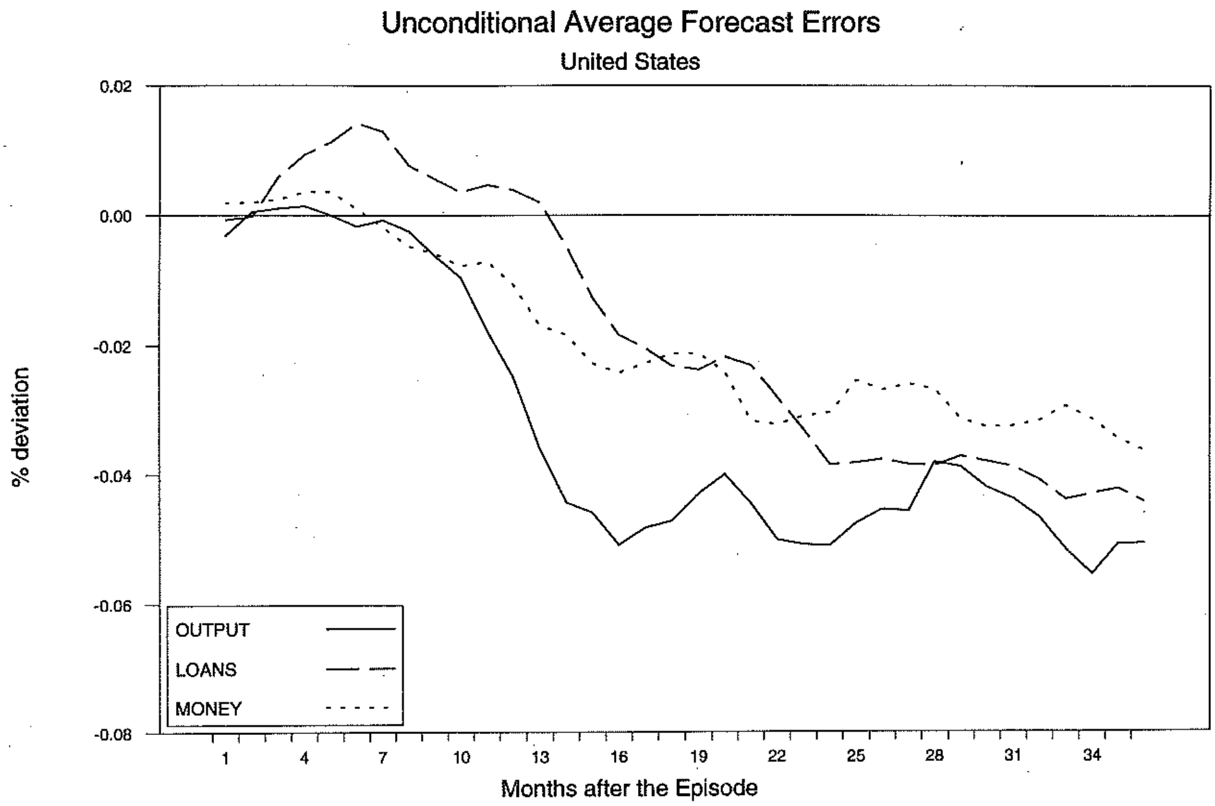

Average Forecast Errors Conditional on Output
United Kingdom
% deviation
0.016
0.000
-0.016
-0.032
-0.048
-0.064
-0.080
-0.096
OUTPUT
LOANS
MONEY
1
2
3
4
5
6
7
8
9
10
11
12
Quarters after the Episode

Figure 1d


Unconditional Average Forecast Errors
United States
0.02
0.00
-0.02
-0.04
-0.06
-0.08
% deviation
OUTPUT
LOANS
MONEY
1
4
7
10
13
16
19
22
25
28
31
34
Months after the Episode

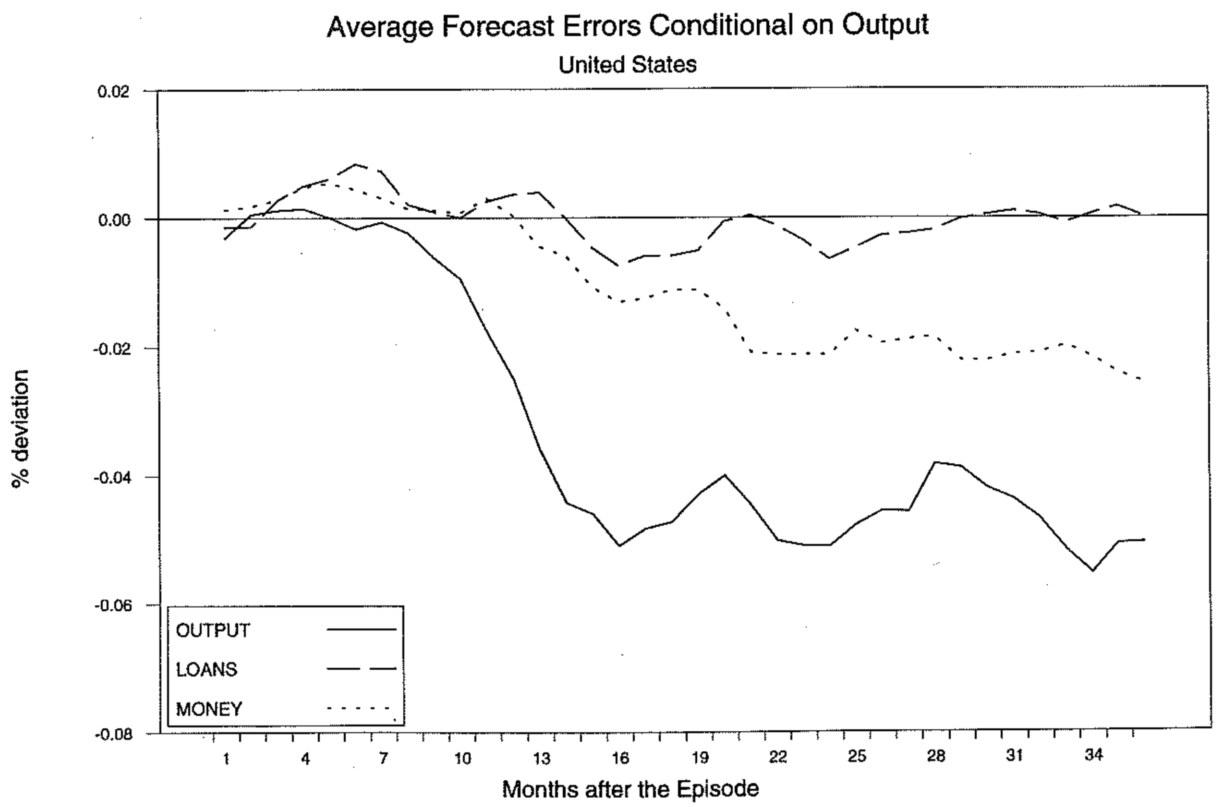
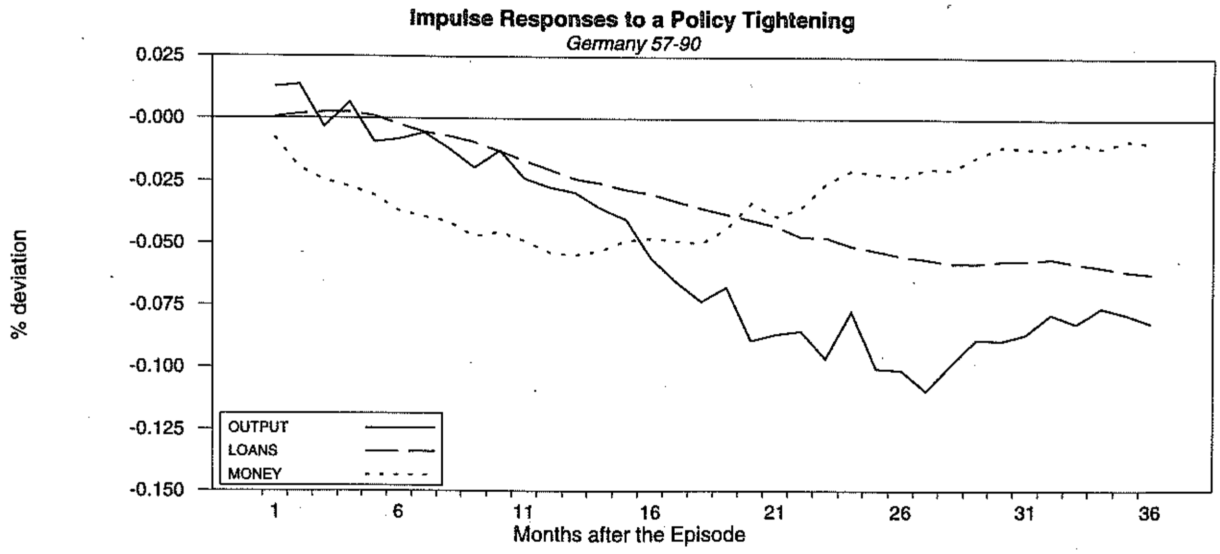
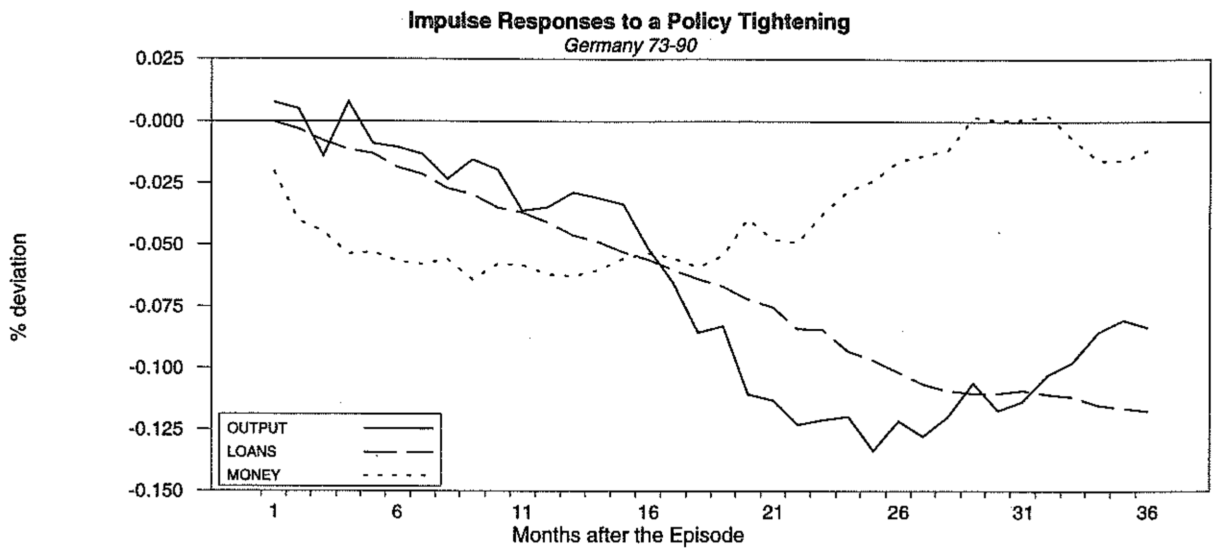

Average Forecast Errors Conditional on Output
United States
0.02
0.00
-0.02
-0.04
-0.06
-0.08
% deviation
OUTPUT
LOANS
MONEY
1
4
7
10
13
16
19
22
25
28
31
34
Months after the Episode

Figure 2a


Impulse Responses to a Policy Tightening
Germany 57-90
0.025
-0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
% deviation
OUTPUT
LOANS
MONEY
1
6
11
16
21
26
31
36
Months after the Episode


Impulse Responses to a Policy Tightening
Germany 73-90
0.025
-0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
% deviation
OUTPUT
LOANS
MONEY
1
6
11
16
21
26
31
36
Months after the Episode

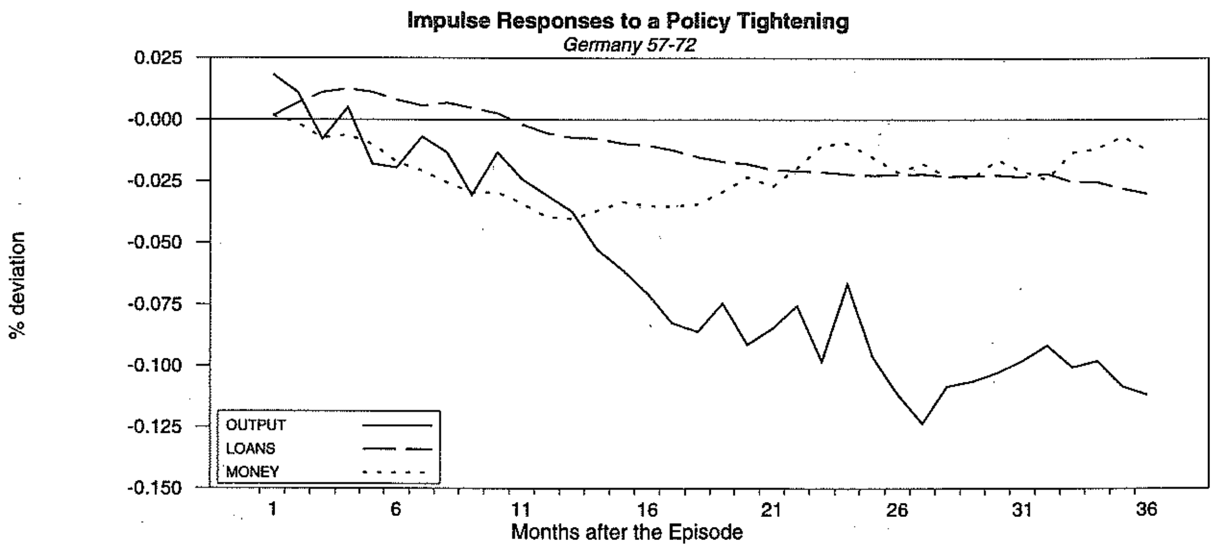

Impulse Responses to a Policy Tightening
Germany 57-72
0.025
-0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
% deviation
OUTPUT
LOANS
MONEY
1
6
11
16
21
26
31
36
Months after the Episode

Figure 2b

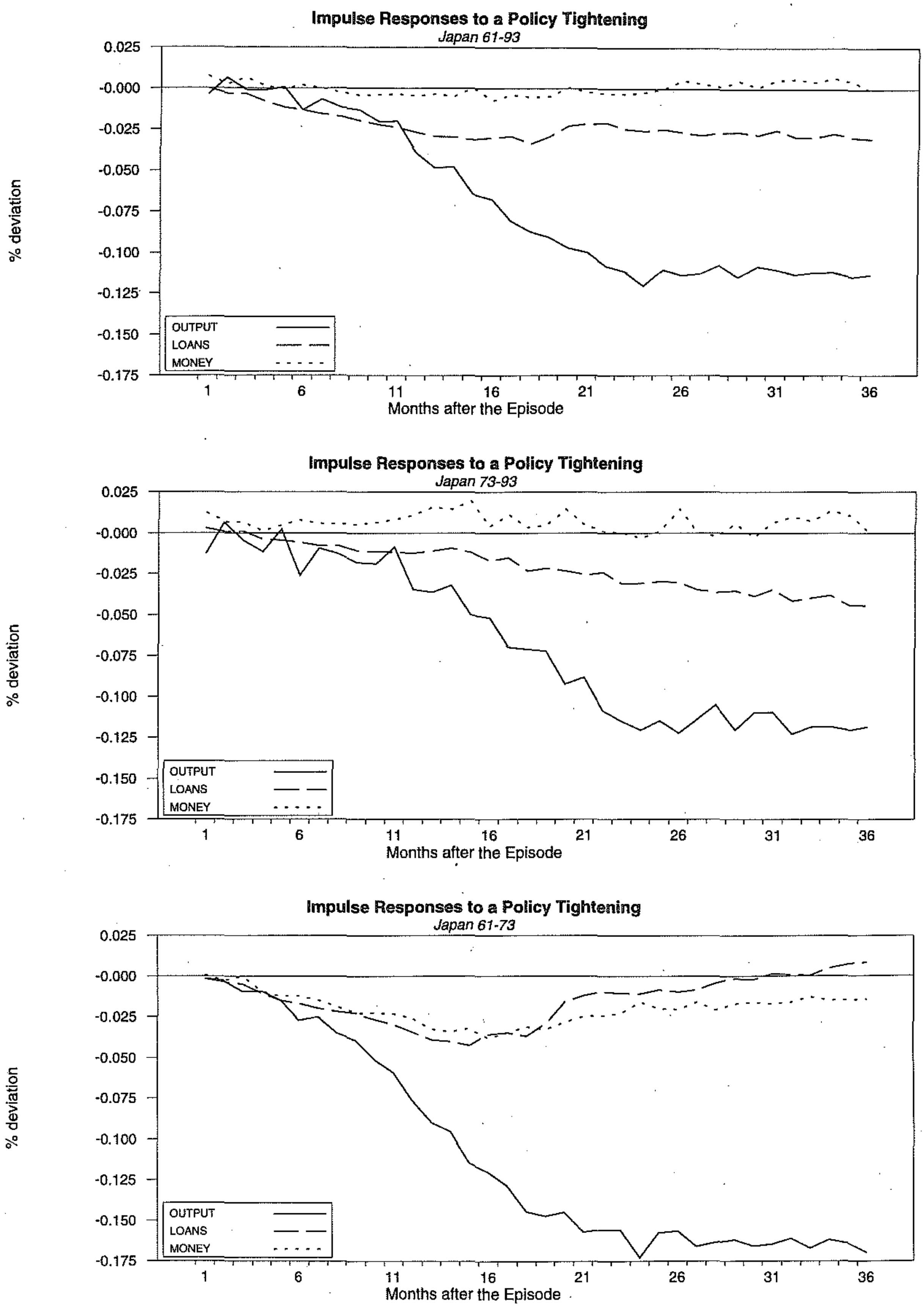
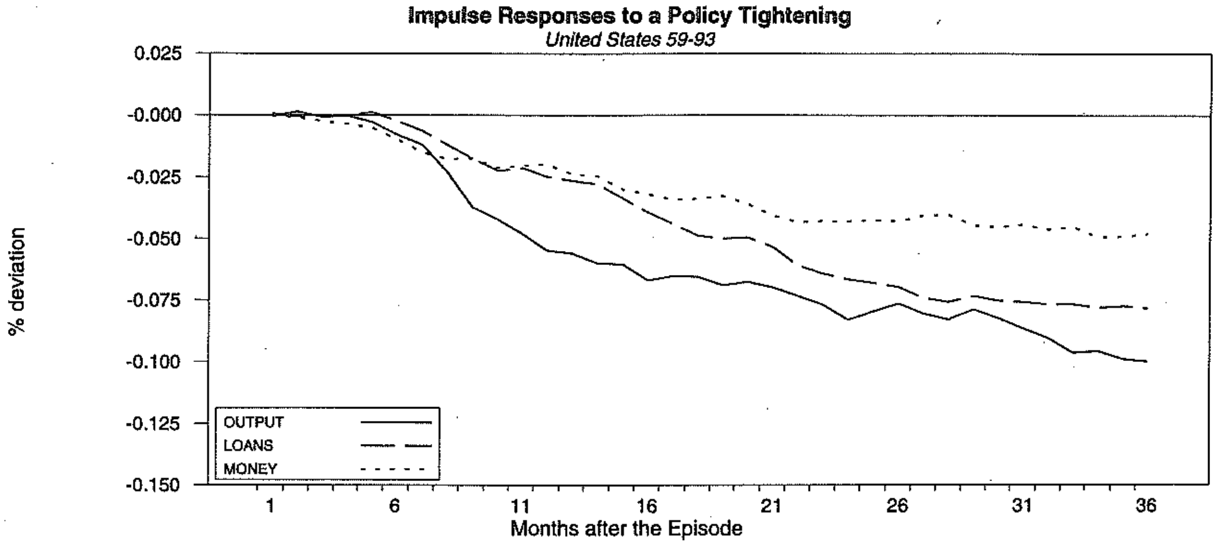
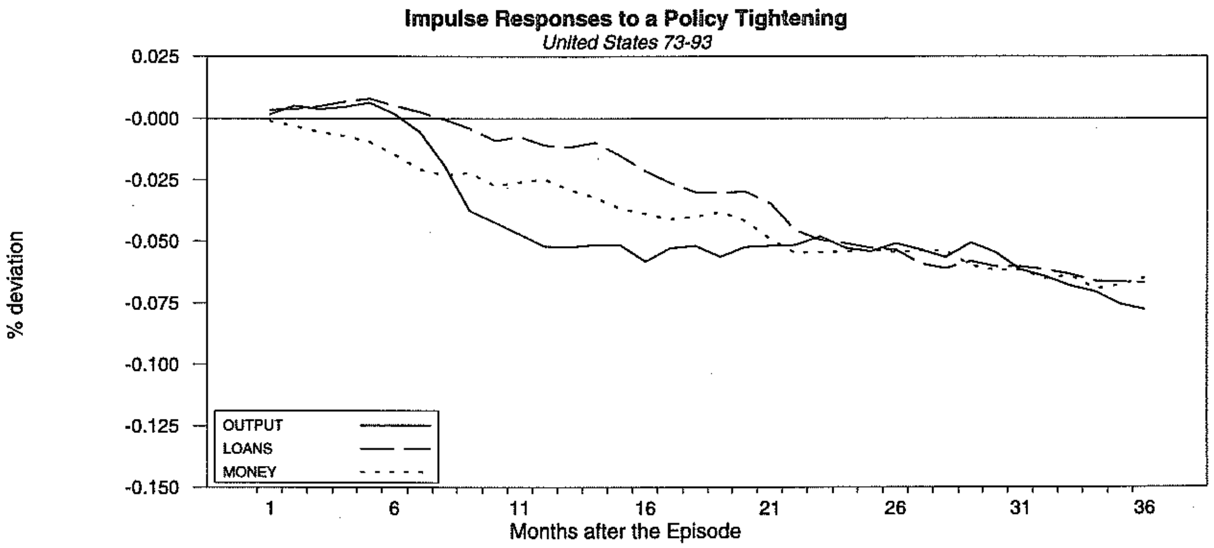

Impulse Responses to a Policy Tightening
Japan 61-93
% deviation
Months after the Episode
OUTPUT
LOANS
MONEY
Impulse Responses to a Policy Tightening
Japan 73-93
% deviation
Months after the Episode
OUTPUT
LOANS
MONEY
Impulse Responses to a Policy Tightening
Japan 61-73
% deviation
Months after the Episode
OUTPUT
LOANS
MONEY

Figure 2c


Impulse Responses to a Policy Tightening
United States 59-93
% deviation
0.025
-0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
OUTPUT
LOANS
MONEY
1
6
11
16
21
26
31
36
Months after the Episode


Impulse Responses to a Policy Tightening
United States 73-93
% deviation
0.025
-0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
OUTPUT
LOANS
MONEY
1
6
11
16
21
26
31
36
Months after the Episode

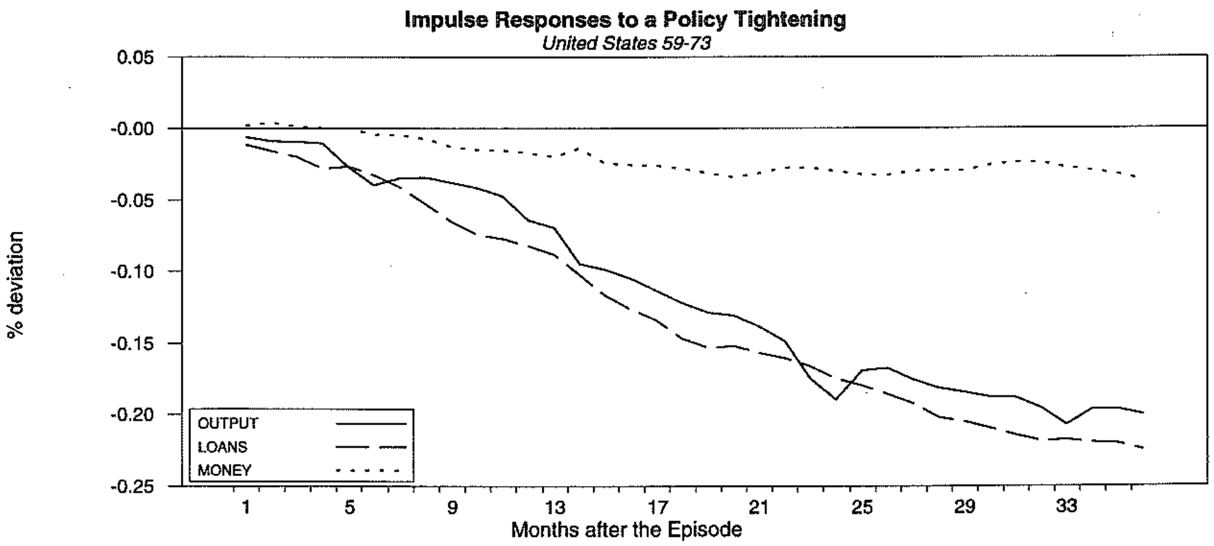
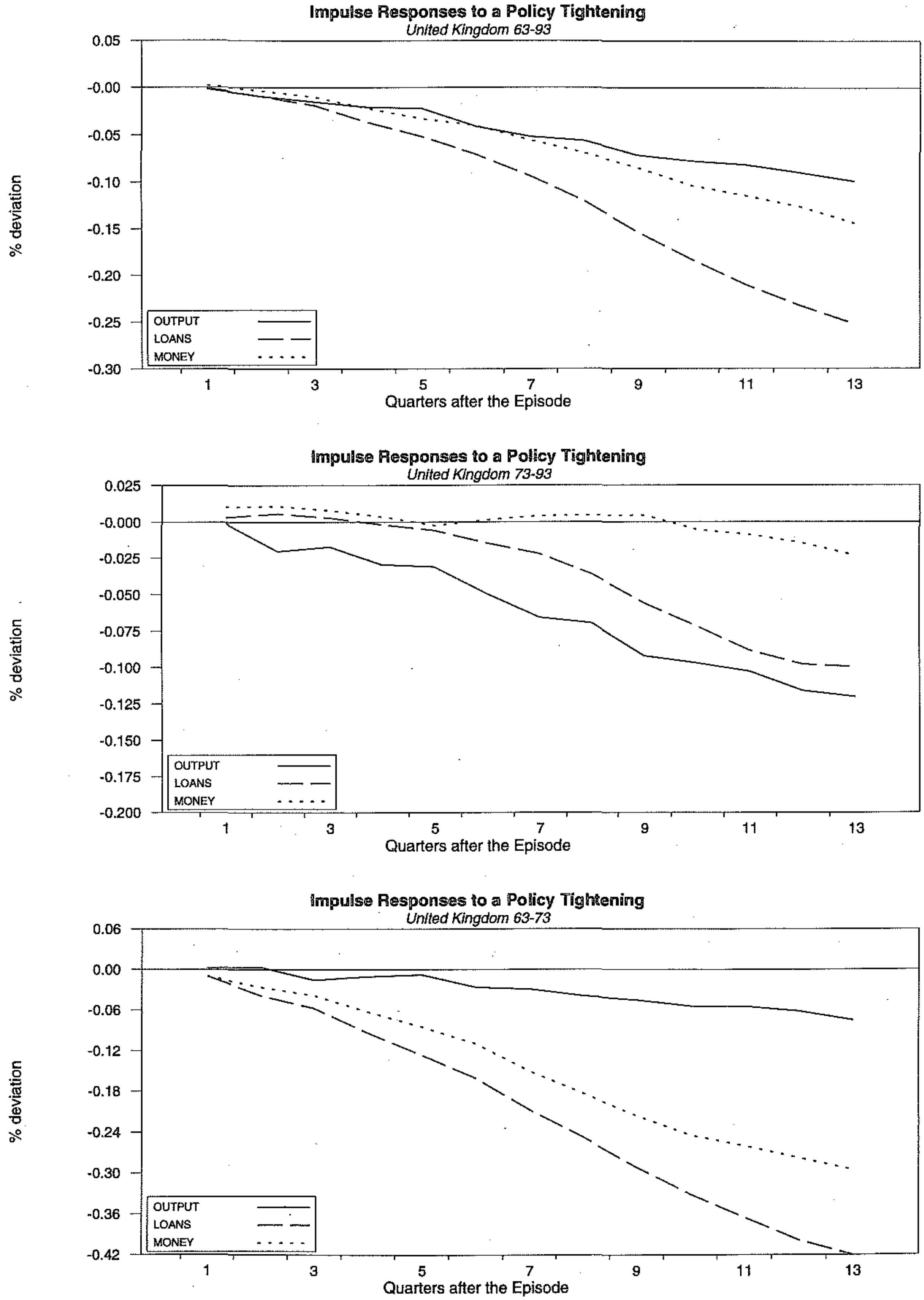

Impulse Responses to a Policy Tightening
United States 59-73
% deviation
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
OUTPUT
LOANS
MONEY
1
5
9
13
17
21
25
29
33
Months after the Episode

Figure 2d


Impulse Responses to a Policy Tightening
United Kingdom 63-93
% deviation
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
OUTPUT
LOANS
MONEY
1
3
5
7
9
11
13
Quarters after the Episode
Impulse Responses to a Policy Tightening
United Kingdom 73-93
% deviation
0.025
-0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
-0.175
-0.200
OUTPUT
LOANS
MONEY
1
3
5
7
9
11
13
Quarters after the Episode
Impulse Responses to a Policy Tightening
United Kingdom 63-73
% deviation
0.06
0.00
-0.06
-0.12
-0.18
-0.24
-0.30
-0.36
-0.42
OUTPUT
LOANS
MONEY
1
3
5
7
9
11
13
Quarters after the Episode

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The monetary transmission mechanism: evidence from the G-7 countries

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Bank for International Settlements

I. INTRODUCTION

The issue of the effects of monetary policy on real economic activity and the rate of inflation lies at the core of macroeconomics. However, despite the very large amount of research that has been undertaken on the monetary transmission mechanism, there is little consensus among economists regarding the exact effects of monetary policy and the extent to which these differ across countries. One reason for the lack of consensus is that it is econometrically very difficult to disentangle time series on financial variables such as interest rates and exchange rates into the parts due to monetary policy measures and the parts merely reflecting endogenous responses of financial markets to unobserved economic disturbances. Alternative empirical methodologies therefore tend to give different estimates of the role and effects of monetary policy. One consequence of the sensitivity of the results to the choice of identification strategy is that, since most studies focus on one country, it is difficult to compare estimates from different countries. Thus, relatively little is known about the extent to which the monetary transmission mechanism differs across countries.

In this paper we provide some evidence of the monetary policy transmission mechanism in the G-7 countries using a parsimonious macroeconometric model comprising output, prices and a short-term interest rate. To enhance the comparability of the results from different countries, we use similar data series, the same sample periods and an identical econometric framework for all the countries in the study. Thus, there are no obvious reasons to believe that the observed differences in the effectiveness of monetary policy are artefacts of the econometric methodology.

The paper is structured as follows. In Section II we discuss and motivate the empirical methodology, first presenting the empirical model estimated in this paper and the data series used. Next we briefly review the Structural Vector Autoregression (SVAR) methodology and discuss how we identify shifts in the stance of monetary policy. In Section III we turn to the empirical results. We use impulse response functions to evaluate the responses of output, inflation and interest rates to aggregate supply and demand disturbances and to innovations in monetary policy. Next, we study the relative importance of the different shocks using forecast error variance decompositions, and assess whether our identifying assumptions generate plausible results. We end the section by decomposing observed movements in output, prices and interest rates into the parts due to responses to supply and demand shocks, and the monetary policy shock. The purpose of this analysis is to provide an informal way of assessing whether the estimated models are sensible. Since the estimated monetary policy shocks differ in size and persistence across countries, we standardise the shock in Section IV and simulate the effects on the level of real GDP and prices of a 100 basis point increase, maintained for eight quarters, in the short-term nominal interest rate. This enables us to compare the effectiveness of monetary policy across countries. Conclusions are drawn in Section V. The paper ends with a data appendix and a technical appendix, which contains details of the econometric methodology.

II. METHODOLOGY AND DATA

In this paper we use Structural Vector Autoregressions (SVARs) to analyse differences in the effects of monetary policy in the G-7 countries. There are several reasons why SVARs are suitable for studying the monetary transmission mechanism. First, SVARs require only a minimum of restrictions in order to disentangle movements in endogenous variables such as output, prices and interest rates into the parts due to underlying shocks, such as shifts in aggregate supply and demand schedules and changes in the stance of monetary policy. The transparency of the identifying restrictions is of particular interest in a cross-country study, since it facilitates an assessment of whether the results are driven by different or implausible identifying assumptions. Second, vector autoregressions come with a number of convenient tools - impulse response functions, forecast error variance decompositions and historical decompositions - that are useful in answering a host of questions concerning the effects of the shocks and their role and importance in specific historical episodes. Third, once an identification scheme has been adopted, SVARs are easy to estimate, which makes them particularly suitable for multi-country studies.

Notwithstanding their many advantages, SVARs are also subject to limitations. While SVAR models allow us to address questions regarding the effects of monetary policy, they cannot be used to analyse the effect of changes in the monetary policy *regime* on the economy. More concretely, the SVAR techniques used in this paper decompose monetary policy into a systematic and an unsystematic part. The systematic part may be thought of as the monetary policy reaction function and corresponds to the "average" response of monetary authorities to macroeconomic disturbances such as aggregate supply and demand shocks. Because of the reduced form nature, SVAR techniques unfortunately do not allow us to distinguish between the *direct* effects of such shocks and any *indirect* effects they have by eliciting systematic responses by the central bank (as captured by the policy reaction function). The unsystematic part, which we label "monetary policy shocks" in what follows, can be interpreted as deviations from this average reaction function over the sample period. Most of the work reported below focuses on the effects of such monetary policy shocks and their role in macroeconomic fluctuation in the last decade.

A second widely recognised problem with SVARs is that the results are sensitive to the ways in which the models are identified. Thus seemingly small changes in the identifying assumptions can lead to substantial changes in the estimated effects of the shocks and in their relative importance over the sample period. This is very much the case also with our empirical results. Given this sensitivity, it is incumbent on the researcher to motivate the choice of identifying restrictions.

The rest of this section is organised as follows. We first present and motivate the simple three-variable SVAR model that we study and discuss the choice of the data set. Next, we review what is meant by identifying a SVAR and motivate our choice of identifying restrictions. Section III then turns to the results.

1. The empirical model

The purpose of SVAR analysis is to decompose movements in some *observed* time series into the parts that are due to *unobserved* underlying shocks which are structural in the sense that they can be given an economic interpretation. More concretely, in what follows we attempt to decompose movements in real income levels, prices and short-term interest rates into the parts due to shifts in aggregate supply schedules ("supply shocks"), shifts in aggregate demand schedules ("demand shocks") and changes in monetary policy ("monetary policy shocks"). To formalise the discussion and using standard notation, let $x_t^T = [\Delta y_t \quad \Delta p_t \quad r_t]$ be the vector of endogenous variables, with Δy_t denoting real GDP growth, Δp_t the rate of inflation and r_t the nominal short-term interest rate.[1]

1 The stationarity properties of the time series used are examined in the data appendix.

Furthermore, let $\varepsilon_t^T = \begin{bmatrix} \varepsilon_t^s & \varepsilon_t^d & \varepsilon_t^p \end{bmatrix}$ be the vector of structural shocks, with ε_t^s denoting a supply shock, ε_t^d a demand shock and ε_t^p a monetary policy shock. Typical examples of supply shocks are exogenous changes in energy prices or the terms of trade, productivity shocks or tax and wage shocks. Demand shocks can be thought of as government spending shocks or shifts in investment and consumption functions.

The structural model can then be written as:

$$x_t = A(L)\varepsilon_t \qquad (1)$$

where the matrix lag polynomial $A(L)$ contains the responses of the endogenous variables to the underlying structural disturbances.

Discussion

Given our interest in the monetary transmission mechanism, the three variables used above constitute the smallest possible SVAR model. The model can be thought of as a minimalist empirical version (of the reduced form) of a standard aggregate supply/aggregate demand macroeconomic model comprising an IS-curve, a Phillips curve and a monetary policy reaction function. While the fact that there are only three endogenous variables is an attractive feature of the model, in particular in the context of a multi-country study, this also limits the number of structural shocks that we can identify. Although this issue is typically not discussed in any great length in the VAR literature, the choice of the dimension of the SVAR should be thought of as an integral part of the identification procedure, since we can identify (at most) one structural shock for each endogenous variable. Thus, the number of variables included should be determined by the number of shocks that one thinks play a role in determining movements in the endogenous variables.

Our choice of output, prices and a short-term interest rate has two important implications which need to be noted. First, by limiting the number of endogenous variables, we implicitly assume that different supply and demand shocks (e.g. oil price shocks versus productivity shocks, or increases in government spending as opposed to shifts in the consumption function) have similar effects on income, prices and interest rates, so that they can be aggregated into a "typical" aggregate supply or demand shock.

Second, and maybe more importantly for this study, we assume that output and prices capture all the information to which monetary authorities respond when setting short-term interest rates. This assumption excludes, for example, that the central bank responds to developments in the exchange rate market that are not due to aggregate supply and demand developments. This assumption may be a good first approximation in the case of the larger economies in our sample, but appears less attractive for the smaller and more open economies. In these countries, changes in policy interest rates that are a response to exchange market tensions will appear as policy shocks (or shifts in the policy reaction function). As in such a case the response of the economy could very well differ from the effect of "pure" policy shocks, e.g. because the exchange rate responds differently, one needs to be cautious in comparing the effects of monetary policy between these two groups of countries.

The stance of policy

An important issue that arises in studying the monetary transmission mechanism is how to measure the stance of monetary policy. Implicit in our use of short-term interest rates is the hypothesis that such rates capture the stance of policy. The reasons we focus on prices, rather than quantities, as indicators of monetary conditions are twofold. First, central banks themselves typically regard themselves as pursuing monetary policy by setting the interest rate(s) at which they provide financing to the commercial banking system, which in turn implies that central banks control short-term interest quite precisely elsewhere in the economy. Indeed, all the central banks included in this study are likely to subscribe to this description of policy. Second, while monetary aggregates in principle can be used as indicators of the stance of monetary policy, they are subject in practice to a wide variety of other disturbances, including shifts in the demand for money, which often dominate the information they contain about changes in the state of policy.[2]

Conceptually, the ideal interest rate to use as a measure of the stance of monetary policy would be the official interest rate at which marginal financing is provided to the banking system. Unfortunately, it is impractical to pursue this approach for several reasons. For instance, central banks typically provide financing using a number of different interest rates, which makes it difficult to choose "the" representative rate. Furthermore, the exact interest rate that is relevant has in many countries changed over time in response to, in many cases, profound developments of central banks' monetary operating techniques. Central banks may also alter the stance of policy without changing official interest rates, for instance by varying the availability of credit at the official rates. Since market-determined interest rates typically respond very quickly to changes in monetary policy irrespective of whether they are expressed by a change in an official interest rate or by a change in the availability of credit, we use three-month interest rates as measures of the stance of policy.

2. The identification problem

Next we provide a brief overview of the identification problem as it arises in the case of SVARs, using the empirical model in (1) as an example. The purpose of the overview is to explain what is meant by identification and to explain the restrictions used to identify the model estimated in this paper.

To obtain an estimate of (1), the first step is to model the vector of endogenous variables using the following unrestricted VAR (disregarding for simplicity deterministic variables):

$$D(L)x_t = v_t \tag{2}$$

where D(L) is a finite-order matrix polynomial in the lag operator L. Equation (2) can be estimated and inverted to yield the moving average representation

$$x_t = C(L)v_t \tag{3}$$

where $C(0) = I$, and $v_t^T = \begin{bmatrix} v_t^y & v_t^p & v_t^r \end{bmatrix}$ is a vector of regression residuals, with variance-covariance matrix $Ev_t v_t^T = \Omega$, which have no economic interpretation. The lag polynomial $C(L)$ traces out the dynamic responses of the endogenous variables to the regression residuals.

By "identifying" the VAR, we map the parameters of the non-structural model (3) into the structural model (1). Note that (1) and (3) imply that

$$v_t = A(0)\varepsilon_t \tag{4}$$

and

$$A(L) = C(L)A(0) \tag{5}$$

2 In preliminary work we incorporated monetary aggregates (M_3 or M_2) in the analysis, but found that they appear largely determined by money demand shocks that in turn have little, if any, impact on the economy. The reason for these findings is simply that monetary aggregates are dominated by disturbances unrelated to the state of monetary policy, e.g. financial deregulation or temporary external capital flows.

Equations (4) and (5) illustrate that in order to identify the model we need to find an estimate for A(0), the contemporaneous impact matrix. This is done by imposing sufficient restrictions to enable us to solve for a unique A(0), using estimates of C(L), or equivalently D(L), and Ω. To do so we assume, as is typical in VAR studies, that the structural shocks have a unit variance-covariance matrix, i.e. $E\,\varepsilon_t \varepsilon_t^T = I$.[3] Together with equation (4), this implies that:

$$\Omega = A(0)A(0)^T \tag{6}$$

Since Ω is 3x3, it contains six unique elements, which yield six identifying restrictions on the impact matrix A(0). To identify A(0) we need three more restrictions, which can stem from assumptions regarding either the contemporaneous (short-run) or long-run effects of the structural shocks on the endogenous variables.[4] The existing literature on VARs suggests that the choice of identifying restrictions should be guided by the precise questions that we would like to address.

Bernanke and Blinder (1992) identified monetary policy shocks in the United States using the restriction that monetary policy has no instantaneous impact on output and inflation. While this assumption is appealing given the broadly held view that the effects of monetary policy take a considerable time to be felt, it does not allow us to identify shocks to aggregate supply and demand conditions for goods and services. Since monetary policy to a large extent may be interpreted as reactions by policy to the inflation and output effects of goods market disturbances, it is of substantial interest to see how such shocks affect interest rates. This, of course, requires them to be identified. Thus, while Bernanke and Blinder's restrictions may be helpful in identifying monetary policy shocks, they are not useful if we also wish to study the interest rate response to aggregate supply and demand shocks.

Long-run restrictions can also be used to identify SVARs. However, again their usefulness depends on the shocks we would like to identify. Indeed, long-run restrictions have typically been used in the literature to distinguish between aggregate supply and demand disturbances which are poorly identified using short-run restrictions. However, there are only a few examples of long-run restrictions being used to study monetary policy shocks. One reason for this is that it is difficult to think of long-run restrictions that uniquely identify monetary policy shocks. Keating (1992) and Walsh (1993) use the restriction that monetary policy actions can have no long-run effects on real variables such as real output, the real interest rate or the real money stock. While this assumption is plausible, temporary demand shocks are likely to satisfy the same long-run restrictions, so that it is difficult to distinguish between these and monetary policy actions.

Given the relative advantages of short or long-run restrictions, in this paper we follow Galí (1992), who employs a combination of short and long-run restrictions to identify a SVAR.[5] First, in order to identify the aggregate supply shock, we assume that the aggregate demand and monetary policy shocks do not have permanent, but perhaps persistent, effects on the *level* of real

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3 The assumption that the shocks have a unit variance is just a normalisation. If there are only three fundamental shocks to the system, then the orthogonality assumption is not particularly stringent, as one can always redefine the shocks to be uncorrelated. To the extent that other unidentified shocks are important and affect each of the endogenous variables contemporaneously, the orthogonality assumption will lead to a misspecification of the three shocks. In this case the suggested solution would, however, be to increase the dimension of the system.

4 Sims (1980) in his seminal work on VARs assumed that the instantaneous impact matrix was lower triangular. Bernanke (1986), Blanchard and Watson (1986) and Sims (1986) proposed contemporaneous zero restrictions that are more general than the recursive restrictions, and which can be given a structural interpretation. Blanchard and Quah (1989) and Shapiro and Watson (1988) pioneered the use of long-run restrictions to identify SVARs.

5 In preliminary work, we experimented with using only short-run or long-run restrictions, but found that such restrictions did not plausibly identify the underlying shocks. For some further discussion, see Section III.3.

GDP.[6] This implies that the aggregate supply shocks are identified by the restriction that only they affect the level of real GDP in the long run. This restriction, which essentially says that the long-run Phillips curve is vertical, is implicit or explicit in much of macroeconomic theory.

In order to discriminate between the aggregate demand and the monetary policy shocks, we follow Bernanke and Blinder (1992) and Galí (1992) and use the restriction that monetary policy has no contemporaneous effect on output.[7] An alternative assumption would be that monetary policy has no contemporaneous effect on the rate of inflation. However, given that we use quarterly data, changes in monetary policy could well have an effect on the price level, either by affecting the exchange rate and import prices or by affecting the price index directly through mortgage interest rates. Thus, the assumption of no instantaneous pass-through to prices seems less plausible. It would also be possible in principle to assume that monetary policy has no contemporaneous effect on either inflation or real output. However, such over-identifying restrictions are more difficult to use since the "separation" between estimation and identification that is possible in the case of just-identified models breaks down.[8]

The three additional restrictions discussed above, together with equation (6), allow us to find an estimate of A(0) and to identify the structural model. The actual implementation of these restrictions is somewhat complicated and is therefore relegated to the technical appendix.

III. RESULTS

Next we turn to the econometric results, which stem from estimates of the SVAR model discussed above on quarterly data for the period 1979:1-1993:4, using real GDP to measure economic activity and consumer price indices to measure the rate of inflation. Exact descriptions of the data are provided in the data appendix.

The purpose of this section is to assess whether our identification scheme generates plausible estimates of the structural shocks, particularly the monetary policy shocks, and of the effects of such shocks on the different economies in the sample.[9] Comparison of the results across countries plays an important part in this assessment: since we believe that monetary policy shocks have the same *qualitative* effects in different countries, we would have little faith in the restrictions unless they yielded sensible estimates for a number of countries.

The discussion is organised as follows. We first use impulse response functions to study the reactions of short-term interest rates, output and prices to monetary policy shocks, and aggregate supply and demand disturbances.[10] Since it is not clear whether real or nominal interest rates play a more important role in the transmission process, we provide results for both. Second, we study the relative importance of the different shocks using variance decompositions. We end the section by briefly discussing the historical decompositions of movements in interest rates, output and prices into the parts due to aggregate supply, aggregate demand and monetary policy shocks.

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6 This implies that the second and third elements in the first row of A(1) are zero. From equation (5) it follows that this also implies two linear restrictions on the elements of the A(0) matrix.

7 Thus, the third element in the first row of A(0) is zero.

8 See Roberts (1993) for details.

9 By "plausible" we mean that the signs (and also the size and persistence) of the effects are realistic: e.g. a monetary policy tightening should increase nominal and real interest rates, depress output and reduce prices.

10 The real interest rate is defined as the nominal interest rate minus the inflation rate over the last four quarters.

Figure 1.1

Canada: Estimated impulse response functions (1979:1-1993:4)

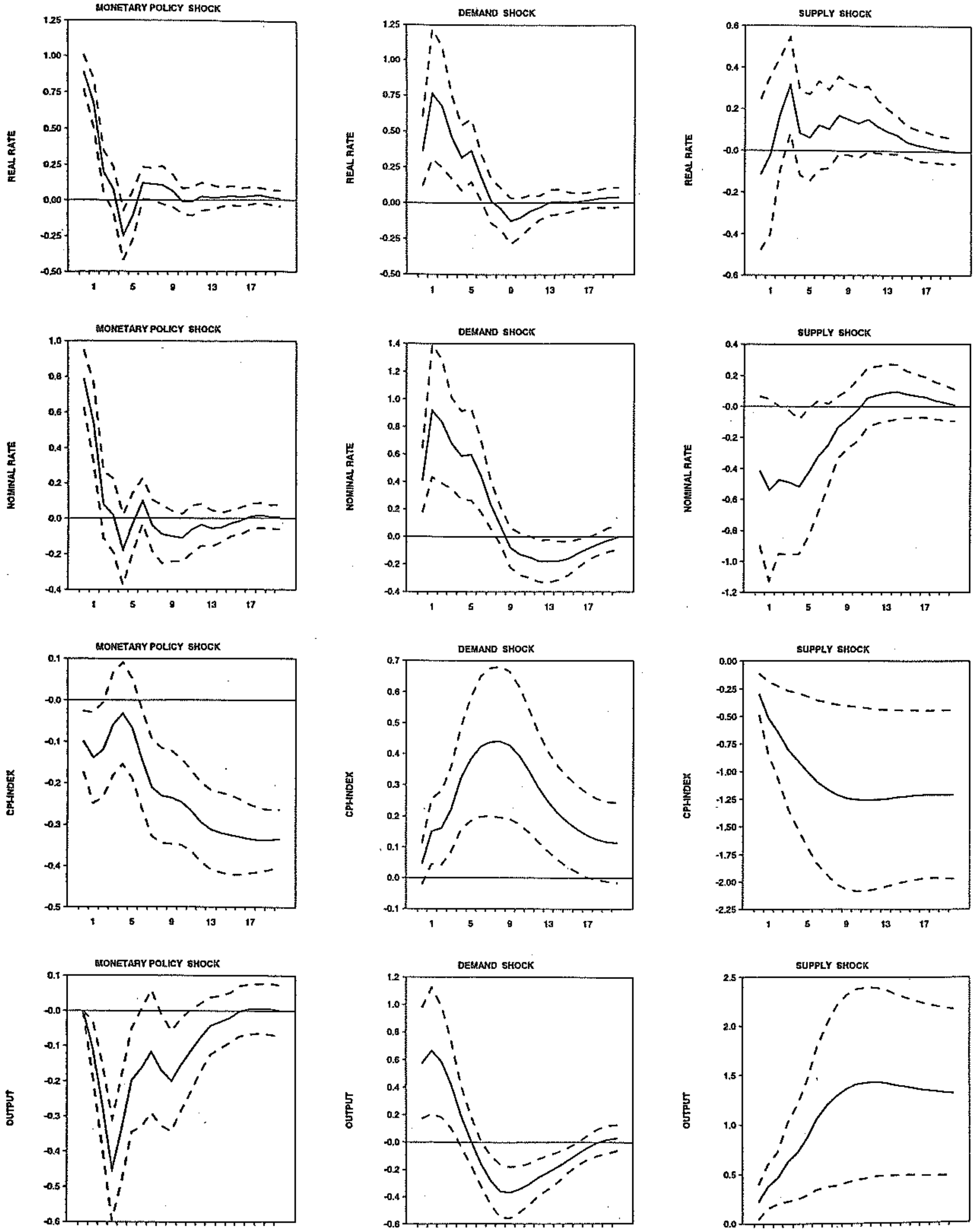


Figure 1.2

France: Estimated impulse response functions (1979:1-1993:4)

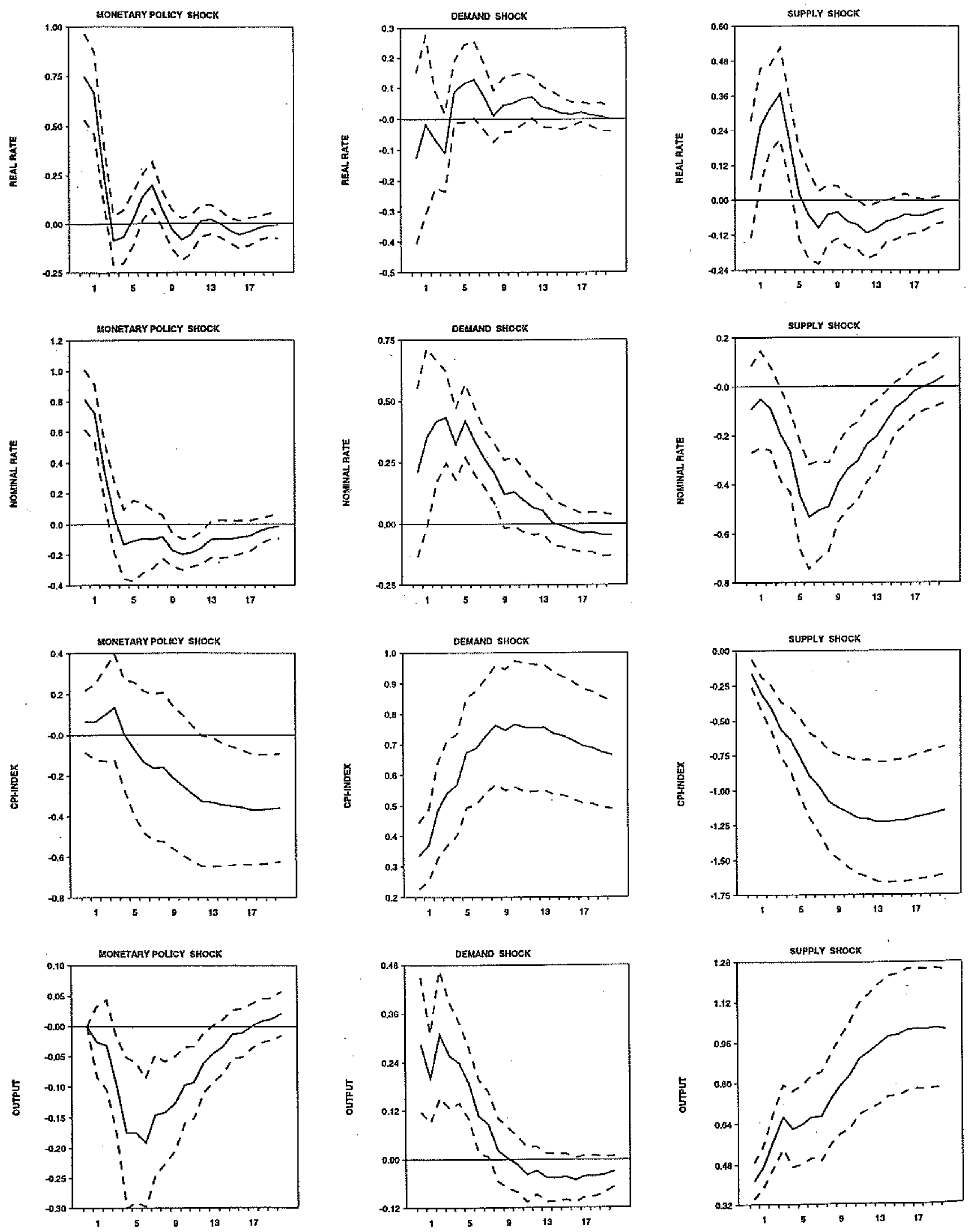


Figure 1.3

Germany: Estimated impulse response functions (1979:1-1993:4)

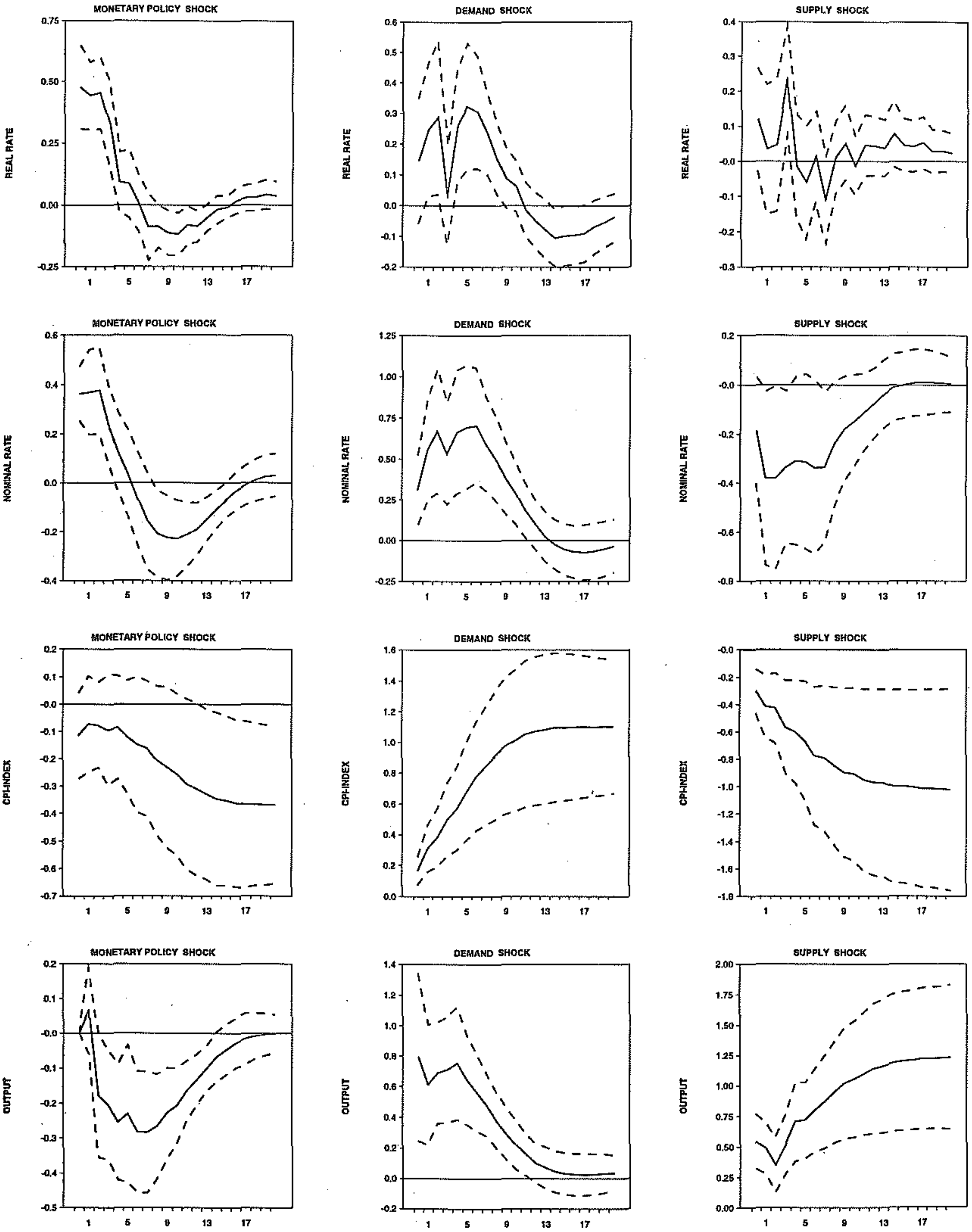


Figure 1.4

Italy: Estimated impulse response functions (1979:1-1993:4)

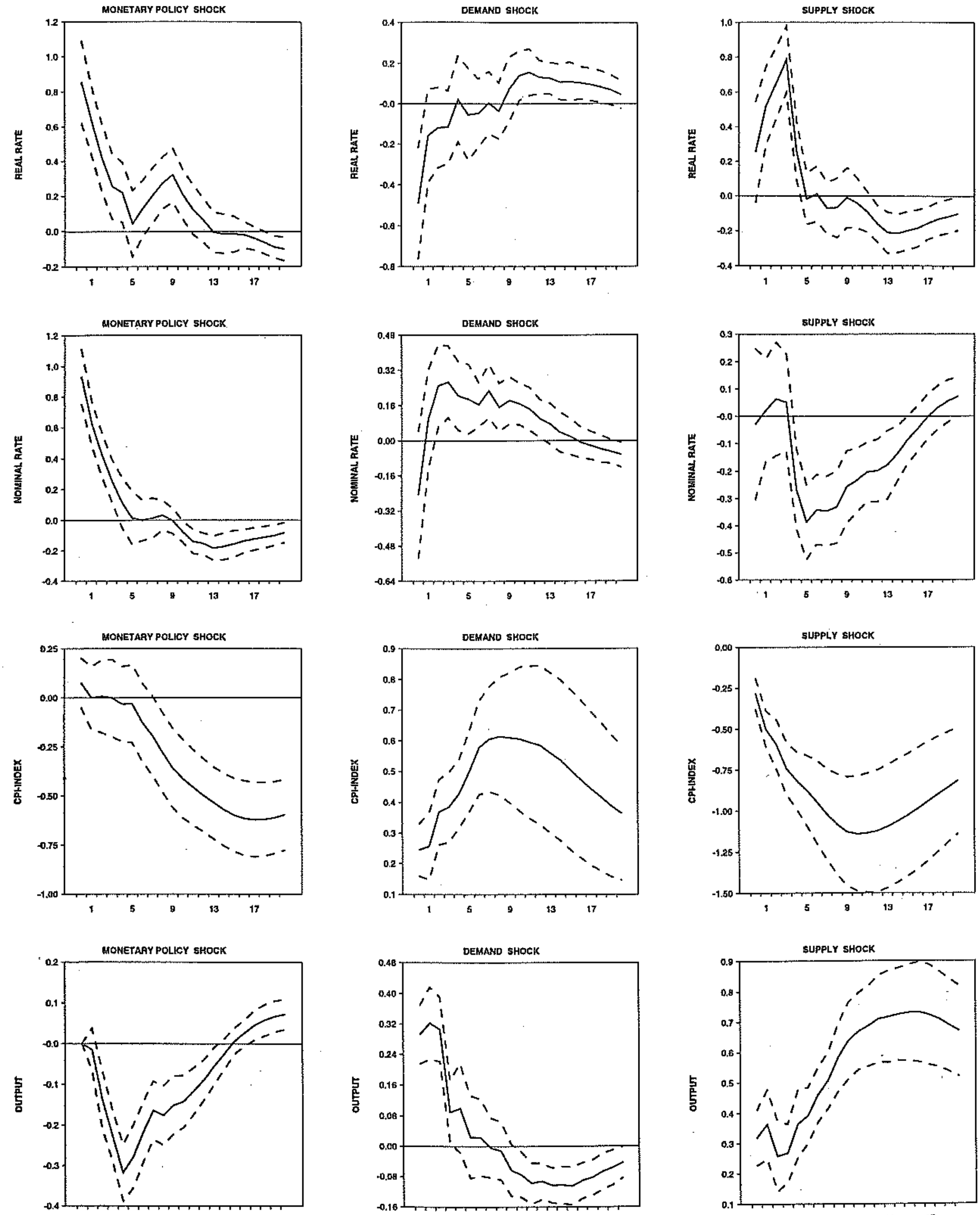


Figure 1.5

Japan: Estimated impulse response functions (1979:1-1993:4)

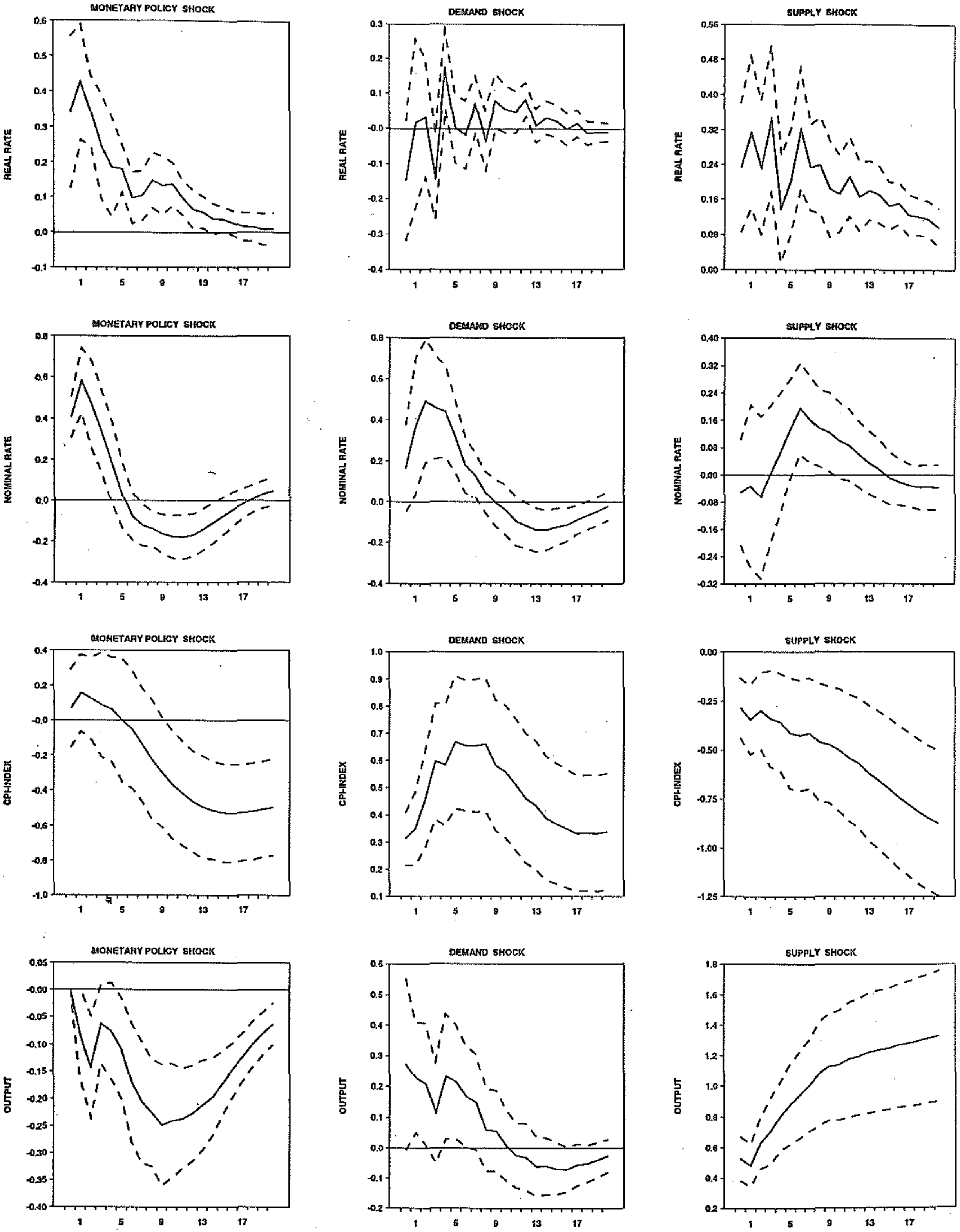


Figure 1.6

United Kingdom: Estimated impulse response functions (1979:1-1993:4)

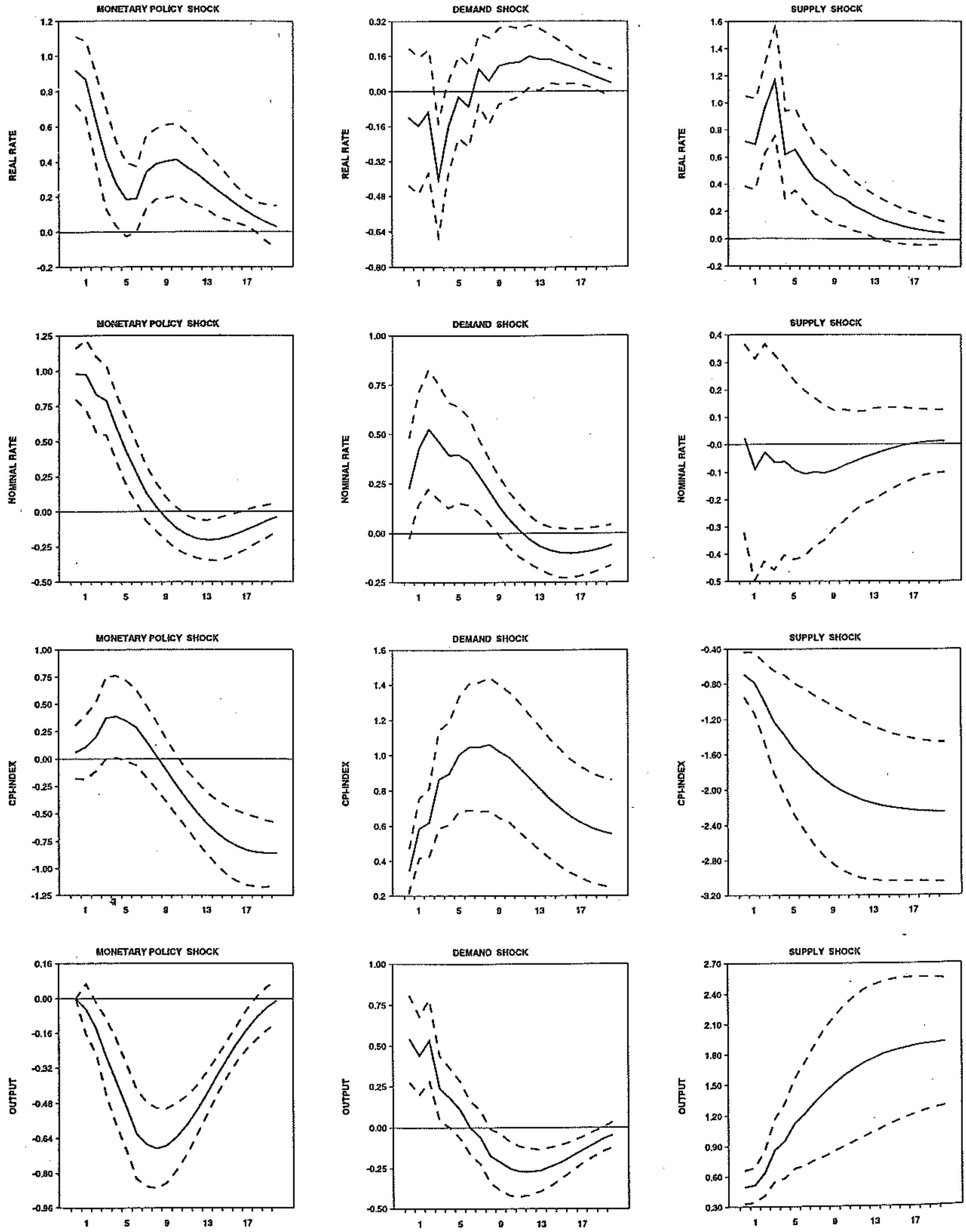
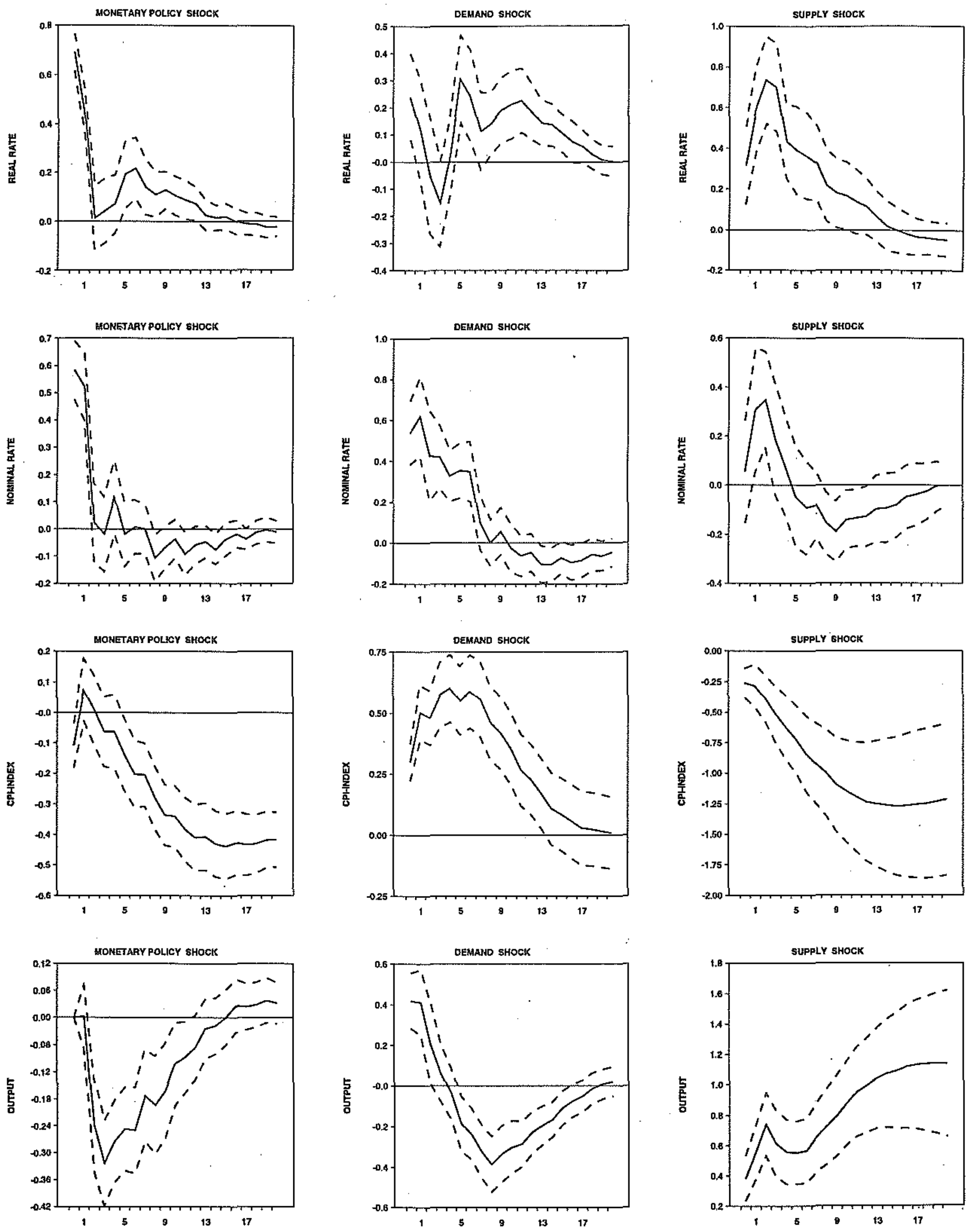


Figure 1.7

United States: Estimated impulse response functions (1979:1-1993:4)



1. Impulse responses

Figures 1.1-1.7 provide the estimated responses of the levels of real and nominal short-term interest rates, the level of real GDP and - with the exception of the United Kingdom - the consumer price level in the G-7 countries to the three structural shocks. For the United Kingdom, we found that monetary policy shocks consistently led to increases in both the consumer price index, and the consumer price index adjusted for mortgage interest payments. In what follows, we therefore use the GDP deflator in the case of the United Kingdom.

Monetary policy shocks

The first column of graphs displays the responses of the economy to monetary policy shocks together with ± 1 standard deviation confidence intervals.[11] The second graph in the first column shows the effect of a tightening on the short-term interest rate. A one standard deviation monetary policy shock increases short-term interest rates by between 60 and 100 basis points, depending on the country considered. Exceptions to this general pattern are Germany and Japan, where the typical tightening is about 40 basis points. The persistence varies substantially across countries: in Canada and the United States nominal interest rates return to the starting level after about three quarters while in the United Kingdom eight quarters or so elapse before the nominal interest rate returns to baseline. One finding is that nominal interest rates fall for a while below their initial level in a number of countries. However, the real short-term interest rate, plotted in the first graph, does not display this "J-curve" behaviour, which suggests that the undershooting of the nominal rate is an endogenous response to the fall in prices caused by the initial tightening of monetary policy.

The third graph in the first column shows the responses of consumer prices to the monetary policy shock. The graphs illustrate that in all countries the price level falls following a tightening of monetary policy and it appears 12-16 quarters elapse before the fall in the price level is arrested. The impact effect of a monetary policy tightening on consumer prices might differ somewhat, but does not seem to be significantly different from zero except in Canada. The immediate response on prices might be due to the effects of a tightening of monetary policy on the exchange rate and import prices. This may also explain why consumer prices in Germany fall contemporaneously with the monetary policy shocks, while prices in France and Italy, which operated under fixed exchange rates during a large part of the sample period, and in Japan and the United States, which are large and relatively closed economies, are initially unaffected by the monetary policy shock.

The fourth graph in the first column shows that the increase in interest rates depresses output in all countries. It is striking that the output effects are very similar across countries: except in the case of the United Kingdom, where the effect is somewhat larger, monetary policy shocks reduce output by approximately 0.2 to 0.4% relative to baseline. The time paths of the GDP responses are quite similar across countries, although in Canada the peak effect is quite abrupt. In most countries the negative effect on output peaks after about five to six quarters and is undone after about two to three years. The point estimates for the within-the-year response of output in Japan are essentially zero and insignificant. Consequently, our results for Japan suggest that the impact effect of monetary policy is relatively muted and that the effects are somewhat delayed.

Aggregate demand shocks

The second column in Figures 1.1-1.7 provides the responses of real and nominal interest rates to expansionary aggregate demand shocks. Such demand shocks could stem from increases in government spending or shifts in the consumption or investment functions. Note that nominal interest rates increase in all countries following a demand shock. The responses of real interest rates, however, vary across countries. In Canada, Germany and the United States demand shocks increase

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11 The confidence bands are bootstrapped with 100 draws. Some experimentation suggested that using more than 100 draws had no impact on the results.

real interest rates. However, in France, Italy and Japan the real interest rate is essentially unaffected by the demand shocks, and in the United Kingdom real rates fall.

The third graph in the second column shows that a typical aggregate demand shock increases the price level by between 0.5 to 1.0%, with the peak effect typically reached after about six quarters. In France, Germany and the United Kingdom, the effect on the price level appears very persistent or permanent, while in the other countries the price level tends to fall back towards its initial level.

The output responses are provided in the fourth graph in the column. In all countries the demand shock expands output instantaneously. The size of the impact effect varies across countries, from about 0.3% in France to as much as 0.8% in Germany. Furthermore, the results indicate that output falls back *below* baseline for a while in Canada, Italy, Japan, the United Kingdom and the United States, so that our estimates point to some cyclical behaviour following demand shocks.

Aggregate supply shocks

Finally, we turn to the effects of aggregate supply shocks, which are provided in the third column of Figures 2.1-2.7. As before, we first analyse the responses of real and nominal interest rates and then turn to prices and output.

The first and second graphs in the last column show the responses of interest rates to supply shocks. As can be seen, the reactions of the real and nominal interest rates continue to be quite different. In France, Germany, Italy and Japan, nominal interest rates typically fall, but real rates rise, in response to expansionary supply disturbances. This finding is not difficult to reconcile with theory. Expansionary supply shocks increase the return to capital and therefore real interest rates. At the same time, they reduce inflationary pressures and nominal interest rates. In the United Kingdom and the United States, both rates rise following the disturbance, although the nominal interest rates very quickly return to their original level. In Canada, real rates are essentially unaffected by the supply shock, while nominal rates fall.

Turning to the effects of supply shocks on prices and output, the results indicate, not surprisingly, that supply shocks expand income and depress prices by about 1% (in the United Kingdom the effects appear larger: about 2%). The long-run effects are also relatively slow to appear: in most cases the adjustment to the new equilibrium takes at least 12 quarters.

2. Variance decompositions

We next assess the relative importance of the three structural shocks for the behaviour of real and nominal interest rates, output and the price level. Table 1 gives an overview of how large a fraction of the variance of the forecast error of the endogenous variables is due, at different forecast horizons, to the three structural shocks.

Monetary policy shocks

The table illustrates that monetary policy shocks tend to explain only a very small part of the forecast errors on output and inflation.[12] We view this as an encouraging finding, since it suggests that innovations in monetary policy play only a minor role in macroeconomic fluctuations. Of course, the finding that monetary policy shocks - or the unsystematic part of monetary policy - is relatively unimportant does not contradict the notion that the monetary policy reaction function plays a significant role in offsetting or propagating the effects of aggregate supply and demand shocks.

12 Cochrane (1994) uses a number of approaches to identify monetary policy shocks in the United States. One interesting finding is that the importance of monetary policy shocks shrinks as the identification of such shocks becomes more credible, judged by the shape of the impulse response functions.

Table 1

Variance decompositions

Canada				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	64	18	17
	4	23	23	54
	20	17	27	56
Real interest rate	1	84	1	14
	4	46	5	49
	20	41	9	50
Real GDP	1	0	13	87
	4	12	34	54
	20	2	91	7
Consumer prices	1	10	88	2
	4	3	91	6
	20	4	89	6

France				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	93	1	6
	4	69	3	28
	20	36	38	26
Real interest rate	1	96	1	3
	4	76	22	2
	20	69	25	6
Real GDP	1	0	68	32
	4	1	80	19
	20	1	96	3
Consumer prices	1	3	19	78
	4	3	42	55
	20	4	66	30

Germany				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	50	13	37
	4	23	21	56
	20	15	19	66
Real interest rate	1	87	5	8
	4	76	7	17
	20	54	7	38
Real GDP	1	0	32	68
	4	3	31	66
	20	2	81	16
Consumer prices	1	10	69	21
	4	3	58	39
	20	4	44	51

Table 1 (cont.)

Variance decompositions

Italy				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	93	0	6
	4	88	0	12
	20	56	28	16
Real interest rate	1	71	6	23
	4	45	45	10
	20	45	44	11
Real GDP	1	0	54	46
	4	10	51	40
	20	6	89	5
Consumer prices	1	4	55	41
	4	0	75	25
	20	13	68	19

Japan				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	85	1	14
	4	57	1	42
	20	47	7	47
Real interest rate	1	60	28	11
	4	56	39	5
	20	39	55	6
Real GDP	1	0	79	21
	4	2	87	11
	20	2	96	2
Consumer prices	1	2	44	53
	4	4	33	63
	20	19	45	36

United Kingdom				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	95	0	5
	4	81	0	18
	20	74	1	25
Real interest rate	1	61	38	1
	4	38	58	4
	20	38	58	5
Real GDP	1	0	45	55
	4	4	64	32
	20	8	90	3
Consumer prices	1	1	80	20
	4	4	67	29
	20	6	78	16

Table 1 (cont.)

Variance decompositions

United States				
Variable	**Quarters**	**Shocks**		
		policy	**supply**	**demand**
Nominal interest rate	1	54	0	46
	4	32	13	54
	20	26	16	57
Real interest rate	1	75	16	9
	4	30	66	4
	20	24	62	14
Real GDP	1	0	46	54
	4	8	71	20
	20	3	90	7
Consumer prices	1	7	40	53
	4	1	38	61
	20	8	81	11

Note that variance decompositions for the short-term interest rate indicate that monetary policy shocks account for a significant part of their forecast error variance, especially in the short run. However, the fraction explained decreases significantly over the long run, when less than one-third of the variation in interest rates is accounted for by monetary policy shocks. Italy and Japan are exceptions, where about half of the forecast error variance can be attributed to monetary policy shocks.

Aggregate supply and demand shocks

The variance decompositions of forecast errors on output indicate that in the short run most of the variation is due to a mixture of aggregate supply and demand shocks. By construction, supply shocks start to dominate demand shocks as increasingly longer forecast horizons are considered. Turning to the relative importance of aggregate supply and demand shocks for the forecast error variance of consumer prices, the results suggest that these vary quite substantially across countries. In Canada, for instance, supply shocks explain approximately 90% of the forecast error on the price level, while in France demand shocks explain about 80% in the short run, and as much as 30% over five years. Finally, aggregate demand shocks typically explain a larger fraction of the variance of the forecast error on short-term interest rates, in particular at horizons of more than one year, than aggregate supply shocks.

3. Does the identification scheme work?

Several aspects of the above results warrant comment. First, the estimated impulse responses are broadly similar across countries and the size and duration of the estimated effects are plausible. Furthermore, there are no cases in which the estimated impulse responses have the "wrong" sign and are significant. We view these findings as encouraging and as suggesting that the mixture of long and short-run restrictions we use produces plausible estimates of the different shocks.

Second, it is interesting to compare the results discussed above with the results in studies using solely short or long-run restrictions. A common finding in VAR studies that solely use short-run restrictions to identify the monetary policy shocks is that a tightening of monetary policy increases inflation rates temporarily.[13] This finding, which is sometimes referred to as the "price puzzle", is typically rationalised as being due to the central bank raising interest rates in response to expectations of increases in the rate of inflation. For this hypothesis to explain the price puzzle, central banks must react to information that is not included in past inflation and real income growth rates and must systematically and correctly predict changes in inflation rates. Using short and long-run restrictions, however, we find that estimated monetary policy shocks reduce inflationary pressures in all the countries we study. The finding that the price puzzle does not arise when aggregate supply shocks are identified by long-run restrictions suggests that the puzzle is due to the fact that the short-run identifying restrictions alone do not properly discriminate between contractionary aggregate supply shocks and monetary policy shocks.[14]

An alternative method to identify monetary policy is to use solely long-run restrictions. Keating (1992) and Walsh (1993) identify monetary policy shocks by assuming that they have no permanent effects on real GDP, the real interest rate or the real money stock. While this restriction is appealing from a theoretical standpoint, we found that using similar long-run restrictions in the three-variable system estimated above does not allow us to discriminate between monetary policy shocks and temporary demand shocks, which also do not have long-run effects on real output and the real interest rate.[15] While the identification strategy used by Keating (1992) and Walsh (1993) provides plausible results in the United States and Canada, a tightening of monetary policy in the four European countries is associated with a reduction of interest rates. This suggests that the monetary policy innovations are misidentified. Furthermore, in the United States and Canada the results also point to a large undershooting of the interest rate following the initial positive shock. This appears to indicate that the impulse response parameters are the results of an interaction of monetary policy and other temporary demand shocks. These results suggest that using only long-run restrictions to identify monetary policy shocks is hazardous.

4. Historical decompositions

Next we provide estimates of the three structural shocks and ask what role the different shocks played in the sample period. Figures 2.1-2.7 present, in the first row, estimates of the three disturbances in the seven countries. These graphs are quite difficult to interpret since, by construction, the disturbances are serially uncorrelated, orthogonal and have unit variance. To better assess their importance, we decompose the time paths of the nominal short-term interest rate (row 2), the real short-term interest rate (row 3), the output level (row 4), and the consumer price index (row 5) into the parts due to the policy (column 1), aggregate demand (column 2) and aggregate supply shock (column 3).

In interpreting the graphs two points should be kept in mind. First, the purpose of this exercise is to see whether the estimates of the three shocks, and the role the SVAR model attributes to them in different historical episodes, are compatible with the established view of monetary policy events in the countries in question. However, since the decompositions are *point estimates* of the role of the three disturbances in different time periods (and thus subject to uncertainty), one should be careful not to overinterpret the smaller movements in these graphs.

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13 We estimated the same three-variable VAR system (ordering the interest rate last) and used the traditional Choleski-decomposition to impose the short-run restriction that changes in monetary policy have no contemporaneous effects on either output or inflation. In all countries the "price puzzle" appears. See also the discussion in Sims (1992).

14 Another unattractive feature of VARs that solely use short-run restrictions is that the impulse response functions imply that monetary policy does have permanent effects on output (if output is modelled as exhibiting a unit root). Our identification strategy plausibly restricts these effects to be zero in the long run.

15 Following Walsh (1993) and Keating (1992), we modelled the interest rate as being non-stationary (see the mixed evidence on this in Table 1 in the data appendix) and assume that monetary policy shocks can have no long-run effects on real output and the real interest rate. This provides a triangular system of long-run zero restrictions, which can easily be implemented using the Blanchard and Quah (1989) methodology.

Figure 2.1

Canada: Historical decomposition of output, prices and interest rates

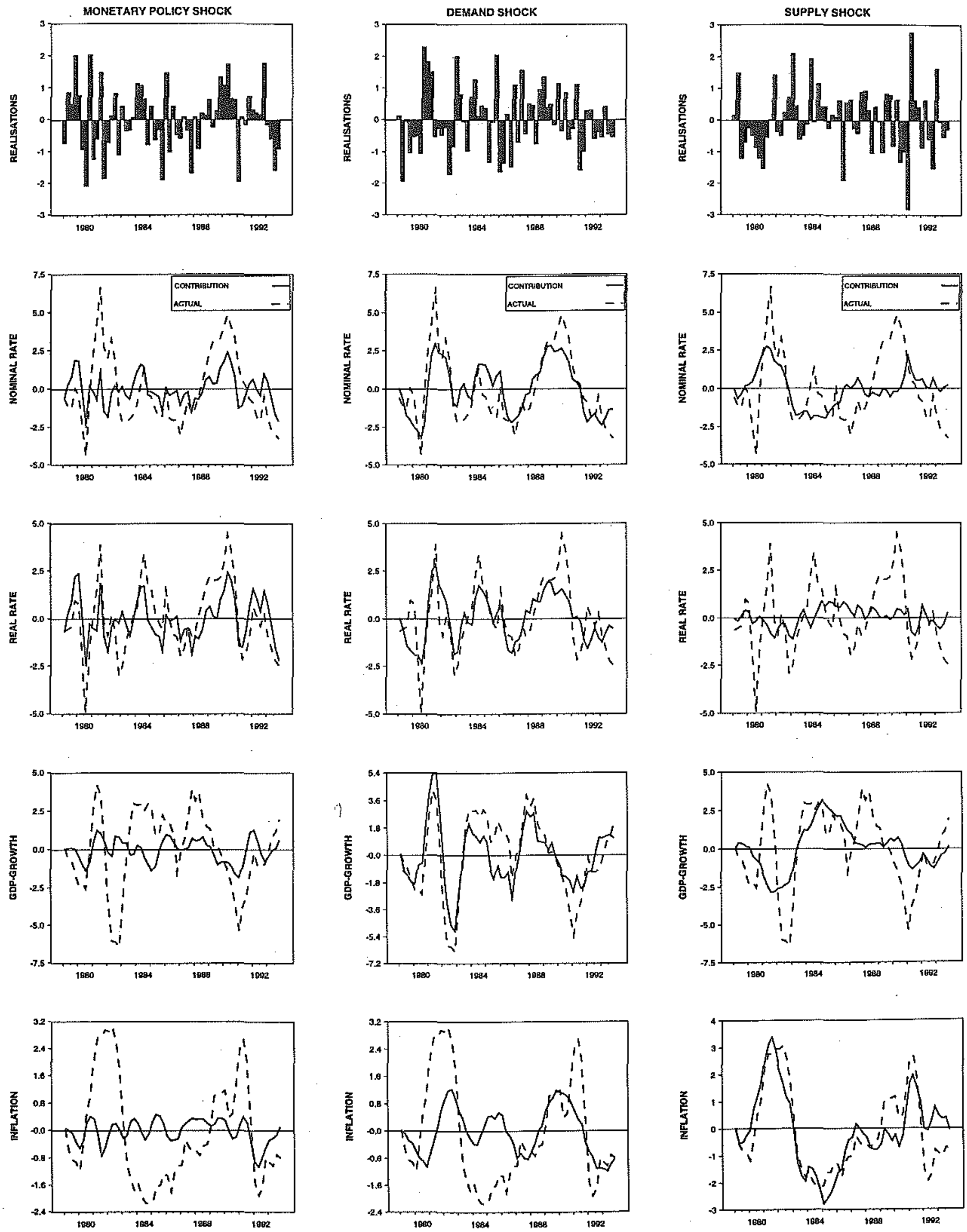


Figure 2.2

France: Historical decomposition of output, prices and interest rates

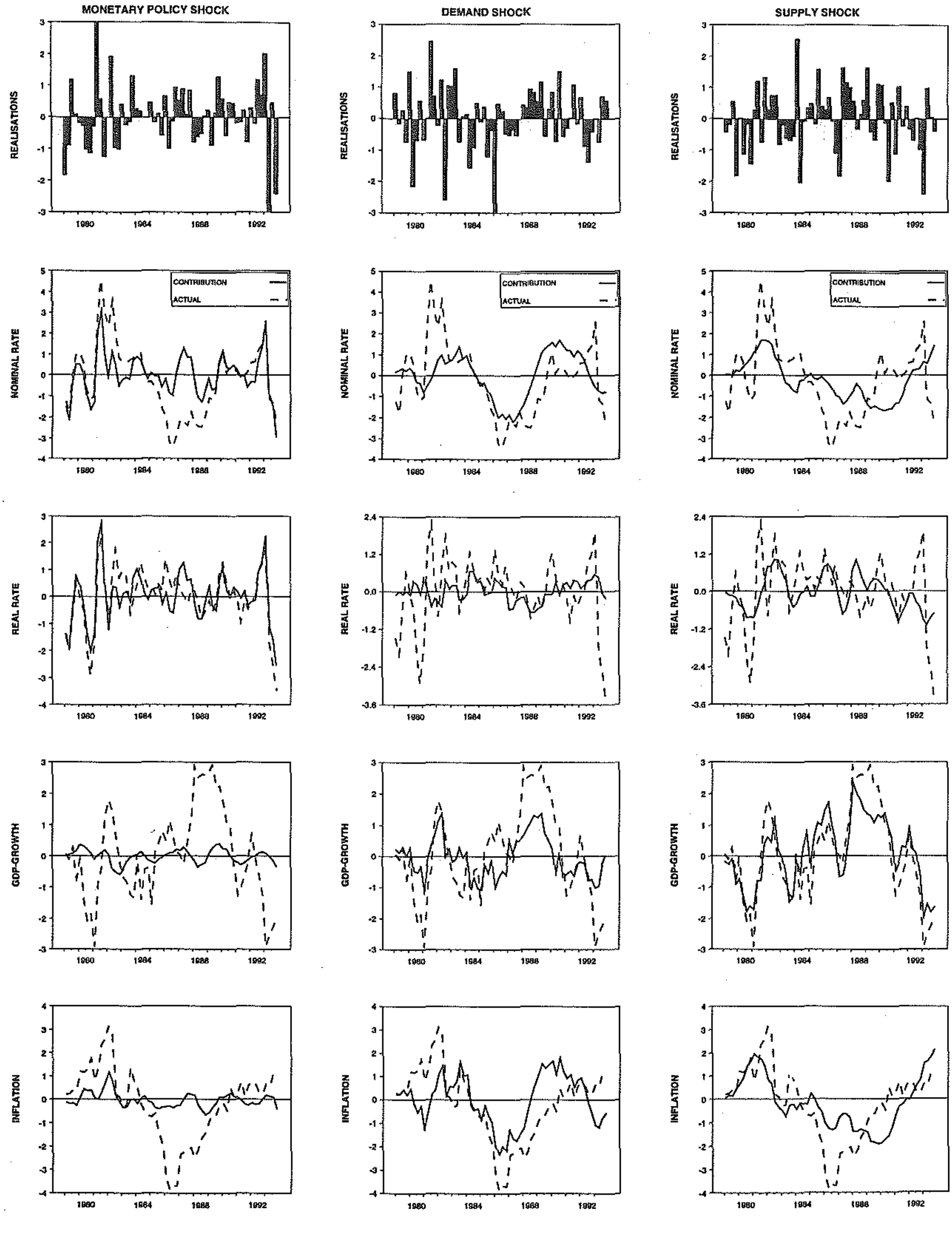


Figure 2.3

Germany: Historical decomposition of output, prices and interest rates

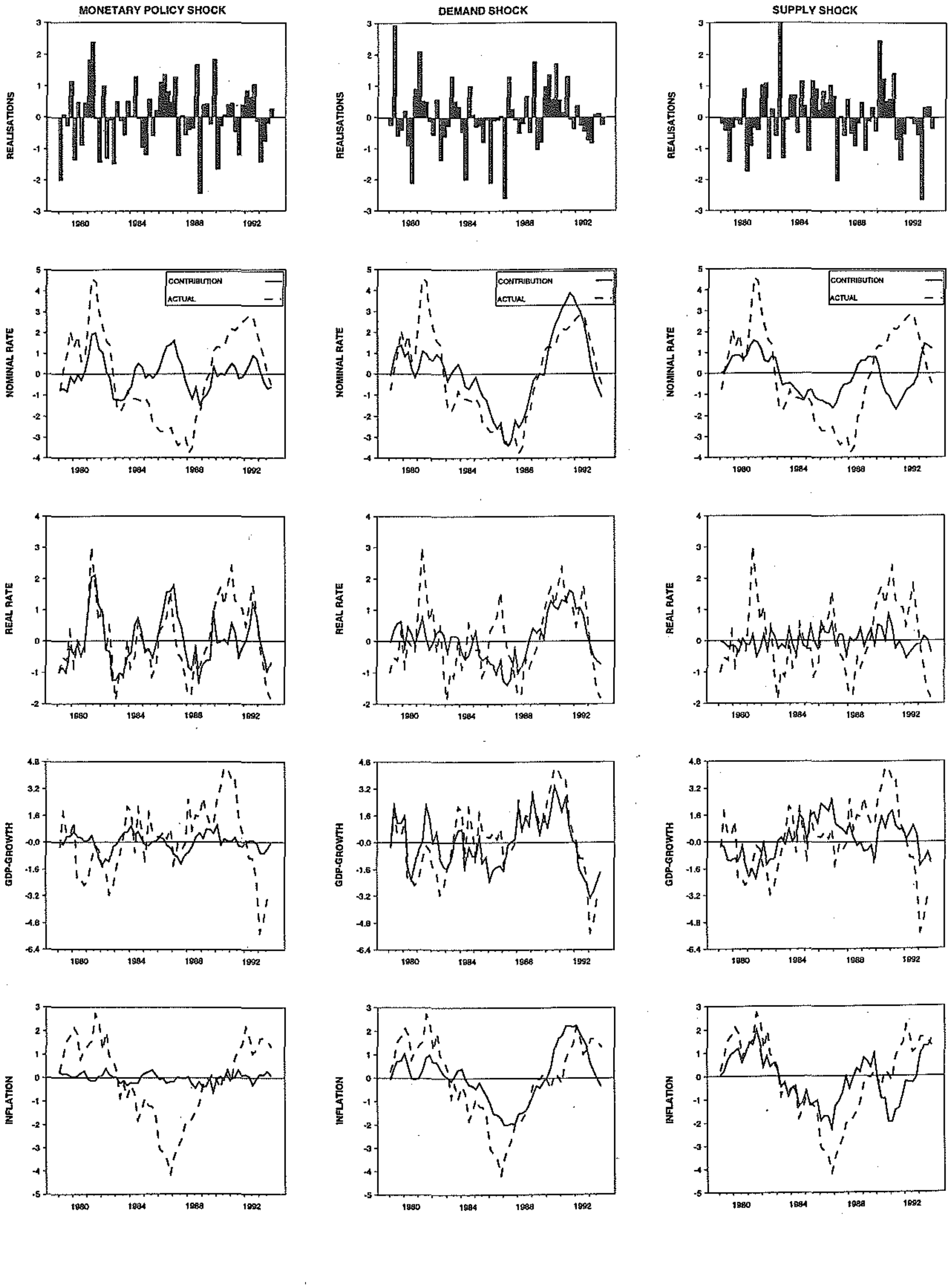


Figure 2.4

Italy: Historical decomposition of output, prices and interest rates

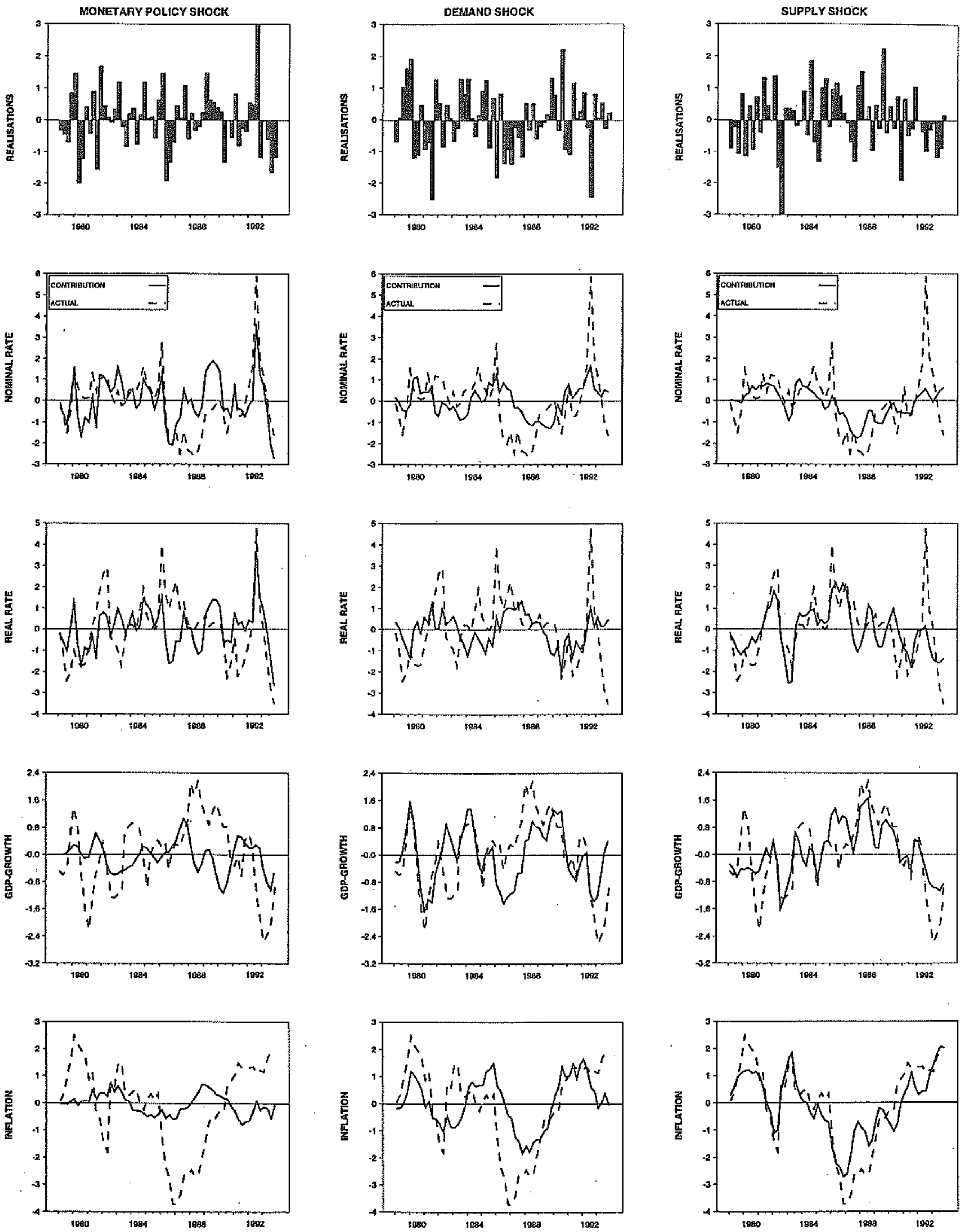


Figure 2.5

Japan: Historical decomposition of output, prices and interest rates

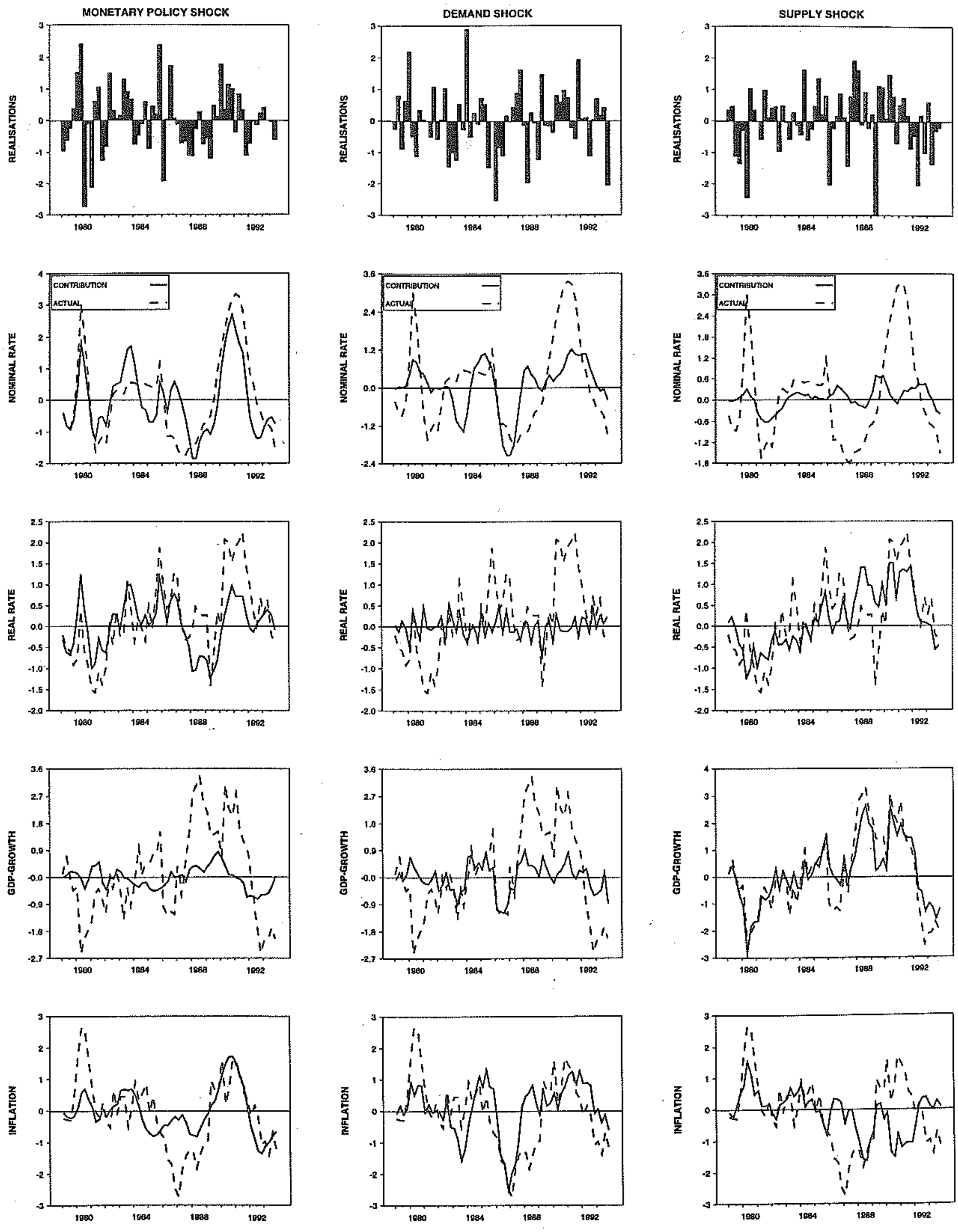


Figure 2.6

United Kingdom: Historical decomposition of output, prices and interest rates

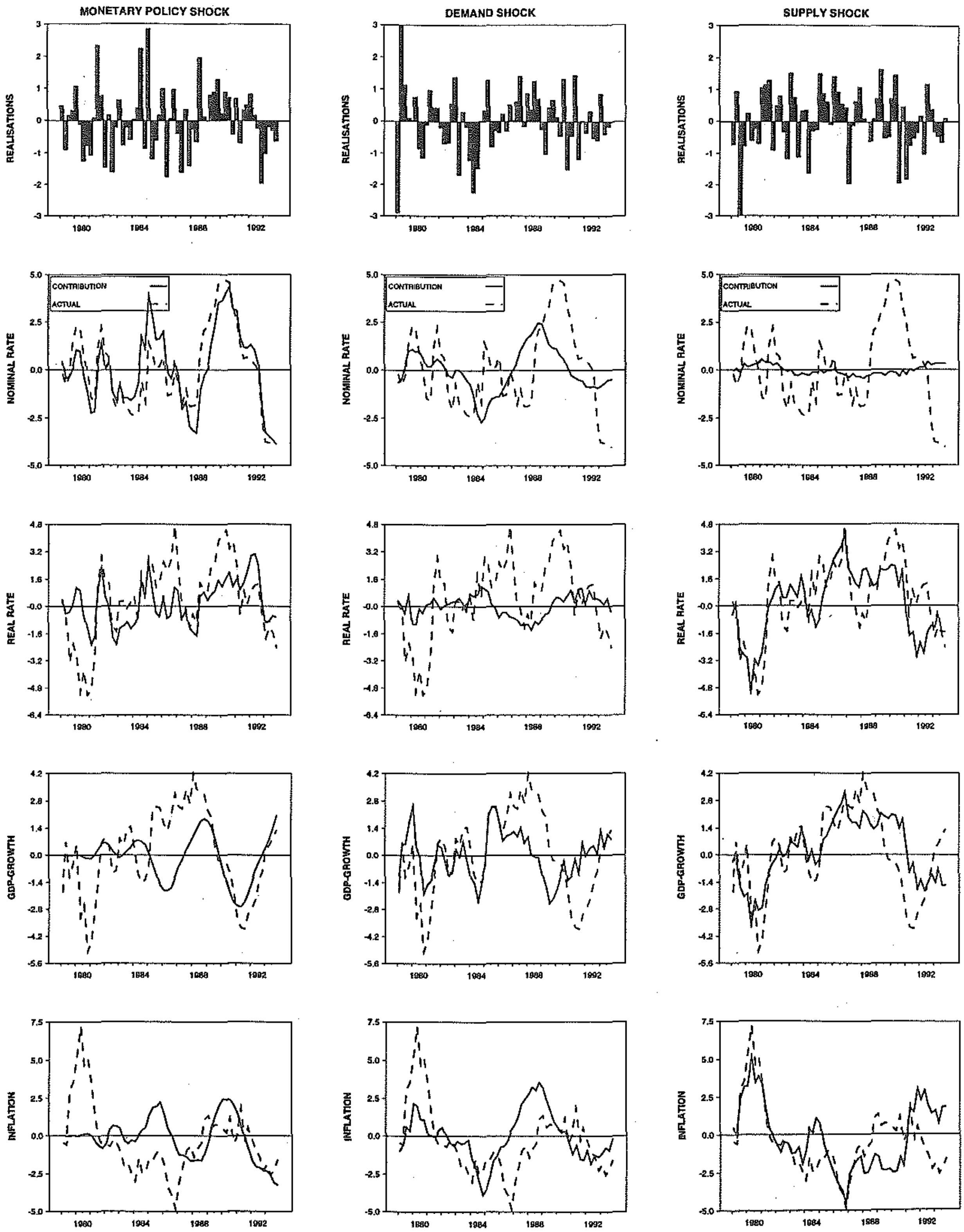
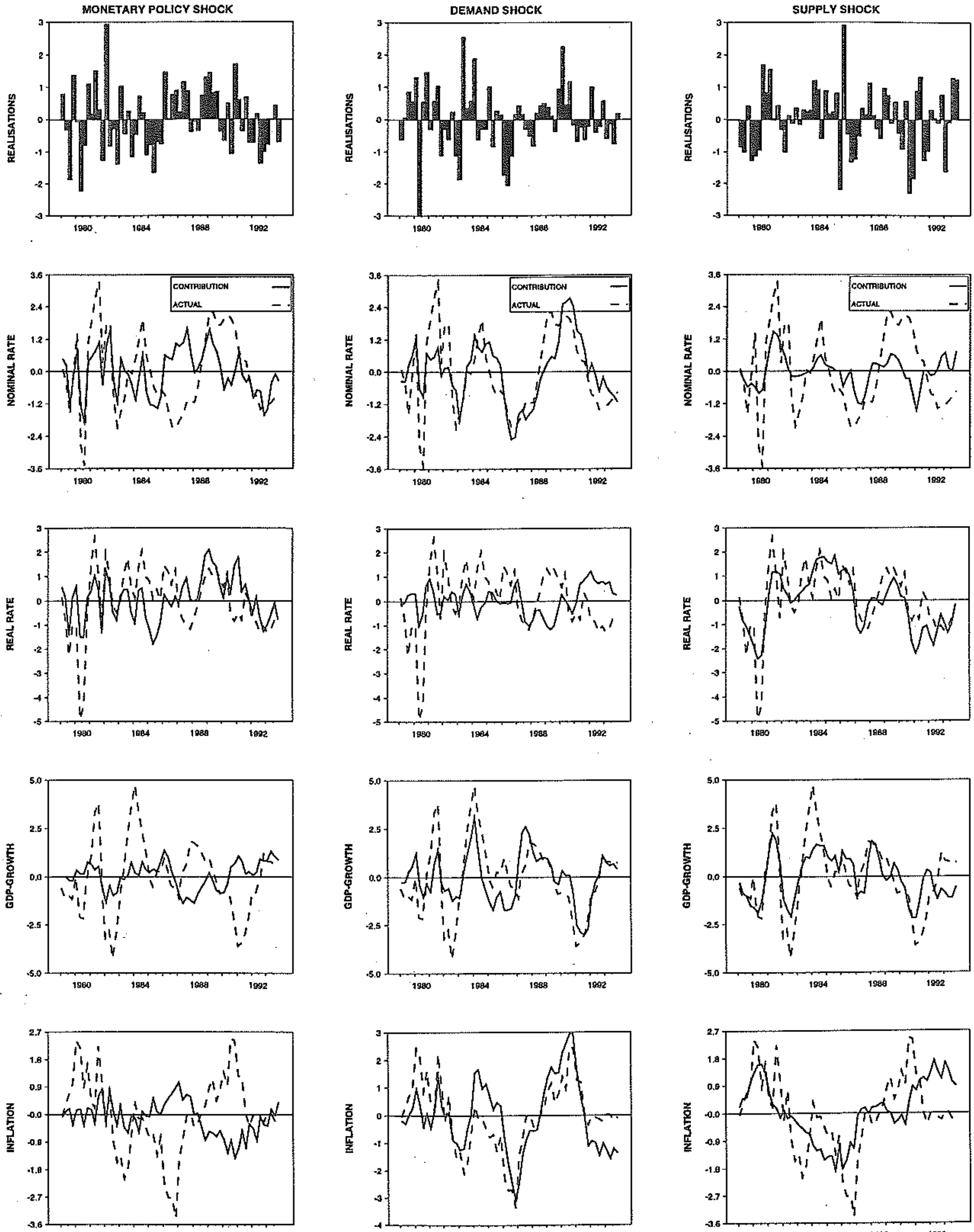


Figure 2.7

United States: Historical decomposition of output, prices and interest rates



Second, the so-called monetary policy shocks may be interpreted as deviations from the "average" response of monetary authorities to the estimated aggregate supply and demand disturbances in the sample period. However, the SVAR techniques do not allow us to identify the central banks' (implicit) reaction functions: the effects of aggregate supply and demand shocks are thus a convolution of their "direct" effect and any "indirect" effect they have by eliciting a tightening or relaxation of monetary policy by the central bank. One implication of this is that the effects and importance of the different disturbances are sensitive to any shifts in the reaction function during the sample period. For example, to the extent that the response of monetary policy to the first and second oil shock differed, as has frequently been argued, including the first oil shock in our sample period would change the estimated impulse response functions to a supply shock. This would in turn change the estimates of monetary policy shocks during the second oil shock.

With these caveats in mind, we next briefly comment on the results for each country. For reasons of space, we focus on business cycle developments since 1985.

Canada

The results for Canada are shown in Figure 2.1. Most of the variation in output since 1987 seems to be due to aggregate demand developments. These aggregate demand movements contributed to a large extent to the rise and decline of nominal and real interest rates and the rise and collapse in inflation since 1988.

However, both monetary policy and supply shocks also play a role during the recent cycle. Striking is that the tax changes in 1991 are attributed to aggregate supply shocks, which lead to a contraction in output and a quite dramatic rise in inflation.

In comparison to the average monetary policy response to economic disturbances during this period, the estimated monetary policy shocks indicate that policy was tightened considerably in 1990, increasing both nominal and real interest rates by about 250 basis points. This seems to have exacerbated the fall in output in 1990 and also contributed to a drop in inflation.

France and Italy

The results for France and Italy are reported in Figures 2.2 and 2.4 and are in many ways very similar. In both countries most of the movements in output and inflation are attributed to longer-run supply developments. Aggregate demand developments also play, however, a role in the recent business cycle and have in France, in particular, contributed to the recent rise and fall in nominal interest rates.

Furthermore, the role of monetary policy innovations in determining output and price movements is limited in France and Italy. The movements in the short-term interest rates over the 1992-93 period, which were caused by monetary policy responses to speculative capital flows, are quite appropriately viewed as discretionary monetary policy by the model, but have especially in France only negligible effects on output and prices.

Germany

Figure 2.3 shows that, as in France and Italy, discretionary shifts in German monetary policy have played only a very limited role in determining recent output and price developments. One notable difference with the results reported for France and Italy, however, is the clear role of aggregate demand movements in accounting for the expansion in 1990 and 1991 and the subsequent contraction in economic activity. The increase in interest rates between 1988 and 1992, and the subsequent relaxation of monetary policy, is viewed as largely due to the response of interest rates to the behaviour of aggregate demand over the period. The results are thus compatible with the view that the Bundesbank tightened monetary conditions in order to reduce the inflationary pressures associated with German unification.

Japan

The results for Japan are provided in Figure 2.5. One surprising feature is that the movements in the nominal interest rate are, to a comparatively large degree, attributed to monetary policy shocks. In particular, the large increase and subsequent decrease in interest rates since 1988 appear only to a modest degree due to central bank responses to aggregate demand shocks, and not at all to supply shocks. Turning to the real interest rates in row 3, it appears that monetary policy was relatively loose during 1987-88 with real interest rates more than 100 basis points below baseline and was subsequently tightened in 1989, leading to positive real interest rates since then. This tightening captures the "bursting of the bubble economy" by the Bank of Japan in 1989. This period of relatively loose monetary policy, followed by a relative tightening, contributed to the recent rise and decline in prices and output. Most of the recent collapse in output is, however, attributed to negative supply developments.

United Kingdom

In Figure 2.6 we provide the results for the United Kingdom. A striking finding is that also in the United Kingdom a very large fraction of the movements in nominal interest rates is due to monetary policy shocks; thus, only a very small part of changes in interest rates can be forecast by past inflation and output.[16] Perhaps even more striking is the finding that the estimates suggest that the monetary policy shocks have played an increasingly important role in accounting for fluctuations in real GDP growth and inflation. In particular, the fluctuation in GDP growth and inflation since 1988 are, according to our estimates, essentially entirely due to the monetary policy shocks.

United States

Finally, in Figure 2.7 we present the estimates for the United States. Turning to the decomposition of real income, we note that aggregate demand shocks have played a critical role in accounting for the recent recession, with aggregate supply developments playing a smaller but reinforcing role. The increase in nominal interest rates between 1986 and 1990, and the subsequent reduction, appear almost entirely due to these aggregate demand shocks, although their effects on the real interest rate are relatively subdued.

Interestingly, the estimated monetary policy shocks suggest that, in comparison with the average response to economic disturbances during this period, monetary policy has followed a pronounced counter-cyclical pattern since 1986: first by raising interest rates relatively early in the upturn, and subsequently by lowering them. In particular, the reduction in real rates between 1989 and 1993 is mainly attributed to a discretionary easing of monetary policy, with slack aggregate demand playing a contributing role. Rows 4 and 5 show that the implied contributions to output and prices offset part of the negative demand and supply developments.

IV. THE EFFECTS OF MONETARY POLICY: SOME SIMULATIONS

In this section we compare the effects of monetary policy across countries. A direct comparison of the impulse responses is made difficult by the fact that a typical monetary policy shock varies in size and duration across countries. For example, in Germany and Japan the typical shock is small in terms of basis points but quite persistent, while in Canada and Italy a typical shock is large but transitory. In order to render the results comparable, we standardise the monetary policy shocks

16 One possible explanation for this finding is that the monetary policy reaction function may have shifted repeatedly over the sample.

by assuming that the central bank raises the nominal short-term interest rate by 100 basis points for eight quarters, after which the interest rate is returned to baseline.[17]

Of course, it is conceptually unappealing to perform simulation experiments by fixing endogenous variables. In this case, however, the increase in the short-term interest rate is of moderate size and only temporary, and it is not grossly at odds with the actual behaviour of interest rates during the estimation period.

In most countries this standardised simulation leads to a new long-run equilibrium, with output returning to baseline and prices converging to a new long-run level.[18] However, in Germany, Japan and to a lesser extent in France, the results display some instability with prices continuing to fall even 20 quarters after the initial increase in interest rates. The reason for this is that, as indicated by the earlier discussion, a typical monetary policy tightening in Germany and Japan is followed by a period of undershooting of the nominal interest rates. This phenomenon, which was also noted to a lesser degree in the other countries, is explained by the fact that nominal interest rates endogenously respond to the fall in prices caused by the initial monetary tightening. Since nominal interest rates tend to fall after the initial monetary policy shock, additional positive (tightening) monetary policy shocks are required to maintain the nominal rate at baseline, even after the initial policy tightening is undone. While in the other countries these additional shocks eventually die out, in the German and Japanese case ever larger policy shocks are needed to maintain the baseline path of the nominal interest rate. This results in output and inflation declining at an increasing rate, while the real interest rate is increasing.[19]

These problems could be alleviated in two ways. We could let the nominal interest rate adjust automatically after fixing the first eight quarters. Depending on how important the endogenous undershooting is, this could then lead to quite different nominal interest rate paths thereafter. Alternatively, we could fix the path of the real interest rate. In panel (b) of Figure 3 we chose the latter solution, as it might be theoretically more appealing to standardise the effect on the real interest rate.

In Figure 3 we compare the results of the standardised monetary policy simulation experiment across countries for both a fixed nominal interest rate path (first column) and a fixed real interest rate path (second column). It should be stressed that the plotted responses are point estimates. Focusing initially on the first column, several comments can be made. As discussed above, forcing the nominal interest rate path to return to baseline results in a prolonged period of high real interest rates and thus tight monetary policy. This is particularly the case in the United States, where prices respond quite vigorously to the monetary policy tightening. As discussed above, it is also the source of the instability in the German and Japanese case, explaining the persistent effects on output and prices towards the end of the simulation period.

In most countries the effect of the monetary tightening on output is quite rapid. The effect on output in Germany, Canada and the United States is quite similar and reaches a peak effect of about 1.5% below baseline after nine quarters. The effects in France and Italy, on the other hand, are also similar, but the peak effect is only half of this. One obvious explanation for the difference is that, as discussed in Section III.4, part of the monetary policy shocks were related to counteracting the effects of speculative capital flows on the nominal exchange rate as both Italy and France were members of the ERM during most of the estimation period. The difference in effectiveness of

17 The actual time path of the short-term nominal interest rate is chosen to facilitate a comparison with the simulation results of the central bank macroeconometric models.

18 This is an implication of our identifying assumption that the long-run Phillips curve is vertical.

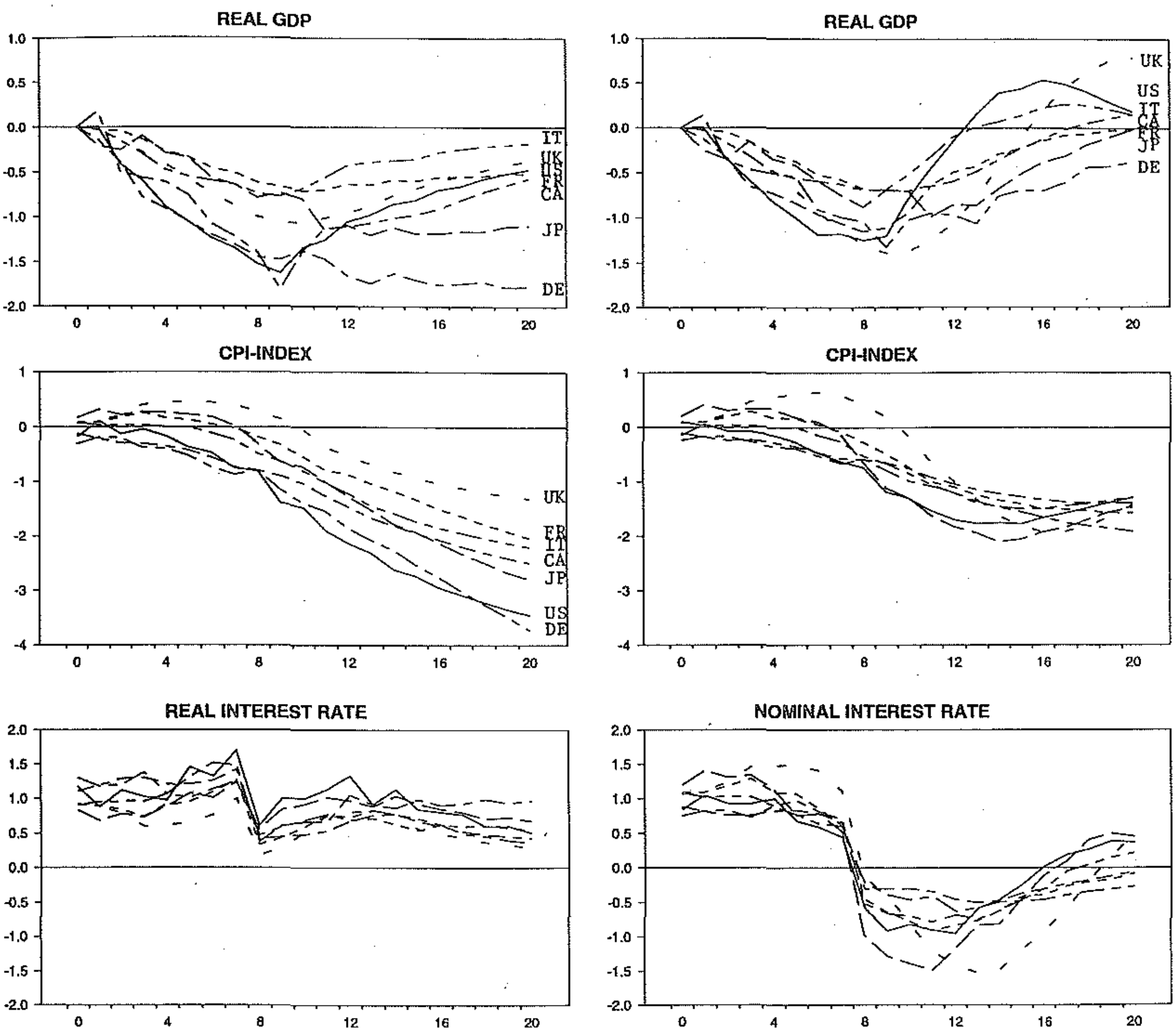
19 It is interesting to note that this is exactly the same problem some of the large-scale macroeconometric models have when they perform this simulation experiment.

Figure 3

The effect of a monetary tightening on output, prices and interest rates: a cross-country comparison

(a) 100 basis points increase in the nominal short-term interest rate during eight quarters

(b) 100 basis points increase in the real short-term interest rate during eight quarters



monetary policy could thus be related to the lack of an exchange rate channel in France and Italy.[20] The effects on output in Japan and the United Kingdom fall in between these two extremes, with the effect of a Japanese monetary tightening being somewhat more persistent than in other countries.

Output in most countries returns back to its baseline level after six to seven years. Exceptions in Figure 3 are Germany, Japan and France, where the policy experiment leads to very prolonged effects on both output and inflation because of the instability problems discussed above.

The second row of Figure 3 shows the effects on the consumer price index. Apart from (mostly insignificant) contemporaneous price jumps, the monetary policy tightening takes some time to affect prices. This is most clearly the case in the United Kingdom, Japan, France, and Italy, where prices only start falling after more than a year. In part this probably reflects the smaller effects on output in these countries. For France and Italy it could again also be explained by the lack of an exchange rate channel. The longer-run effect on the price level is more pronounced in the United States than in most of the other countries. This could, however, be related to the higher real interest rate after eight quarters.

In the second column of Figure 3 we report the effects on output, prices and the nominal interest rate of increasing the real interest rate by 100 basis points during eight quarters. To the extent that it is the real rather than the nominal interest rate that matters more for spending decisions, this simulation may provide a more comparable policy experiment. As can be seen from comparing the first and second columns in Figure 3, the range of outcomes is smaller in this case. Furthermore, the results for output and prices during the first eight quarters are very similar to the results in the first column. The third graph of the second column shows that, after the initial tightening for eight quarters, nominal interest rates undershoot in all countries to account for the declining prices caused by the initial monetary tightening. Nominal interest rates return to baseline, as prices stabilise around their new long-run level towards the end of the simulation period. This undershooting accounts for the somewhat different dynamics of output and prices after the initial shock. The problems of instability in Germany, Japan and France disappear, and in most countries output returns to baseline before the end of the simulation period. One exception is Germany, where the effects of a monetary tightening on output are again more persistent than in the other countries. It is quite striking how similar the effects on prices are in this case.

V. CONCLUSIONS

In this paper we provide some evidence of the monetary policy transmission mechanism in the G-7 countries using a parsimonious macroeconometric model of output, prices and a short-term interest rate. To enhance comparability, we use similar data series, the same sample period and the same econometric methodology for all the countries in the study. In what follows we sum up some of the main conclusions we have drawn from the research underlying this paper.

Although in many respects SVARs are an appealing methodology to use in cross-country analysis, it should be stressed that the estimated effects of monetary policy shocks are in general sensitive to the choice of identifying restrictions. Indeed, what would appear to be small changes in the identifying restrictions can lead to drastic changes in the estimated impulse responses.

Despite this, we are relatively confident that our results capture fundamental relationships in the data for three reasons. First, the results using our proposed identifying scheme are broadly

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20 Preliminary results from estimated models in which we include the exchange rate confirm this hypothesis. In contrast to what one would expect, the exchange rate actually depreciates following a monetary policy tightening in France and Italy. Presumably this undoes some of the negative effects of the policy tightening on output.

stable across countries and over time.[21] Second, they compare quite well with the results from structural macroeconometric models and avoid the so-called "price puzzle" found in many other VAR studies of the transmission mechanism: i.e. the tendency of a monetary policy tightening to, at least temporarily, increase prices. Third, they provide plausible accounts of different historical episodes.

The estimates of the effects of monetary policy provide little evidence of large differences in the transmission mechanism across countries, particularly not when estimated confidence bands are taken into account. We find that over the estimation period the effects of a standardised monetary policy tightening on output and inflation are very similar in Canada, Germany and the United States. The point estimates of the effect on output in France and Italy are somewhat smaller, but may be due to the absence of a significant exchange rate channel in these countries during the estimation period. The effects on output in the United Kingdom and Japan fall somewhere in between. The finding that differences in monetary policy effectiveness across countries are limited does not necessarily imply that there are no such differences, only that they are difficult to document econometrically, at least using VAR techniques.

One of the obvious limitations of using a minimal macroeconometric model is that it is hard to document the channels of monetary policy transmission. One possible extension is to include the exchange rate in the model. This would make it possible to control for differences in the exchange rate channel and would also enable us to identify the effects of exchange market turbulence on the short-term interest rate. We leave this for future research.

21 Except for the United Kingdom, the qualitative results were very similar when we estimated the model over a longer sample period which included the first oil shock.

DATA APPENDIX

Real income is measured by real GDP[22] and prices by the consumer price index,[23] except for the United Kingdom, for which we use real non-oil GDP and the GDP deflator.[24] All series are seasonally adjusted. The selection of the short-term interest rate varies between countries. For Canada, the United Kingdom and the United States we use the yield on three-month Treasury bills.[25] For France, Germany, and Japan we use three-month money market rates.[26] The quarterly data points are averages of the monthly observations.

In order to use long-run identifying restrictions, shocks to the endogenous variables must have long-run effects, i.e. the relevant variables need to be non-stationary. As a preliminary step it is therefore useful to investigate the long-run properties of the data using unit root tests. Table A contains the results from Augmented (with 4 lags) Dickey-Fuller tests on the data, together with critical values from MacKinnon (1991). The power of the tests is likely to be affected adversely by the inclusion of the lagged differences, since some lags are likely to be insignificant.

Note that in many cases we can reject the hypothesis that the *level* of prices is non-stationary when no time trend is included in the tests. When the time trend is included, however, the test statistics typically fall drastically. We interpret this result as being due to the fact that in the early part of the sample the rate of inflation was typically quite high, and then fell gradually to very low levels in the early 1990s. In the absence of a time trend, the secular fall in the inflation rate is interpreted as the price level converging to a constant level; in the presence of the time trend, the fall in inflation is properly interpreted as being secular in nature, and not as evidence that the price level is stationary.[27] Given the low power of ADF tests, we interpret the results as indicating that the rates of inflation and real output growth are stationary around a linear time trend.

Turning to the short-term interest rates, the results indicate that at the 10% level we can reject the unit root hypothesis in France, Germany, Italy and the United Kingdom using at least one of the two tests. Given the low power of the tests, we again conclude that the short-term interest rates are likely to be stationary.

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22 The code in the BIS database is RHGB.

23 The code is VEBA..01, except for Italy, where VEBAIT02 was used.

24 The codes are RUGBGB04 and RNBBGB01.

25 The codes were as follows: Canada, HEPACA01; Italy, HEPAIT02; the United Kingdom, HEPAGB01; the United States: HEPAUS02.

26 The codes were as follows: France, HEEAFR02; Germany, HEEADE02; Japan, HEEAJP02.

27 It is interesting to note that in the case of variables that are likely to be stationary, such as the rate of inflation or real income growth, there is typically little difference between the test statistics with and without a time trend.

Table A

ADF tests for unit roots
1973:1-1993:4

Countries	**Variables**	**Without trend**[1]	**With trend**[2]
Canada	p_t	- 3.16 **	- 0.80
	Δp_t	- 1.46	- 3.23 *
	y_t	- 1.68	- 1.70
	Δy_t	- 3.75 ***	- 4.02 **
	r_t	- 2.21	- 1.87
	Δr_t	- 3.58 ***	- 3.91 **
France	p_t	- 2.61 *	- 0.37
	Δp_t	- 1.06	- 2.68
	y_t	- 1.53	- 2.23
	Δy_t	- 3.46 **	- 3.69 **
	r_t	- 2.75 *	- 2.72
	Δr_t	- 5.15 ***	- 5.25 ***
Germany	p_t	- 1.34	- 2.19
	Δp_t	- 1.88	- 1.81
	y_t	- 0.35	- 3.03
	Δy_t	- 3.52 ***	- 3.51 **
	r_t	- 3.51 ***	- 3.48 **
	Δr_t	- 4.05 ***	- 4.03 **
Italy	p_t	- 3.26 **	0.02
	Δp_t	- 1.69	- 3.63 **
	y_t	- 1.85	- 2.22
	Δy_t	- 4.89 ***	- 5.29 ***
	r_t	- 2.62 *	- 2.42
	Δr_t	- 5.66 ***	- 6.03 ***
Japan	p_t	- 5.35 ***	- 5.15 ***
	Δp_t	- 2.27	- 3.76 **
	y_t	- 0.71	- 3.04
	Δy_t	- 3.60 ***	- 3.64
	r_t	- 1.57	- 2.52
	Δr_t	- 3.44 **	- 3.64 **
United Kingdom	p_t	- 3.26 **	0.01
	Δp_t	- 1.69	- 3.62 *
	y_t	- 0.39	- 2.33
	Δy_t	- 2.21	- 2.20
	r_t	- 2.93 **	- 2.74
	Δr_t	- 4.38 ***	- 4.57 ***
United States	p_t	- 2.88 *	- 1.71
	Δp_t	- 2.20	- 3.40 *
	y_t	- 0.13	- 3.16
	Δy_t	- 3.78 ***	- 3.72 **
	r_t	- 1.70	- 1.88
	Δr_t	- 2.98 **	- 3.10

Note: */**/*** indicates significance at 10/5/1% level.

[1] Critical values: -2.58; -2.90; -3.51. [2] Critical values: -3.25; -3.46; -4.07.

TECHNICAL APPENDIX

This appendix presents the precise form of our estimated equations and reviews how the identifying restrictions are imposed. The estimation strategy follows Shapiro and Watson (1988).

The model consists of three equations: an income equation, a price equation and an interest rate equation. We first estimate the income equation, which is given by (disregarding the constant and trend term):

$$\Delta y_t = \sum_{k=1}^{n} \alpha_k \Delta y_{t-k} + \sum_{k=0}^{n-1} \beta_k \Delta^2 p_{t-k} + \sum_{k=0}^{n-1} \delta_k \Delta r_{t-k} + \varepsilon_t^y \tag{A1}$$

where n denotes the order of the VAR. The results reported in the paper are based on n=5. Since the *change* in the inflation rate and interest rates enters in the equations, the *level* of the inflation rate and interest rates have no permanent effects on the level of income. Thus, the residual is proportional to the aggregate supply shock, ε_t^y. Note also that since contemporaneous prices and interest rates enter, the equation is estimated with instrumental variables, using Δy_{t-j}, Δp_{t-j}, and r_{t-j} $(j = 1,...,n)$ as instruments.

We also estimate, by OLS, the inflation and interest equations, which are given by:

$$\Delta p_t = \sum_{k=1}^{n} \phi_k \Delta y_{t-k} + \sum_{k=1}^{n} \gamma_k \Delta p_{t-k} + \sum_{k=1}^{n} \eta_k r_{t-k} + v_t^p \tag{A2}$$

$$r_t = \sum_{k=1}^{n} \kappa_k \Delta y_{t-k} + \sum_{k=1}^{n} \lambda_k \Delta p_{t-k} + \sum_{k=1}^{n} \mu_k r_{t-k} + v_t^r \tag{A3}$$

These are reduced form equations, in the sense that the errors are correlated with the aggregate supply shock in (A1), and are linear combinations of the structural aggregate demand and monetary policy shocks. Next we disentangle these contemporaneous correlations in the data.

The estimated reduced form errors in v_t are functions of the underlying, unobserved, structural disturbances in ε_t. More precisely, we have that:

$$\begin{bmatrix} v_t^y \\ v_t^p \\ v_t^r \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \times \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^d \\ \varepsilon_t^m \end{bmatrix} \tag{A4}$$

We calculate the a_{ij}'s and the structural shocks using a two-step procedure. We first decompose the regression errors into three orthogonal shocks, which we then normalise to have unit variance.

Since the residual in the first equation, v_t^y, is proportional to the supply shock, ε_t^y, we set $a_{11} = 1$. Since the structural shocks are orthogonal, we can obtain preliminary estimates of a_{21} and a_{31} by running the following regressions:

$$v_t^p = a_{21}\varepsilon_t^y + \xi_t^p \tag{A5}$$

$$v_t^r = a_{31}\varepsilon_t^y + \xi_t^r \tag{A6}$$

ξ_t^p and ξ_t^r are correlated, but, by construction, orthogonal to ε_t^y. To proceed, note that

$$\xi_t^p = a_{22}\varepsilon_t^d + a_{23}\varepsilon_t^m \tag{A7}$$

$$\xi_t^r = a_{32}\varepsilon_t^d + a_{33}\varepsilon_t^m \tag{A8}$$

Our task is to obtain estimates of the variables on the right-hand side of (A7 - A8). Since monetary policy shocks have no contemporaneous effect on the level of income, its effect on the income level through the interest rate ($a_{33}\delta_0$) and on the income level through the price level ($a_{23}\beta_0$) must sum to zero, so that $a_{23} = -a_{33}\delta_0 / \beta_0$. This in turn implies that $\varepsilon_t^d = \dfrac{(\xi_t^d + \delta_0 / \beta_0 \xi_t^r)}{(a_{22} + \delta_0 / \beta_0 a_{32})}$. We therefore set the (non-normalised) demand shock equal to $\xi_t^d + \delta_0 / \beta_0 \xi_t^r$. We can then obtain a preliminary estimate of a_{22} and a_{32} by estimating (A7) and (A8). The residual in (A8) is proportional to the monetary policy shock, so we set $a_{33} = 1$, which in turn gives us an estimate of a_{23}.

The obtained estimates of the a_{ij}'s and the structural shocks are preliminary in the sense that the structural shocks do not have unit variance. The last step of the identification procedure involves normalising the shocks and parameters. Note from (A4) that we have:

$$v_t v_t^T = \Omega = A\varepsilon_t \varepsilon_t^T A^T \tag{A9}$$

whereas in the main text we noted:

$$\Omega = A(0)A(0)^T \tag{6}$$

Thus, we set $A(0) = A\sqrt{\varepsilon_t \varepsilon_t^T}$, which completes the identification.

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Central bank macroeconometric models and the monetary policy transmission mechanism

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I. INTRODUCTION

In this paper we give a brief overview of the results of the central bank model comparison project, which forms part of a wider project conducted at the BIS on the role of financial structure in the monetary policy transmission mechanism. The goal of comparing the central bank macroeconometric models is twofold. First, to the extent that the models are used in policy evaluation and formulation, they are likely to reflect a stylised description of how central banks perceive changes in policy-determined rates affect other interest rates, asset prices and exchange rates and subsequently spending, output and inflation. Second, a comparison of the simulation outcomes of a standardised monetary policy experiment across countries may shed light on differences in the transmission mechanism and the effectiveness of monetary policy and possibly on the role of financial structure in accounting for these differences.

To that end a standardised monetary policy simulation experiment was agreed upon in two preparatory meetings.[1] As the focus was on how policy-determined interest rates affect the economy, it was agreed that each central bank modelling group would simulate the effects of a temporary 100 basis point increase in the policy rate for eight quarters, after which the policy rate would return to baseline. This experiment was to be simulated with both endogenous and exogenous nominal exchange rates. Moreover, in order to be able to interpret the simulated effects on output more easily, it was also agreed that the effects on real GDP would be decomposed both by GDP component and by channel of transmission. Five channels of interest rate transmission were to be reported: (i) an income/cash flow channel, (ii) a wealth channel, (iii) a direct interest rate channel on consumption capturing substitution effects, (iv) a cost-of-capital channel on investment, and (v) an exchange rate channel.[2]

In this summary report we compare the main features of the simulation results reported by each of the participating modelling groups. Details on the country results, and a short description of the central bank macroeconometric model used, can be found in the papers written by each of the participants and collected in this volume. The structure of the paper is as follows. Before discussing the output effects of an increase in the policy-determined interest rate, we first give in Section II a brief overview of how financial structure affects the monetary policy mechanism as it is depicted by most of the central bank models. In Section III we analyse the cross-country differences in output and inflation responses to a standardised monetary policy tightening and compare these for the G-7 countries with the simulation results from the Multi-country Model (MCM) of the Federal Reserve and from a simple three-variable SVAR model.[3] The latter simulations have the advantage that they use one methodology to estimate the policy effects in different countries, thus eliminating the complications of cross-country comparisons when different methodologies are used. We conclude

1 These meetings were held on 8th-9th June and 7th-8th September 1994 at the BIS. The summary of points of agreement regarding the policy simulations can be found in the Appendix.

2 The label "direct interest rate effect on consumption" was preferred over the label "substitution effect" because, in the models that cannot identify wealth or income effects on consumption, this channel will include these effects. This is, of course, also true for the cost-of-capital channel.

3 These simulation results are reported in Tryon (1995) and Gerlach and Smets (1995).

that although the central bank models suggest quite substantial cross-country differences in the output effects, these differences are less obvious when the same methodology is used. In Section IV we then make an attempt to explain the cross-country differences by analysing the decomposition results by transmission channel. From this analysis it follows that most of the cross-country differences are due to the cost-of-capital channel. Finally, in Section V we draw some conclusions.

II. FINANCIAL STRUCTURE AND CENTRAL BANK MACROECONOMETRIC MODELS

In most of the central banks' macroeconometric models the transmission mechanism of monetary policy is modelled as an interest rate transmission process. The central bank sets the short-term interest rate, which influences interest rates over the whole maturity spectrum, other asset prices and the exchange rate. These changes in financial variables then affect output and prices through the different spending components.[4]

The role of money is in most cases a passive one, in the sense that money is demand determined.[5] An explicit banking sector is in general absent from these models and only rarely do balance-sheet items of households or the corporate sector explicitly enter in the spending equations.[6] This implies that the role of financial structure can only indirectly be assessed. Within the framework of the interest rate transmission mechanism discussed above, the structure of financial markets plays a double role. First, financial structure and the balance-sheet positions of the different sectors determine which interest rates or asset prices are modelled and how sensitive spending is with respect to these rates. Second, the structure of balance-sheet positions also determines the importance of income and cash-flow effects. The rest of this section deals primarily with the first issue. For a discussion of the second issue we refer the reader to Section IV.2, where the income/cash-flow channel as identified in the macroeconometric models is analysed.

The structure of financial markets and the balance-sheet positions of the different sectors determine which interest rates are modelled. It is quite striking that only the continental European countries and Japan model lending and deposit rates and make an effort to model the behaviour of financial institutions (see e.g. entry 4 in Table I). This undoubtedly reflects the larger importance of bank lending in these countries and until recently the absence of securities markets as an alternative source of finance for non-financial firms and households. This is by itself, of course, no evidence for the existence of a separate bank credit channel in these countries.[7] In most countries lending rates respond quite vigorously to the corresponding short or long market rate and there seems to be little evidence that spreads between market rates and lending rates widen systematically in response to a monetary tightening. For example, Nicoletti Altimari et al. (1994) suggest that in the BIQM model of the Banca d'Italia rates set by financial institutions respond as quickly to the short-term rate as long-term bond yields and that this response is faster since the deregulation of the money market. Possible exceptions are the Banque de France model, in which the spread between the lending rate and the

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4 In most central bank models the effect of the short-term interest rate on other interest rates, asset prices and exchange rates is modelled through relatively simple term structure and arbitrage equations. A more elaborate determination of bond, stock and house prices and interest rates set by financial institutions can be found in the Quarterly Model of the National Bank of Belgium.

5 Exceptions are the Bundesbank model, where the real money stock is used to calculate a so-called price gap, which is a proxy for inflation expectations, and the MTF (Bank of England), MOISEES (Bank of Spain) and Austrian central bank models, which incorporate real money balances as a wealth variable in some of the spending functions.

6 One exception is, for example, the Banque de France model, in which credit variables enter consumption and housing investment equations. These variables may capture both changes in interest rates (and their substitution effects) and a direct credit impact on household demand. See Cordier and Ricart (1995).

7 For a more systematic comparison of the response of bank loans and money to monetary policy changes in the United States, Germany, Japan and the United Kingdom, see Tsatsaronis (1995).

market rate explicitly depends on the debt ratio of the corporate sector, the model of the National Bank of Belgium, in which the bank lending rate appears to respond quite sluggishly, and the model of the Swiss National Bank, in which the interest rate spread between a short-term market rate and the variable rate charged on new mortgage-backed loans enters the spending equation. On the other hand, in those models that determine bank deposit rates there is some evidence that these respond more sluggishly to changes in the market rates.

Of more importance is probably whether the different spending components respond to short or long rates. To the extent that long-term rates respond only partially to a temporary short-term interest rate increase, a larger dependence on long-term rates will *ceteris paribus* reduce the effects of a monetary tightening on output. The importance of changes in long versus short rates is nicely illustrated by a sensitivity analysis in Boeschoten and Van Els (1995). In the Dutch central bank model (MORKMON II) most of the spending decisions taken by the different sectors in the economy depend on long rates. As the temporary increase in the short-term interest rate increases long rates by only 0.2 %, the effects on spending are expected to be small. Boeschoten and Van Els find indeed that a 100 basis point rise in the short rate that does not affect long rates has almost no real effects, while the same rise in long rates causes output to fall by 0.5%, much larger than the currently estimated effect.

The importance of short versus long rates varies quite substantially across models and spending components. In the MPS model of the Federal Reserve most of the investment spending components depend on longer-term rates. Similarly, in the Bank of Japan Macroeconometric Model (BOJMOD) the important interest rates are either the long-term bond yield, which determines the exchange rate and stock prices, or the long-term bank lending rate, which determines residential and non-residential investment. As mentioned before, Japanese long-term bond yields and lending rates respond almost identically to the increase in the short rate. In the Bundesbank model short-term interest rates on savings and time deposits affect households' savings decisions, while long-term interest rates are of more importance for the investment decisions of enterprises. In the model of the Banque de France, consumption does not depend directly on interest rates, but does depend on mostly short-term credit. Residential construction, on the other hand, does depend on the real long-term interest rate. The dynamics of other private investment responds to changes in the lending rate, which itself depends on the short-term market rate and a risk premium. Also in the BIQM model investment responds most vigorously to short-term rates. In the Belgian model both short and long rates enter the cost of capital of investment, although housing investment responds primarily to long-term rates. In the Austrian model the bank lending rate plays an important role.

Two models in which the spending components depend almost exclusively on short-term interest rates are the QPM model of the Bank of Canada and the MTF model of the Bank of England. Not surprisingly, these models also happen to produce large and rapid effects on aggregate demand, as will be discussed in the next section. In the current version of the QPM model, investment is not modelled as depending on the cost of capital, while consumption (broadly defined to include inventories and residential construction) is very responsive to the slope of the yield curve (i.e. the difference between the 90-day commercial paper rate and the ten-year and over bond yield).[8] As discussed in Longworth and Poloz (1995), this reflects the fact that almost all household liabilities bore interest rates with maturities of five years and less. Most of the debt of non-financial firms is at longer maturities, but it appears very hard to find any significant interest rate effects on private investment.[9]

This brief overview of which interest rates matter in the various models indicates that central bank models do reflect differences in financial structure across countries. In the next two

8 The capital stock does depend on the long-run cost of capital which, however, does not vary with a temporary change in the short-term interest rate.

9 The effects of temporary changes in the cost of capital, which were incorporated in earlier versions of QPM, have been turned off in the current production version of the model, pending the completion of new research on this issue.

sections we discuss the output and inflation effects of a monetary tightening and find out whether one can relate differences in monetary policy effectiveness to variations in financial structure.

III. OUTPUT AND PRICE RESPONSES TO A STANDARDISED MONETARY POLICY TIGHTENING

In this section we analyse the macroeconomic effects on output and prices of the agreed standardised monetary policy tightening, and compare the results from the central bank models with simulation results from the Multi-country Model (MCM) of the Federal Reserve and a simple SVAR model.

Graph 1 depicts the response of real GDP to the temporary interest rate increase. As the simulation experiment was designed to focus on the short to medium-term effects of monetary policy, we plot only the first five years and focus in particular on the effects in the second and third years of the simulation period. This time span corresponds more or less to the lags one usually considers to be important when looking at the effects of monetary policy changes. As can be seen in the graph, already in the fourth and fifth years of the simulation the size and dynamics of output may differ very strongly across models. This reflects different methodologies on how and whether to incorporate long-run constraints on the economy and problems of instability which can arise when trying to peg the nominal interest rate path. The latter is in particular a problem in the MPS model of the Federal Reserve, in which shocks to inflation, in this case a price decrease, are very persistent and lead to persistently high real interest rates, as explained in Mauskopf (1995). The sizable overshooting of output over baseline in the results for Canada occurs as the monetary policy reaction function is allowed to work to move inflation up to its target level after it was driven substantially below it in the two years when short-term nominal interest rates were set 100 basis points above control.[10]

Although a full standardisation of the experiments has not been achieved in many respects, the simulation results of the central bank models point to some clear differences between the output effects of a temporary interest rate increase, in continental European countries on the one hand, and the Anglo-Saxon countries and Japan on the other. In the United States, Japan and Canada the peak effects on output within three years are more than 100 basis points below baseline, while in the United Kingdom the peak effect is about 90 basis points. In continental European countries the peak effects on output are less than 50 basis points below baseline.[11]

Of course, the economies considered in this project differ substantially in their degree of openness. This can influence the effectiveness of unilateral monetary policy moves in two ways. First, monetary policy may be more effective in more open economies through the exchange rate channel. The importance of this channel, however, critically depends on the degree and speed of exchange rate pass-through into domestic prices. Graph 4 shows that the differences between continental European and the other countries remain clear when the nominal exchange rate is kept at baseline. Second, a unilateral tightening will be less effective in more open economies to the extent that a contraction of domestic demand leaks into lower imports. In other words, the more open the economy, the smaller the multiplier effects. The effect of different propensities to import can partially be neutralised by looking at the response of domestic demand. Table IV.1 includes a column with the contribution of domestic demand to the total change in GDP. From this it can be seen that for the first two years, in particular, the differences between France, Germany and Italy and the United States and Japan become

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10 For the rationale behind this experiment, see Hunt, O'Reilly and Tetlow (1995)

11 The simulation results reported in the graphs refer to the policy experiment with endogenous exchange rates. For the BIQM model (Banca d'Italia) we report the simulation results with fixed bilateral exchange rates in the ERM to increase the comparability with the results for the other ERM countries (see Nicoletti Altimari et al. (1995)). For the QPM model (Bank of Canada) we plot the simulation results of the third scenario; i.e. an interest rate increase in a regime of inflation targeting from an initial steady-state equilibrium (see Hunt et al. (1995)).

less important, whereas the response of domestic demand in the United Kingdom is larger than in Canada, Japan and the United States. With the exception of Switzerland, the effects in the smaller European countries remain even then rather limited.[12]

A distinction between continental European and Anglo-Saxon countries is also evident in the simulated price responses. Graph 2 plots the effects of the temporary monetary tightening on the GDP deflator, whereas Graph 3 combines output and inflation responses in a Phillips-curve diagram. The case of the United States is again hard to compare with the other simulation results because of the instability of the policy experiment in the MPS model. In contrast with the continental European countries, where the price effects are quite small, in the MTF and QPM models the GDP deflator falls by about 3 to 4% below its baseline value. Japan is an exception in this picture in the sense that the disinflation following the experiment is comparable with the European results whereas the output effects are comparable with the Anglo-Saxon results. This suggests a higher effectiveness of monetary policy on output, or from another perspective a higher output cost of bringing down inflation. The output-inflation trade-off in France, Germany and Italy is very similar, suggesting a similar cost of disinflating. The importance of openness for the inflation-output trade-off is also obvious from comparing the simulation results for Belgium and the Netherlands in Graph 3 with the ones for France, Germany and Italy. A higher share of imports in total output increases the importance of the direct exchange rate channel on inflation through import prices and reduces the effects on output because of higher leakage. The initial perverse effect of a monetary tightening on inflation in the MTF model of the Bank of England is mainly due to the increase in mortgage payments which feeds into the retail price index.

Much of the discussion that follows will try to explain the differences and similarities in output effects using the decomposition results. However, before doing so two other observations must be made. First, it is a well-known conclusion from various national model-comparison projects that differences in modelling methodologies may to a large extent influence the simulation results of a standardised experiment in a given country. The use of different central bank models to compare simulation results across countries will clearly be subject to the same caveat. This may make one of the goals of the exercise, i.e. to spot differences in the monetary policy transmission mechanism due to underlying differences in economic and financial structure, much more difficult to achieve. It is, for example, widely known that the way in which expectations are modelled will significantly impact the speed with which other interest rates, exchange rates, and asset prices respond to changes in the policy rates. The extent to which the results are dependent on the choice of modelling methodology becomes apparent in the comparison of the two cross-country studies (the MCM model and the SVAR analysis) with the national model results (see Graph 1). The use of forward-looking expectations in the term structure and interest rate parity equations of the MCM model forces long-term interest rates and exchange rates to overshoot and then fall back to baseline in response to the temporary increase in the short rate. This brings forward the effects on spending, output and inflation in each of the G-7 countries.

Second, the results from the MCM and SVAR simulations appear to suggest that, if one applies similar methodologies across the G-7 countries, the differences in the output and inflation effects of a monetary tightening become less clear (Graph 1). The SVAR results show, for example, that the effects on output in Germany are very similar to the effects in the United States and Canada, while the smaller effects in France and Italy may be due to the absence of an exchange rate channel during the estimation period (1979-93). Similarly, the output and price effects in the MCM model are almost identical in the United States, Japan, Germany, France and Canada. The larger effect in theUnited Kingdom and the smaller effect in Italy can to a large extent be accounted for by differences in the net asset position of the private sector and the implied income/cash flow channel.[13]

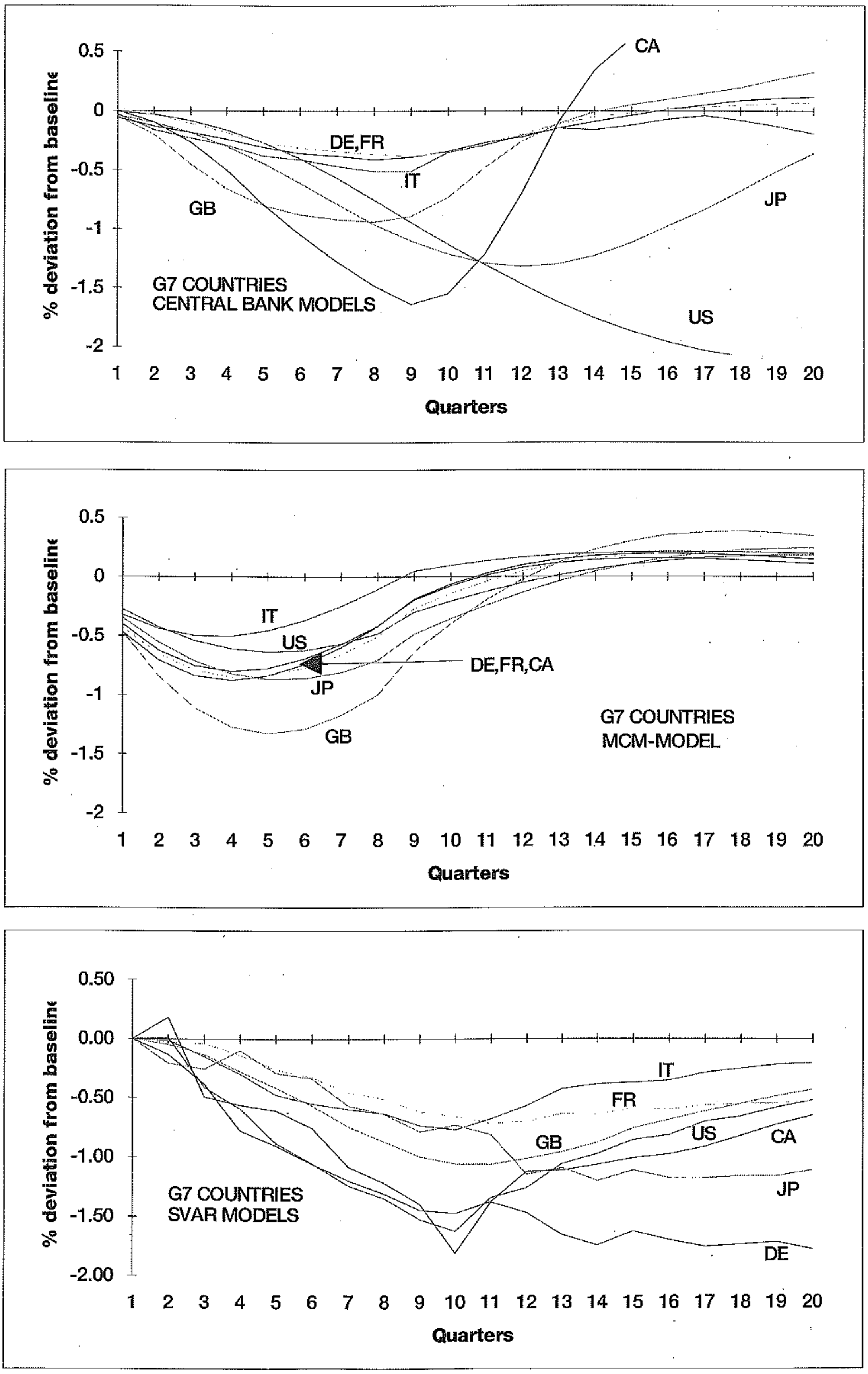
12 To the extent that multiplier effects become more important over time, they can also explain the more persistent effects in Japan and the United States in the third year and beyond.

13 See Section IV.2.

Graph 1

Real GDP responses to a 100 basis point increase in policy-determined interest rates during eight quarters

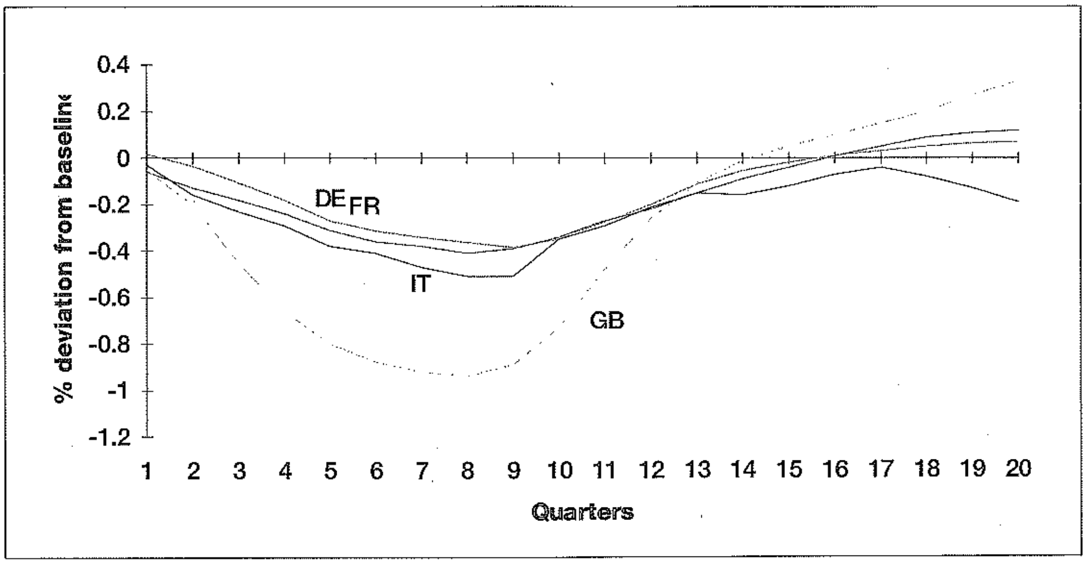
(G-7 countries)

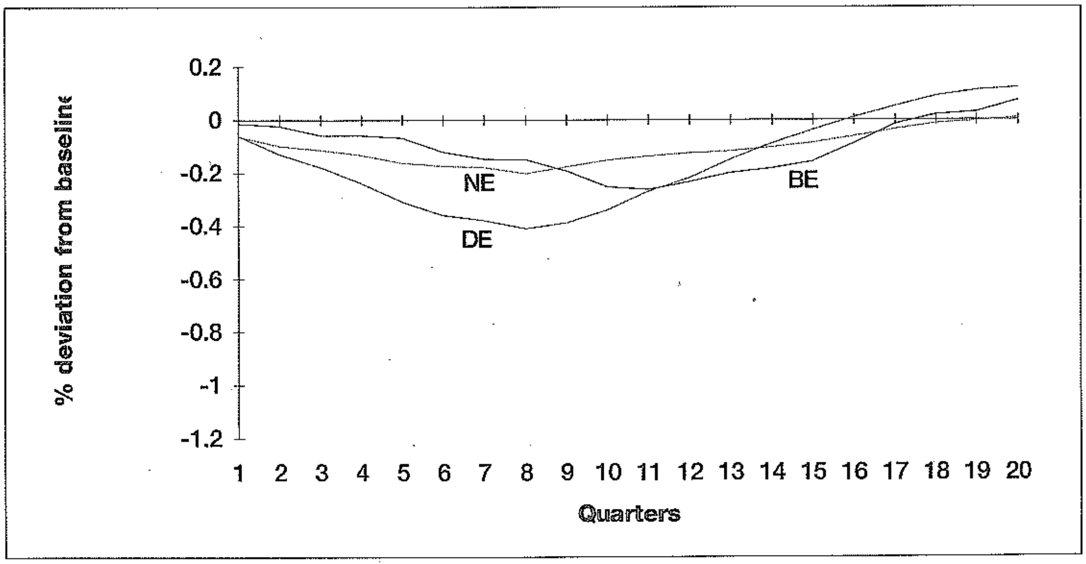


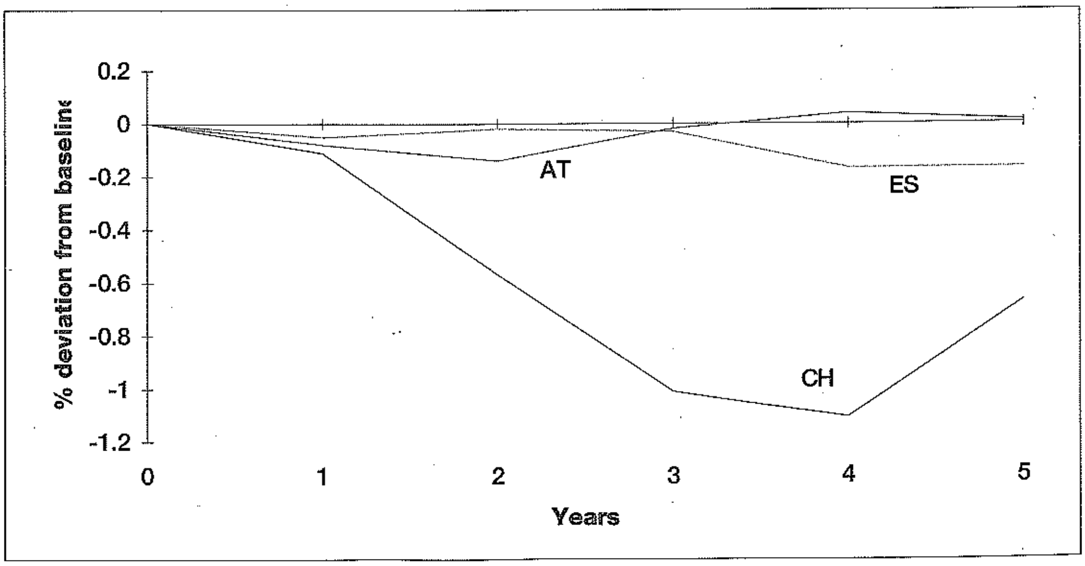
Graph 1 (cont.)

Real GDP responses to a 100 basis point increase in policy-determined interest rates during eight quarters

(selected European countries (central bank models))



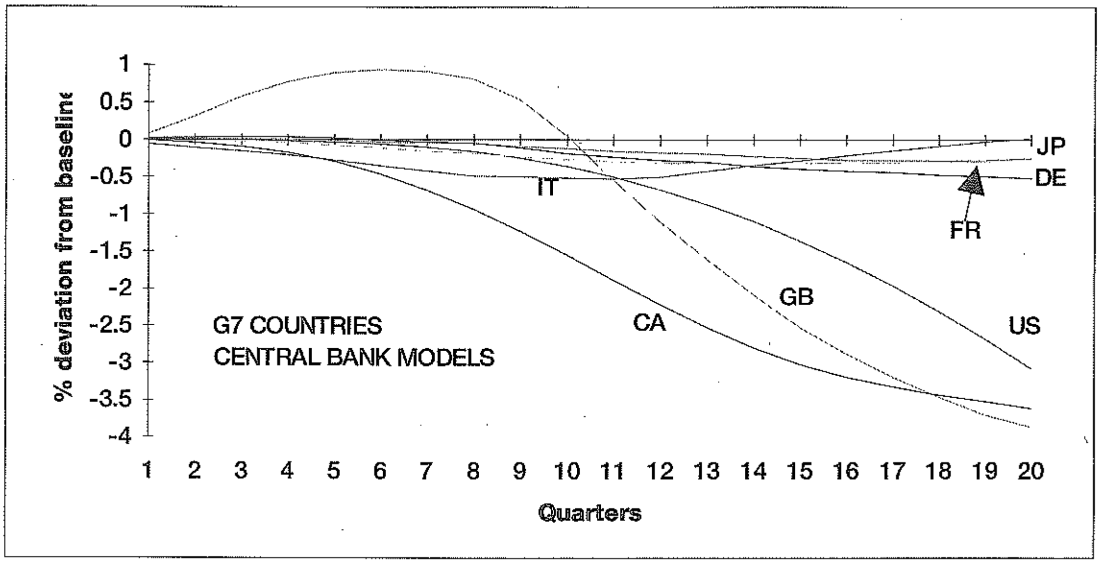


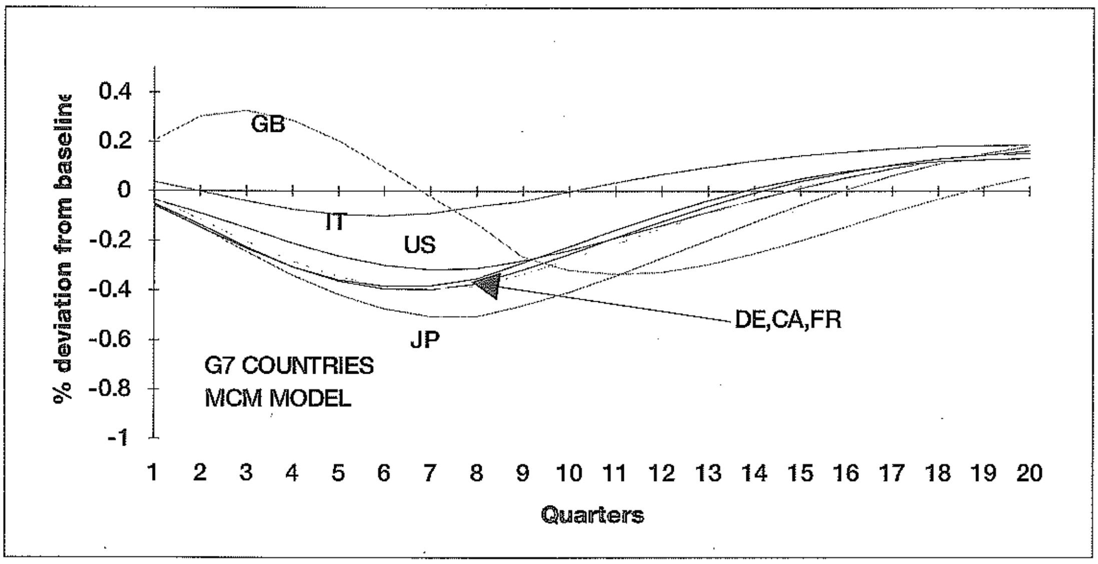


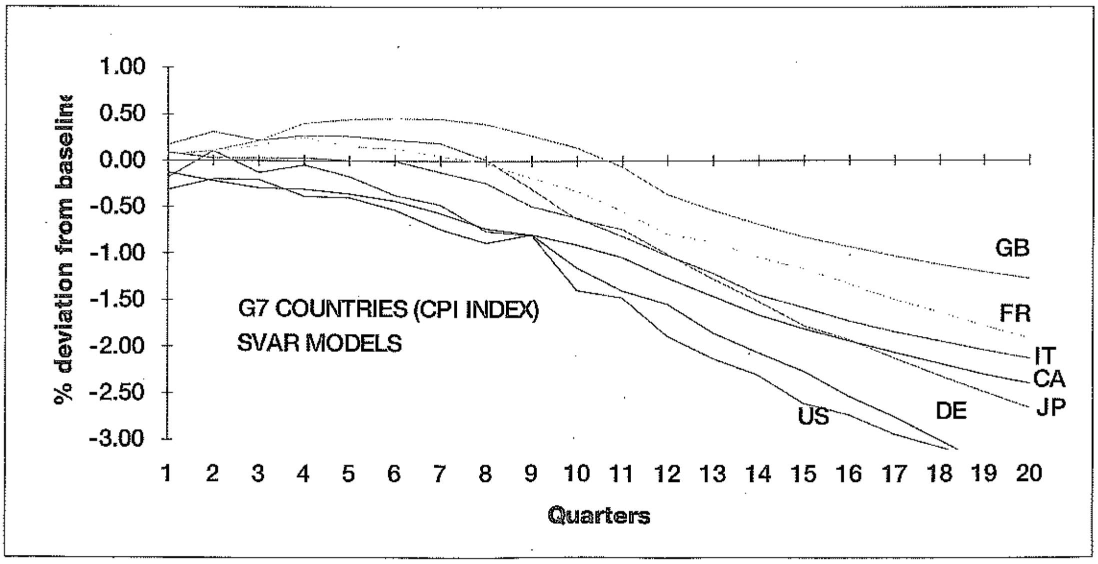
Graph 2

Responses of the GDP deflator to a 100 basis point increase in policy-determined interest rates during eight quarters

(G-7 countries (various models))



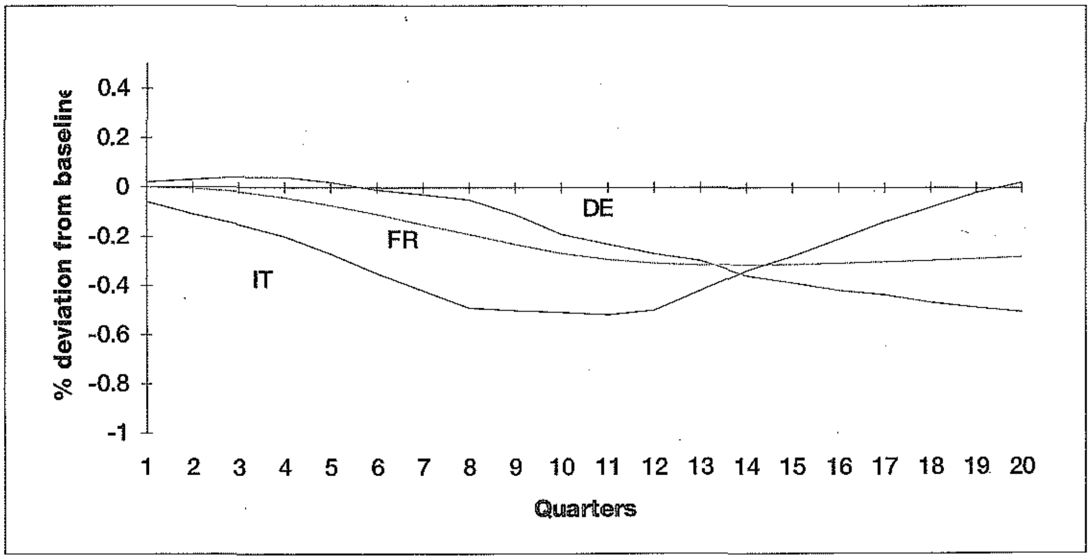


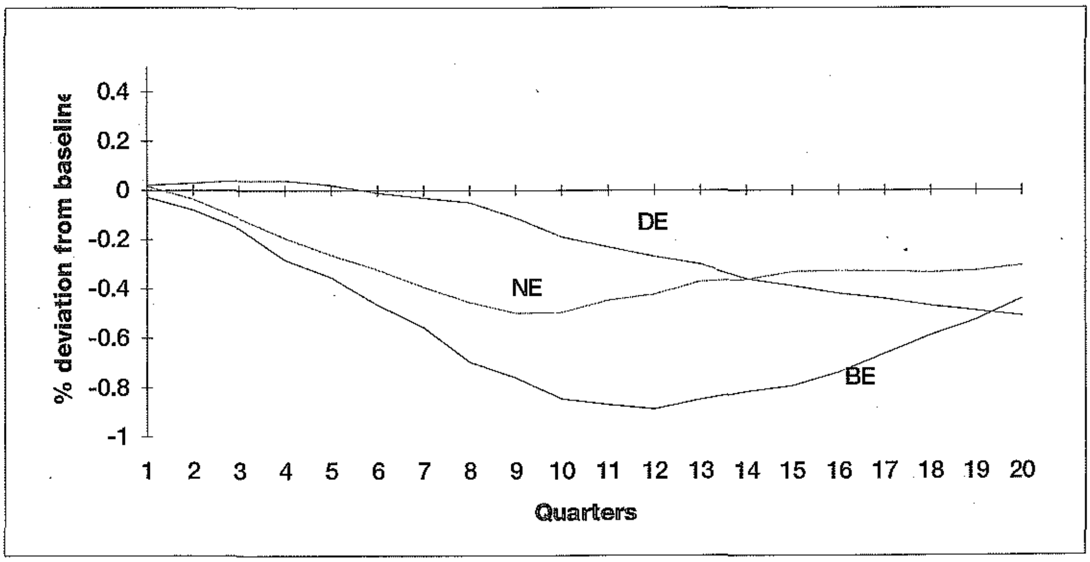


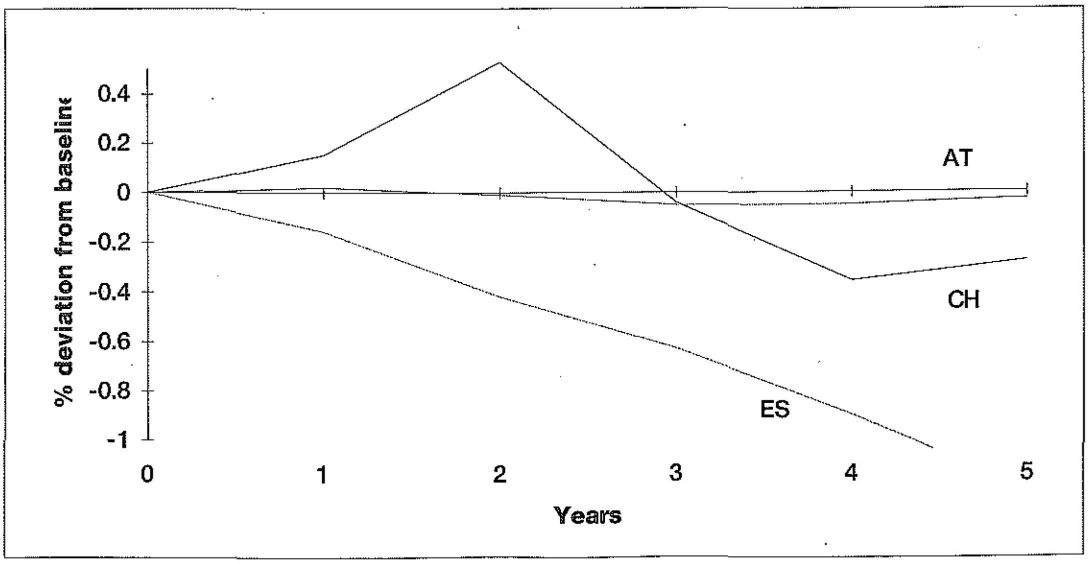
Graph 2 (cont.)

Responses of the GDP deflator to a 100 basis point increase in policy-determined interest rates during eight quarters

(selected European countries (central bank models))







The lack of clear differences in the effectiveness of monetary policy actions in the MCM and SVAR models suggests that the observed differences in the central bank simulations might be attributed to some extent to differences in modelling strategies. Still, the choice of a particular modelling framework by the staff of a central bank almost certainly reflects their view on how monetary policy changes are transmitted to the economy.[14] Moreover, central bank models are typically much richer in structure and allow us to better study idiosyncratic features of the economy in question. In this context it remains interesting to compare the simulation results of the central bank models and to try to understand what channels drive the differences in simulation results. This is done in the next section.

IV. CHANNELS OF MONETARY POLICY TRANSMISSION

Tables III.1 and IV.1 give a cross-country overview of the contribution to real GDP of the channels of monetary policy transmission as identified in the central bank macroeconometric models. In Tables III.2 and IV.2 the same decomposition exercise is reported for the G-7 countries using the MCM model.[15] At the preparatory meetings it was agreed that five channels would be reported: the income/cash-flow channel, the wealth channel, a direct interest rate effect on consumption, a cost-of-capital channel and an exchange rate channel. In this section we discuss the definition of these channels and their role in explaining the cross-country differences identified in Section III.

Although an effort has been made to standardise as much as possible the definition of the channels and the method of identifying their contribution, important differences in interpretation remain. Caution is thus advised when drawing conclusions from any differences in the relative importance of these channels across countries. In particular the decomposition results reported in Hunt et al. (1995) and Dhar et al. (1995) are not comparable with the other results. Both models are more aggregated than most of the other central bank models and the methodology used in the QPM model is quite different from the other models. This makes the identification of the exact same channels as the ones proposed at the BIS meetings very hard.

The core model in MTF, for example, does not distinguish between the different components of domestic demand (although inventories are modelled separately). As a result substitution effects on consumption cannot be distinguished from cost-of-capital effects on investment and, similarly, substitution effects on spending can not be distinguished from income or wealth effects. Furthermore, as is described in the paper by Dhar et al. (1995), it is not clear what is the interpretation of the reported "wealth channel". It primarily comes from a significant effect of real money balances in the domestic demand equation. A higher interest rate makes people hold less real money balances, which in turn reduces domestic demand. While real money balances were originally put in the domestic demand equation to capture real balance effects, Dhar et al. suggest that it might actually capture substitution effects instead, as people put more of their savings in interest-bearing investments. Similarly, the income/cash-flow channel reported in the paper is not comparable with what other modellers report. In the MTF model this channel captures the effect of higher interest rates on mortgage payments and the retail price index. The rise in the price index then has a negativeimpact on spending and output, as it reduces real money balances and leads to a real appreciation of the pound sterling.

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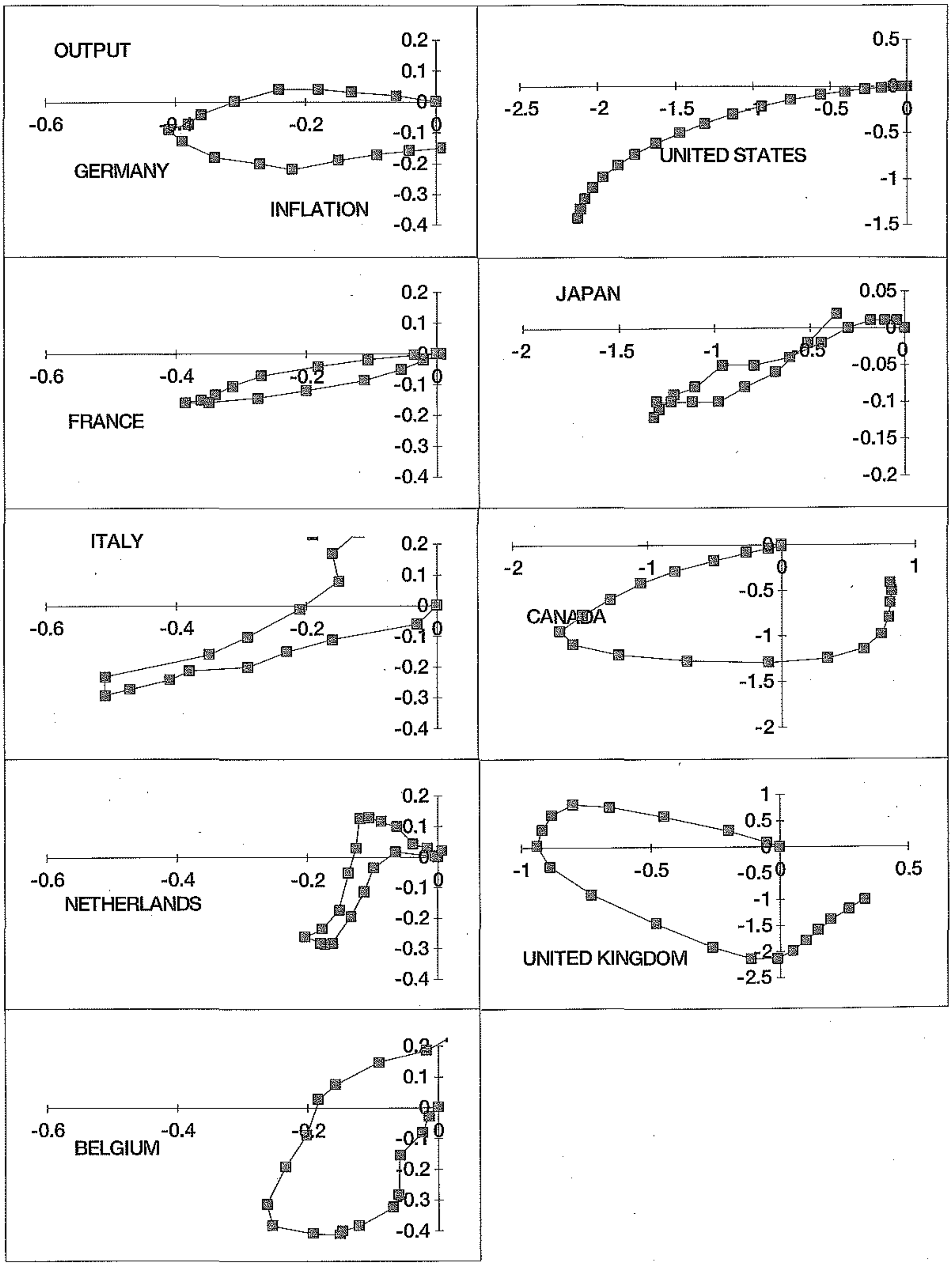
14 See e.g. Longworth and Poloz (1995) and Nicoletti Altimari et al. (1995). Whether this is a consensus view (as in the Bank of Canada) depends on the central bank in question. It should be mentioned that the use and importance of the central bank macroeconometric models in actual policy formulation and evaluation vary across central banks. Moreover, some of the macroeconometric models that take part in this exercise are still in the experimentation phase.

15 The results are from Tryon (1995).

Graph 3

Responses of output and inflation to a temporary 100 basis point increase in policy-determined interest rates in a Phillips curve diagram

(central bank models*)



* Output: percentage deviations from baseline; inflation: deviation of the percentage change in the GDP deflator from baseline.

The decomposition results reported in Hunt, O'Reilly and Tetlow (1995) are also not directly comparable with what other modellers report. According to the definitions that were agreed upon, there are only two channels that can be identified in the QPM model. These include a direct interest rate effect on consumption (where consumption is broadly defined to include inventories and residential construction and depends on the difference between the 90 day commercial paper rate and the long-term rate) and an exchange rate channel. The reported cost-of-capital channel captures all effects on private investment. In the simulation experiment these are primarily accelerator effects as the optimal capital stock only depends on the long-run cost of capital, which does not change in the policy experiment. Similarly, the wealth effect captures the effect of changes in the net foreign asset gap, i.e. the difference between the desired long-run net foreign asset ratio and the actual ratio, on consumption. As the net foreign asset gap changes primarily because the real exchange rate responds, it could also be interpreted as part of the exchange rate channel.

Despite the caveats mentioned above, the decomposition exercise does give some insights on which channels are responsible for the different output effects in the central bank models. In what follows we round up the usual suspects.

1. The exchange rate channel

The exchange rate channel captures the effect of the policy rate on the nominal exchange rate. Given the sluggishness of prices, the resulting change in the real exchange rate induces domestic residents to import less, and foreigners to buy more domestic goods. Moreover, changes in the nominal exchange rate will (depending on the degree of pricing to market) immediately feed into higher import prices, providing a very powerful direct effect of monetary policy on domestic wages and prices. Changes in international competitiveness may also affect domestic prices by influencing the mark-up of prices over costs. As mentioned before, the importance of this channel depends critically on the degree of openness of the economy.

One problem in measuring the importance of this channel concerns the considerable uncertainty surrounding the response of the nominal exchange rate to the policy rate. While some harmonisation has been achieved for the purpose of this exercise, large differences remain in the way that the nominal exchange rate is modelled. The QPM, MCM and BIQM models use uncovered interest rate parity with at least partly forward-looking exchange rate expectations, whereas others rely on a real uncovered interest parity condition with adaptive expectations or use more general reduced-form exchange rate equations. Moreover, the French, Belgian and Dutch modellers assumed that the nominal exchange rates within six ERM countries remain fixed. Graph 5 depicts the response of the real effective exchange rate to the temporary tightening.[16] As can be seen in the top panel, the general pattern is very similar in the models which use adaptive expectations, although the size of the response is much less in Belgium, France, Germany and the Netherlands than in Japan or the United Kingdom. The ever appreciating real exchange rate in the United States in the lower panel illustrates the instability problem that arises from fixing the nominal interest rate path in the MPS model.

In order to control for the exchange rate channel (which is not at the heart of the issues that we want to address in this exercise), it was also agreed to perform the simulation experiment with exogenous nominal exchange rates. The resulting differences in output responses are depicted in Graph 4. Alternatively, we can look at the contribution of the exchange rate channel to the decline in

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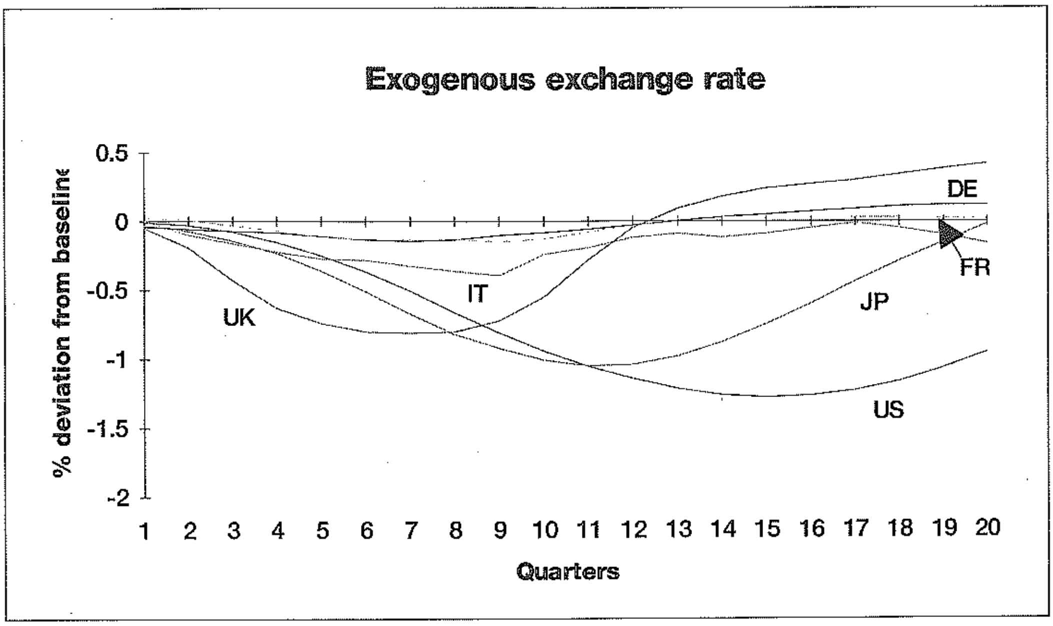
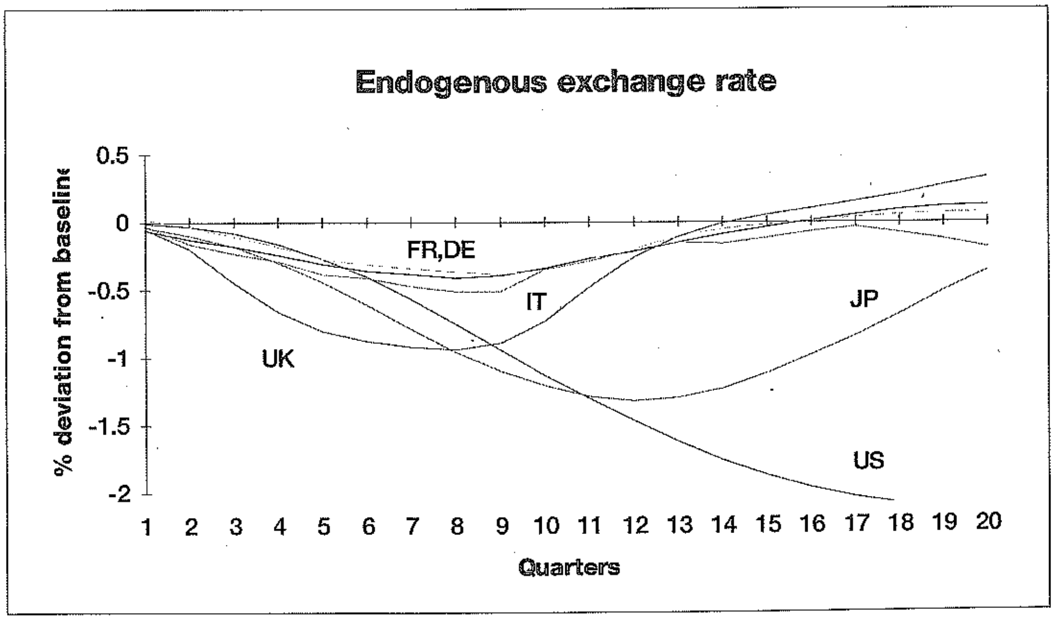
16 In order to increase the comparability with the other European countries, the Italian simulation results plotted in Graphs 1 to 6 are taken from the second policy experiment reported in Nicoletti Altimari et al. (1995), which involves an ERM-coordinated interest rate increase. The different effect on the real effective exchange rate in both scenarios is shown in Graph 5. However, in the tables we report the simulation results for the fully endogenous and forward-looking exchange rate case.

Graph 4

Real GDP responses to a 100 basis point increase in policy-determined interest rates with and without endogenous exchange rates

(central bank models)





output in Table III.1. The cross-country differences of its importance clearly reflect the above-mentioned differences in modelling strategy, the assumptions about which bilateral exchange rates are allowed to float and (more structurally) the degree of openness. Strong short-run contributions can be found in the QPM and BIQM models; in the other models the gradual appreciation over the first eight quarters leads to more important contributions in the second year with the exchange rate channel being more important in the European economies and Canada than in the United States and Japan.[17] Somewhat surprisingly the contribution of the exchange rate channel in the United Kingdom is rather limited.[18] This contrasts with the results reported by Tryon (1994) using the MCM model, which suggest that the exchange rate channel is by far the largest in the United Kingdom, compared to the other G-7 countries.[19]

Another piece of evidence that openness is crucial in determining the relative importance of the exchange rate channel is provided by the results from the MCM model. Table III.2 shows clearly that the exchange rate channel is less important in less open economies such as the United States and Japan. The MCM results show this relationship much clearer as the effect of the interest rate increase on the nominal effective exchange rate is equal across countries.

It should finally be noted that in many countries depending on the strength of the import price channel the exchange rate effect also contributes to a decline in investment, as falling prices *ceteris paribus* increase real interest rates and depress investment.

Although there are significant differences in the importance of the exchange rate channel across countries, it is clear from Table III.1 that they do not explain the cross-country differences in total output effects. We next turn to the importance of the domestic channels.

2. Domestic channels

Differences in financial structure presumably play a larger role in the importance of the domestic channels. Disregarding the exchange rate channel, the distinction between the continental European countries and the other countries remains clear, with Italy and Switzerland occupying an intermediate position. The effect of a monetary tightening in the United States, Japan, Canada and the United Kingdom on average real GDP during the second year lies between minus 40 and 80 basis points. In Italy and Switzerland the effect is respectively minus 29 and 23 basis points and in all the other continental European countries the effect is less than 15 basis points. This distinction also remains if one focuses on the effect on domestic demand as in Table V. In the second year the effects on domestic demand are very similar in the United States, Japan, Italy, Canada and the United Kingdom.[20] France takes an intermediate position and the effects in Germany, the Netherlands, Belgium and Spain are less than half the effect in the first group of countries. In this section we further explore which domestic channels account for these differences.

The income/cash-flow channel

The income/cash-flow channel is designed to capture the effects of variations in the stream of net interest payments of the different sectors on their spending decisions and subsequently

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17 This is more obvious if one considers the relative contribution.

18 Even if the large contribution of the real balance effect and the mortgage payments channel is disregarded, the exchange rate channel only accounts for one-third of the average output effect in the second year. In France and Germany, on the other hand, the contribution of the exchange rate channel is about two-thirds, whereas in Italy it is more than one-half. This difference is even more striking taking into account that the response of the real effective exchange rate in the United Kingdom is much larger than in these countries. See Graph 5.

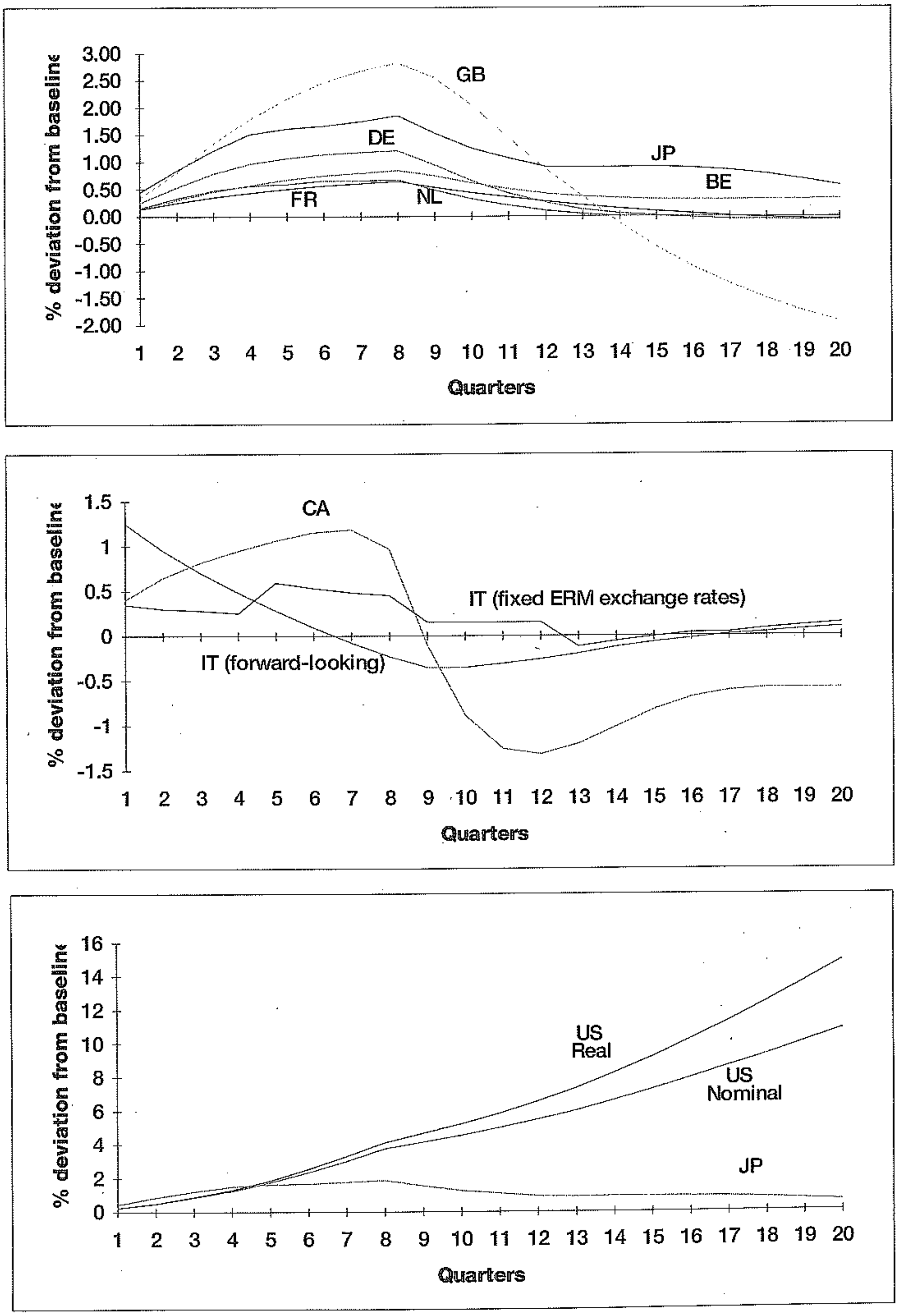
19 See Table III.2.

20 For the United Kingdom this depends on the exclusion of the mortgage payments and real balance channel. If the latter are included the effect on domestic demand in the United Kingdom more than doubles.

Graph 5

Responses of the real effective exchange rate to a temporary 100 basis point increase in policy-determined interest rates

(central bank models)



output.[21] In most models that can identify this channel the most important effects are the impact of variations in interest payments by the household sector vis-a-vis the government and abroad. Often it is assumed as in the MPS and MCM model that interest and dividend payments between the household and corporate sector cancel out. So, although there is no corporate veil, there is a lack of Ricardian equivalence. In those models that do account for variations in interest and dividend payments between different private sectors, different propensities to spend out of that interest income might imply aggregate demand effects. Clearly, the importance of these effects will also depend on the sensitivity of net interest payments to changes in the short-term rate. This will in turn depend on the maturity structure of the outstanding debt and whether fixed or flexible interest rate instruments are held. Income/cash-flow effects are thus a channel where financial structure and the balance-sheet positions of the different sectors play a potentially important role.

A first observation that can be made from Table III.1 is that differences in output effects between continental European and other countries do not appear to be due to the income/cash-flow channel as measured by the central bank models. In the majority of countries the income/cash-flow channel is positive, reflecting the positive net asset position of the private sector. Not surprisingly, the effects are positive and quite large in Italy and Belgium, but also in the United States they are sizable. In Italy and Belgium they eventually outweigh the substitution effects on consumption, although it takes more than a year before their contribution becomes sizable, possibly reflecting the longer-term maturity structure of the debt holdings. Quite striking are the large within-the-year income effects in the United States and France. In France this reflects the positive net asset position of households, which benefit from a substantial increase in their short-term investment income. The corporate sector, on the other hand, faces a rise in the cost of debt, but can compensate this by a fall in the stock of debt following the reduced demand for investment credit.

The income/cash flow contributions are negative in Japan and the Netherlands. In BOJMOD this is mostly due to a significant impact of corporate earnings net of interest payments on non-residential investment. Cash-flow or profitability effects also enter the Italian investment equations, but the effects of interest payments were exogenised for this exercise.

The importance of differences in the net asset position of the private sector is also clear in the MCM simulation results reported in Tables III.2 and IV.2. A large part of the differences in output effects in the second year can be attributed to different income effects, with a substantial positive income effect in Italy and a small negative income effect in the United Kingdom.

The wealth channel

Only four central bank models include endogenously determined stock prices: MPS, BOJMOD, MORKMON II and the Belgian Quarterly Model. The latter two also have endogenous house prices. Table III.1 (entries 11 and 12) shows that in response to the monetary tightening stock prices fall quite dramatically in the United States and Japan by almost 10% on average in the third year.[22] In Belgium and the Netherlands the effects are much weaker, and house prices are relatively more responsive. In accordance with these stock market reactions, the contribution to output in the United States and Japan is quite substantial (-0.14 and -0.11 respectively in the second year), while it is rather limited in Belgium and the Netherlands.

Other central banks also report wealth effects, but these are not directly comparable to the effects of interest rates on asset prices, the value of household wealth and subsequently consumption.

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21 As discussed in the introduction to Section IV, the reported income/cash-flow channels in the QPM and MTF models are quite different from this definition.

22 As with the determination of other asset prices, there is a considerable amount of uncertainty with respect to the response of stock prices to changes in policy rates. See e.g. the discussion in Momma and Shimuzu (1995) on the effects of the large boom and bust in Japanese stock prices on the estimates. In the MPS model the response of stock prices is determined by a simple arbitrage equation, which can produce quite different effects depending on the current dividend price ratio and the level of interest rates.

Examples are the net foreign asset effects on spending in the QPM and MTF models, or the real balance effects in the MTF and MOISEES models.

Substitution effects and the cost-of-capital channel

In our search for the culprit that causes the cross country variations in output effects in the central bank models, we have finally come to the substitution effects on consumption and investment spending. In spite of the recent shift in focus towards wealth and cash-flow effects of monetary policy, substitution effects still form the core of the transmission mechanism of monetary policy in the central bank models and monetary economics in general. However, to the extent that the other channels are only imperfectly modelled, these channels will also pick up cash-flow and wealth effects of interest rate changes. Only in such a framework can one explain the relevance of using short or long rates in the macroeconometric models.

Table III.2, which reports the MCM results, suggests that in the G-7 countries the cost-of-capital channel on investment is the most important channel of monetary policy transmission (together with the exchange rate channel). Substitution (and possibly wealth) effects on consumption are negative, but in general quite small. Moreover, the size of the cost-of-capital channel is broadly comparable across the G-7 countries, with some indication that it is relatively stronger in Japan and the United Kingdom, and relatively weaker in Canada and Germany. This picture is also confirmed in Table IV.2, which shows that private investment is by far the most important component in explaining the decline in real GDP.

These results differ in a number of ways from the results reported in Tables III.1 and IV.1 using the central bank model simulations. First, the size of the substitution effects seems to differ between, on the one hand, Germany, France, the Netherlands, Belgium, Austria and Spain and, on the other hand, the United States, Japan, Canada, the United Kingdom and Italy. In the first group substitution and cost-of-capital effects in the second year are typically less than 20 basis points, while in the second group they are larger than 30 basis points.

One possible explanation lies in how nominal long-term interest rates are determined in these models.[23] In the MPS model the nominal long rates are modelled as long distributed lags of the nominal short rate. In many other models the long rates are not just functions of the nominal short rate, but also of inflation expectations, supply and demand imbalances and possibly foreign interest rates. This has a profound impact on how long-term interest rates respond to a monetary policy tightening. In the MPS model a rise in nominal interest rates will have similar effects on the long rate whether it is due to a rise in inflation expectations or to a rise in the real rate. In the Bundesbank model, on the other hand, inflation expectations explicitly enter the determination of the long rates through the so-called price gap, so that a rise in policy rates has two effects on the long rate: (i) it directly increases the long rate, and (ii) it indirectly reduces the long rate as inflation expectations decrease. Graph 6 compares the responses of the representative long-term interest rate to the temporary increase in short rates in the central bank models. There is indeed some indication that the estimated response of the long rates is smaller in the participating ERM countries, although in many cases the differences are not very large.[24]

The analysis in the paragraph above assumes that it is long rates that matter. However, in Section II it was already indicated that in many cases short rates are important. This might explain why, in contrast with the MCM results, the relative importance of substitution effects versus cost-of-capital effects differs across countries. In the German and Belgian models, for example, substitution effects on consumption may be more important (see Table III.1) because the savings decisions of households depend on short term interest rates, while most of the investment decisions depend on

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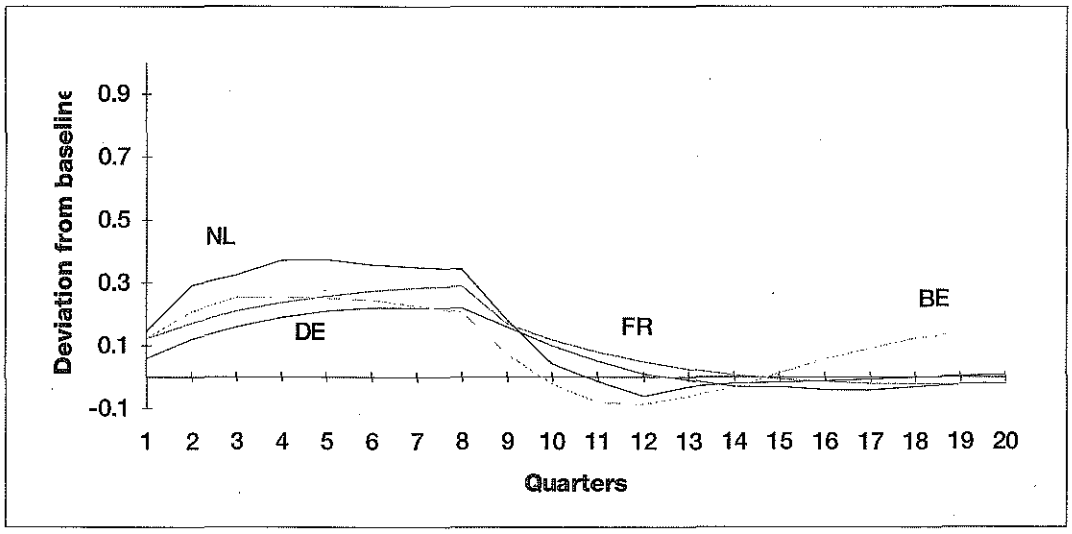
23 Recall that in the MCM simulations this issue does not arise as the response of the nominal long-term rate is identical across countries.

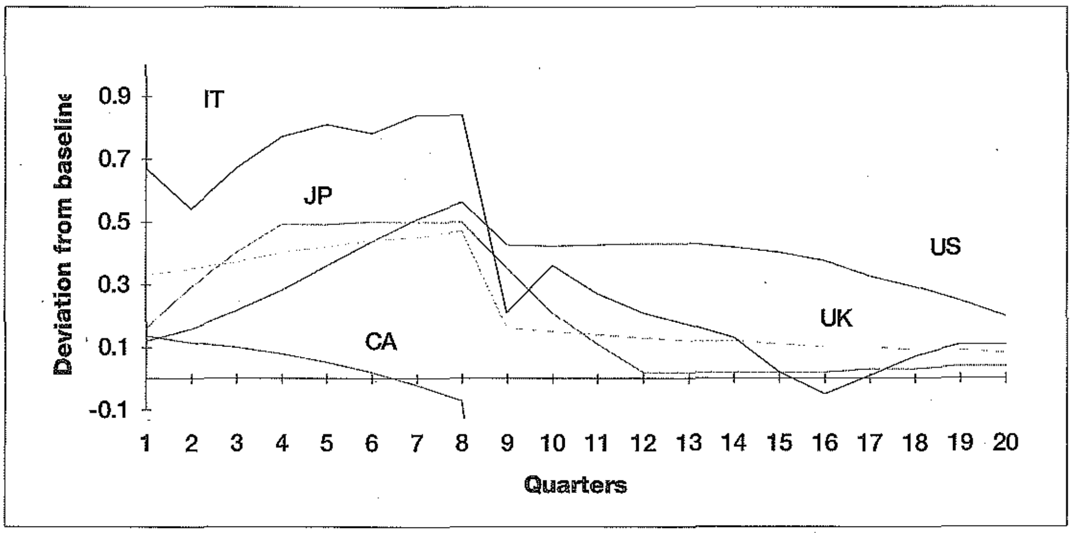
24 The maturity of the long rates will also determine their responsiveness. See e.g. Nicoletti et al. (1995) for one reason why the Italian long rates respond so vigorously.

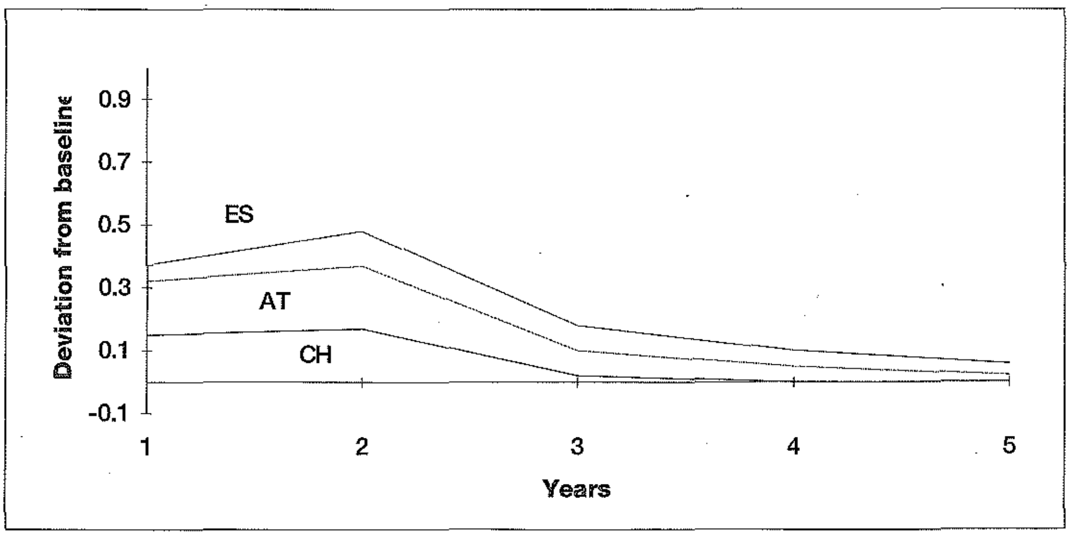
Graph 6

Responses of nominal long-term interest rates to a temporary 100 basis point increase in policy-determined interest rates

(central bank models)







long-term rates. Extreme examples of the importance of this kind of modelling decisions can be found in the MTF and QPM models, where only short rates matter.

In spite of the differences in relative importance of the various transmission channels, it can be seen from Table IV.1 that in all cases investment is the most important GDP component in explaining the decline in output. The interpretation might, however, differ with in some countries investment being purely driven by accelerator effects coming from consumption and net exports, while in other countries investment responds directly to a higher cost of capital.

V. CONCLUSION

In this note we report and summarise the results of a simulation comparison project organised at the BIS that includes the central bank models of twelve countries. This project is only a first step in trying to better understand the structure of these macroeconomic models and their role in policy formulation and evaluation.

More concretely, the central bank modelling groups were asked to simulate the effects on the economy of a 100 basis point increase in policy-determined rates during eight quarters. One of the goals of this exercise was to find out whether cross-country differences in monetary policy effectiveness could be related to cross-country differences in financial structure. In most cases, financial structure is only indirectly modelled. In particular, the structure of financial markets influences the modeller's decision as to which interest rates and asset prices are included and how the different spending components respond to these interest rates. The structure of balance-sheet positions also affects possible income and cash-flow effects that might have been modelled.

Not surprisingly, the conclusions that can be drawn from this exercise are not unambiguous. Although the simulation results from the central bank models appear to suggest that there are differences in the responsiveness of output and inflation to a standardised increase in the interest rate, it is unclear what the relative role is of differences in modelling strategy and differences in the underlying economic and financial structure. The simulation results from econometric models that use similar methodologies across countries suggest that it is hard to find significant differences in monetary policy effectiveness. These approaches do not, however, explicitly take into account differences in financial structure and consequently might be inappropriate to answer the question about the effects of different financial structures.

More systematic research which singles out differences in financial structure and examines the impact on the monetary policy transmission mechanism across countries seems appropriate. There is growing evidence at the micro level that balance-sheet constraints do play an important role in the spending decisions of specific sectors. Macro evidence on how this affects the transmission of monetary policy changes to the economy is, however, harder to find.

In spite of the lack of unambiguous conclusions with respect to the role of financial structure, the decomposition of the output responses to a monetary tightening by channel of transmission proves to be a useful exercise. It helps understand which channels of transmission were responsible for the cross-country differences, and points to some of the particular characteristics in the central bank models. We find that in the central bank models the exchange rate and the cost of capital are the most important channels of transmission, with the exchange rate channel being more important in the more open economies. In countries with a large government debt, such as Italy and Belgium, these effects are partly offset by positive interest income effects.

Table I

Interest rates, exchange rates and asset prices

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
1. Short-term interest rate (%)					
United States	0.86	0.85	0.00	0.00	0.00
Japan	0.92	0.92	0.00	0.00	0.00
Germany	0.88	0.92	0.05	0.02	0.02
France	1.00	1.00	0.00	0.00	0.00
Italy	0.79	1.01	0.23	0.01	0.00
United Kingdom	1.00	1.00	0.00	0.00	0.00
Canada	1.00	1.03	- 2.72	- 1.96	- 1.29
Netherlands	1.00	1.00	0.00	0.00	0.00
Belgium	1.00	1.00	0.00	0.00	0.00
Spain	1.00	1.00	0.00	0.00	0.00
Austria	0.97	0.75	- 0.17	0.04	- 0.01
Switzerland	0.57	0.62	0.05	0.00	0.00
2. Long-term interest rate (%)					
United States	0.19	0.47	0.43	0.41	0.27
Japan	0.34	0.50	0.17	0.02	0.04
Germany	0.13	0.22	0.08	- 0.03	- 0.03
France	0.24	0.29	0.05	- 0.02	- 0.02
Italy	0.62	0.77	0.36	0.18	0.06
United Kingdom	0.37	0.45	0.15	0.12	0.09
Canada	0.11	0.00	- 1.28	- 1.02	- 0.61
Netherlands	0.26	0.31	0.05	0.02	- 0.02
Belgium	0.20	0.23	- 0.02	0.00	0.12
Spain	0.37	0.48	0.18	0.10	0.06
Austria	0.32	0.37	0.10	0.05	0.02
Switzerland	0.15	0.17	0.02	0.00	0.00
3. Mortgage rate (%)					
United States	0.30	0.58	0.43	0.39	0.26
Japan	-	-	-	-	-
Germany	-	-	-	-	-
France	-	-	-	-	-
Italy	-	-	-	-	-
United Kingdom	0.92	1.00	0.08	0.00	0.00
Canada	-	-	-	-	-
Netherlands	-	-	-	-	-
Belgium	0.11	0.31	- 0.01	- 0.06	0.04
Spain	-	-	-	-	-
Austria	-	-	-	-	-
Switzerland (new)	0.12	0.19	0.07	0.00	0.00
(existing)	0.07	0.19	0.07	0.00	0.00
4. Bank lending rate (%)					
United States	-	-	-	-	-
Japan (short)	0.64	0.86	0.16	- 0.14	- 0.17
(long)	0.28	0.49	0.21	0.02	0.03
Germany	0.55	0.88	0.38	0.07	0.02
France	0.43	0.45	0.02	0.00	- 0.01
Italy	0.63	0.90	0.26	- 0.17	- 0.07
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands (short)	1.00	1.00	0.00	0.00	0.00
Belgium	0.75	0.95	0.21	0.00	- 0.01
Spain	-	-	-	-	-
Austria	0.65	0.83	0.31	0.18	0.09
Switzerland	-	-	-	-	-

Table I (cont.)

Interest rates, exchange rates and asset prices

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
5. Deposit rate (%)					
United States	0.49	0.58	0.15	0.11	0.08
Japan	-	-	-	-	-
Germany	0.76	0.83	0.05	- 0.00	0.01
France	-	-	-	-	-
Italy	0.42	0.72	0.28	0.03	0.02
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands	1.00	1.00	0.00	0.00	0.00
Belgium	0.05	0.08	0.02	- 0.02	0.02
Spain	0.17	0.36	0.24	0.08	0.03
Austria	-	-	-	-	-
Switzerland	0.54	0.62	0.08	0.00	0.00
6. Real short-term interest rate (%)					
United States	1.03	1.21	0.52	0.93	1.40
Japan	0.92	0.96	0.10	0.10	0.04
Germany	0.77	0.86	0.12	0.10	0.12
France	1.05	1.10	0.10	0.06	0.01
Italy	1.47	1.13	- 0.14	- 0.35	- 0.27
United Kingdom	0.70	0.70	1.05	1.75	1.10
Canada	1.10	1.61	- 1.52	- 0.80	- 0.67
Netherlands	-	-	-	-	-
Belgium	1.14	1.34	0.31	0.02	- 0.26
Spain	1.28	1.28	0.13	0.30	0.34
Austria (call money)	1.12	0.39	- 0.14	0.09	0.01
Switzerland	0.60	0.43	0.07	0.30	0.06
7. Real long-term interest rate (%)					
United States	0.15	0.46	0.63	0.79	0.98
Japan	0.33	0.54	0.27	0.12	0.07
Germany	0.10	0.18	0.12	0.06	0.07
France	0.29	0.39	0.15	0.05	- 0.01
Italy	1.11	0.91	0.20	- 0.18	- 0.21
United Kingdom	0.03	0.14	1.20	1.87	1.20
Canada	-	-	-	-	-
Netherlands	0.27	0.39	0.18	0.11	- 0.01
Belgium	0.35	0.57	0.28	0.02	- 0.14
Spain	0.65	0.77	0.30	0.40	0.40
Austria	0.34	0.42	0.15	0.10	0.04
Switzerland	0.52	0.43	0.10	0.30	0.06
8. User cost of capital					
United States	0.82	2.46	3.19	3.85	4.32
	0.99	3.44	4.64	4.57	5.39
	3.31	6.52	6.66	9.38	12.81
Japan	-	-	-	-	-
Germany	0.61	1.14	0.73	0.32	0.30
	1.10	1.91	0.99	0.10	- 0.03
	1.28	2.21	1.39	0.75	0.71
France	-	-	-	-	-
Italy	2.05	4.16	1.73	- 0.22	- 0.91
United Kingdom	- 0.10	10.02	1.83	2.97	1.98
Canada	-	-	-	-	-
Netherlands	0.21	1.04	1.56	0.85	- 0.41
Belgium	0.56	0.53	- 0.17	- 0.28	- 0.28
Spain	0.62	0.64	0.16	0.31	0.31

Table I (cont.)

Interest rates, exchange rates and asset prices

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
Austria	0.15	0.17	0.03	0.02	0.01
Switzerland	-	-	-	-	-
9. Nominal effective exchange rate					
United States	0.73	2.95	5.56	8.74	13.10
Japan	1.07	1.91	1.46	1.18	0.96
Germany	0.67	1.33	0.87	0.43	0.45
France	0.79	1.37	0.90	0.50	0.27
Italy	1.69	0.76	0.05	0.00	0.00
United Kingdom	0.62	1.62	2.00	2.00	2.00
Canada	0.78	1.68	0.86	2.02	2.98
Netherlands	0.51	1.00	0.62	0.23	0.21
Belgium	0.37	0.76	0.56	0.32	0.32
Spain	1.16	1.41	0.60	0.86	1.16
Austria	0.22	0.15	- 0.06	- 0.01	- 0.02
Switzerland	1.50	1.50	0.08	0.25	0.31
10. Real effective exchange rate					
United States	0.69	2.71	4.77	6.95	9.72
Japan	0.99	1.73	1.19	0.91	0.73
Germany	0.64	1.15	0.57	0.05	- 0.00
France	0.43	0.64	0.27	0.05	- 0.06
Italy	0.85	0.02	- 0.32	- 0.11	0.05
United Kingdom	11.06	2.53	1.75	- 0.31	- 1.62
Canada	0.70	1.08	- 0.85	- 0.87	- 0.52
Netherlands	0.38	0.65	0.27	0.00	- 0.06
Belgium	-	-	-	-	-
Spain	0.99	0.98	- 0.04	- 0.05	- 0.06
Austria	0.20	0.11	- 0.12	- 0.06	- 0.04
Switzerland	1.47	1.68	0.13	0.00	0.00
11. Stock prices					
United States	- 1.50	- 6.06	- 10.02	- 11.22	- 12.99
Japan	- 6.91	- 13.41	- 9.81	- 1.72	3.42
Germany	-	-	-	-	-
France	-	-	-	-	-
Italy	-	-	-	-	-
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands	- 0.72	- 1.83	- 1.72	- 1.03	- 0.64
Belgium	- 0.49	- 0.83	- 0.56	- 1.04	- 1.75
Spain	-	-	-	-	-
Austria	-	-	-	-	-
Switzerland	-	-	-	-	-
12. House prices					
United States	-	-	-	-	-
Japan	-	-	-	-	-
Germany	-	-	-	-	-
France	-	-	-	-	-
Italy	-	-	-	-	-
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands	- 0.16	- 1.13	- 1.84	- 1.52	- 1.14
Belgium	- 0.46	- 1.93	- 3.35	- 2.86	- 1.09
Spain	-	-	-	-	-
Austria	-	-	-	-	-
Switzerland	-	-	-	-	-

Table I (cont.)

Interest rates, exchange rates and asset prices

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]	**1994**	**1995**	**1996**	**1997**	**1998**
13. Monetary aggregate					
United States	- 0.82	- 1.72	- 2.04	- 2.76	- 4.46
Japan	- 0.55	- 2.10	- 2.48	- 1.37	- 0.55
Germany (M_3)	- 0.44	- 0.83	- 0.80	- 0.64	- 0.43
France (M_3)	- 0.69	- 0.64	- 0.24	- 0.32	- 0.36
Italy (M_2)	- 0.61	- 1.66	- 1.33	- 0.26	- 0.13
United Kingdom	- 0.44	- 0.89	- 0.98	- 1.67	- 2.70
Canada	-	-	-	-	-
Netherlands (M_2)	0.63	0.52	- 0.56	- 0.69	- 0.46
Belgium	- 0.19	- 0.68	- 0.96	- 0.88	- 0.90
Spain	- 0.63	- 1.26	- 1.16	- 0.86	- 0.36
Austria	- 0.61	- 0.18	0.48	- 0.03	0.00
Switzerland (monetary base)	- 0.78	- 1.37	- 0.83	- 0.67	- 0.81
14. Total domestic credit					
United States	-	-	-	-	-
Japan	-	-	-	-	-
Germany (private)	- 0.11	- 0.39	- 0.58	- 0.59	- 0.54
(public)	0.05	0.31	0.75	1.14	1.14
France					
Italy	- 0.14	0.02	0.48	0.90	1.11
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands (bank to private)	- 0.07	- 0.36	- 0.82	- 0.94	- 0.84
(bank to public)	- 1.06	- 1.25	1.04	0.01	0.10
Belgium	- 0.42	- 0.68	- 0.62	- 0.54	- 0.06
Spain	-	-	-	-	-
Austria	- 0.03	- 0.42	- 0.48	- 0.07	0.02
Switzerland	-	-	-	-	-

Table II

Real economic activity, price developments, fiscal and trade balance

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
1. Real GDP					
United States	- 0.07	- 0.50	- 1.21	- 1.80	- 2.09
Japan	- 0.16	- 0.70	- 1.23	- 1.16	- 0.59
Germany	- 0.15	- 0.37	- 0.30	- 0.07	0.09
France	- 0.18	- 0.36	- 0.20	0.01	0.07
Italy	- 0.32	- 0.53	- 0.22	- 0.08	- 0.13
United Kingdom	- 0.35	- 0.89	- 0.59	0.01	0.24
Canada	- 0.22	- 1.15	- 1.28	0.40	0.81
Netherlands	- 0.10	- 0.18	- 0.15	- 0.09	- 0.01
Belgium	- 0.03	- 0.12	- 0.23	- 0.15	0.02
Spain	- 0.05	- 0.02	0.03	- 0.17	- 0.17
Austria	- 0.08	- 0.14	- 0.02	0.04	0.01
Switzerland	- 0.11	- 0.57	- 1.10	- 1.11	- 0.67
2. Private consumption					
United States	0.00	- 0.22	- 0.67	- 0.94	- 0.83
Japan	- 0.08	- 0.36	- 0.64	- 0.67	- 0.41
Germany	- 0.14	- 0.26	- 0.13	0.02	0.13
France	0.07	0.01	- 0.05	0.04	0.08
Italy	- 0.13	- 0.30	0.00	0.38	0.44
United Kingdom	- 0.36	- 0.88	- 0.67	- 0.22	0.05
Canada	- 0.17	- 0.97	- 1.50	- 0.38	0.28
Netherlands	- 0.05	- 0.16	- 0.22	- 0.18	- 0.04
Belgium	0.01	0.02	- 0.07	- 0.10	0.00
Spain	- 0.04	0.19	0.16	- 0.14	0.05
Austria	- 0.12	- 0.15	- 0.08	- 0.12	- 0.12
Switzerland	-	-	-	-	-
3. Government expenditure					
United States	0.01	0.05	0.04	- 0.03	- 0.07
Japan	0.02	0.09	0.22	0.31	0.28
Germany	0.01	0.09	0.16	0.11	0.01
France	0.00	0.00	0.00	0.00	0.00
Italy	- 0.09	- 0.08	- 0.04	- 0.01	0.01
United Kingdom	0.00	0.00	0.00	0.00	0.00
Canada	- 0.09	- 0.45	- 0.49	0.19	0.33
Netherlands	0.00	0.00	0.00	0.00	0.00
Belgium	-	-	-	-	-
Spain	0.09	0.09	0.05	0.05	- 0.00
Austria	0.00	0.00	0.00	0.00	0.00
Switzerland	-	-	-	-	-
4. Private investment					
United States	- 0.47	- 2.34	- 4.79	- 6.57	- 7.38
Japan	- 0.39	- 1.85	- 3.14	- 2.73	- 1.11
Germany	- 0.43	- 1.21	- 0.80	0.30	0.63
France	-	-	-	-	-
Italy (excl. inventories)	- 1.10	- 2.29	- 1.95	- 1.72	- 2.28
United Kingdom	- 1.54	- 4.20	- 3.30	- 1.80	- 2.70
Canada	- 0.11	- 0.81	- 1.16	- 0.08	1.80
Netherlands	-	-	-	-	-
Belgium	- 0.34	- 1.67	- 2.72	1.68	- 0.25
Spain	- 0.43	- 0.88	- 1.01	- 0.92	- 0.49
Austria	-	-	-	-	-
Switzerland	-	-	-	-	-

Table II (cont.)

Real economic activity, price developments, fiscal and trade balance

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
5. Residential investment					
United States	- 0.98	- 3.64	- 5.31	- 6.12	- 7.01
Japan	- 0.65	- 2.86	- 3.52	- 2.17	- 1.23
Germany	- 0.27	- 0.95	- 0.87	0.08	0.57
France	- 1.26	- 2.42	- 1.71	- 0.85	- 0.44
Italy	- 0.34	- 0.71	- 0.77	- 0.84	- 0.64
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands	0.00	- 1.14	- 2.21	- 1.32	- 0.33
Belgium	- 0.86	- 4.27	- 7.12	- 4.02	0.88
Spain	0.09	0.27	0.31	0.21	0.11
Austria	0.00	- 0.15	- 0.24	- 0.02	0.08
Switzerland	-	-	-	-	-
6. Non-residential investment					
United States	- 0.18	- 1.33	- 3.59	- 5.77	- 6.92
Japan	- 0.19	- 1.41	- 2.90	- 2.76	- 1.17
Germany	- 0.67	- 1.56	- 0.71	0.55	0.69
France	- 1.72	- 2.33	- 0.46	0.81	1.07
Italy	- 1.41	- 2.86	- 2.36	- 2.02	- 2.83
United Kingdom	-	-	-	-	-
Canada	-	-	-	-	-
Netherlands	- 0.24	- 0.91	- 1.23	- 0.75	0.06
Belgium	- 0.19	- 0.75	- 1.15	- 0.96	- 0.64
Spain	- 0.62	- 1.27	- 1.41	- 1.24	- 0.64
Austria	- 0.11	- 0.65	- 0.67	- 0.16	- 0.04
Switzerland	-	-	-	-	-
7. Exports					
United States	- 0.02	- 0.29	- 1.06	- 1.99	- 2.82
Japan	- 0.15	- 0.42	- 0.57	- 0.49	- 0.34
Germany	- 0.29	- 0.65	- 0.44	- 0.11	- 0.07
France	- 0.17	- 0.28	- 0.14	0.01	0.08
Italy	- 0.24	- 0.32	- 0.19	0.06	0.17
United Kingdom	- 0.19	- 0.63	- 0.63	- 0.09	0.37
Canada	- 0.13	- 0.75	- 0.68	0.73	0.77
Netherlands	- 0.04	0.05	0.10	0.06	0.02
Belgium	- 0.07	- 0.03	0.05	0.03	0.00
Spain	- 0.26	- 0.52	- 0.30	0.03	0.17
Austria	- 0.20	- 0.15	0.06	0.03	0.03
Switzerland	-	-	-	-	-
8. Imports					
United States	- 0.07	- 0.65	- 1.55	- 1.99	- 1.63
Japan	- 0.02	- 0.24	- 0.40	- 0.08	0.34
Germany	- 0.24	- 0.68	- 0.50	0.06	0.21
France	- 0.43	- 0.70	- 0.03	0.53	0.46
Italy	- 0.39	- 0.97	- 0.50	- 0.08	- 0.28
United Kingdom	- 0.69	- 1.57	- 1.70	- 2.15	- 3.28
Canada	0.05	- 0.01	- 0.69	- 0.89	- 0.05
Netherlands	- 0.01	- 0.09	- 0.22	- 0.20	- 0.02
Belgium	- 0.07	- 0.18	- 0.26	- 0.19	- 0.08
Spain	- 0.43	- 0.69	- 0.63	- 0.42	0.27
Austria	- 0.15	- 0.22	- 0.01	0.06	0.00
Switzerland	-	-	-	-	-

Table II (cont.)

Real economic activity, price developments, fiscal and trade balance

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]					
	1994	**1995**	**1996**	**1997**	**1998**
9. Unemployment rate (%)					
United States	0.02	0.17	0.47	0.76	0.91
Japan	0.01	0.02	0.03	0.02	- 0.00
Germany	0.08	0.24	0.23	0.08	0.02
France	0.02	0.06	0.07	0.04	0.01
Italy	0.03	0.11	0.13	0.11	0.09
United Kingdom	0.15	0.83	1.29	0.97	0.46
Canada	0.10	0.46	0.75	0.32	- 0.25
Netherlands	0.07	0.13	0.12	0.07	0.03
Belgium	0.00	0.01	0.05	0.07	0.04
Spain	0.02	0.03	0.05	0.09	0.09
Austria	- 0.09	- 0.13	- 0.08	- 0.05	- 0.03
Switzerland	0.03	0.21	0.43	0.55	0.41
10. Real disposable income					
United States	0.15	0.10	- 0.25	-0.49	- 0.48
Japan	- 0.12	- 0.39	- 0.71	- 0.82	- 0.53
Germany	0.05	0.14	0.22	0.33	0.40
France	0.11	- 0.05	- 0.18	- 0.02	0.04
Italy	0.07	0.74	0.74	0.12	- 0.31
United Kingdom	0.01	- 0.31	- 0.45	- 0.19	- 0.10
Canada	-	-	-	-	-
Netherlands	0.05	- 0.01	- 0.19	- 0.19	0.00
Belgium	0.30	0.25	- 0.06	- 0.13	- 0.01
Spain	0.13	0.16	0.06	0.01	0.00
Austria	0.09	- 0.04	- 0.15	- 0.06	- 0.04
Switzerland	-	-	-	-	-
11. GDP deflator					
United States	0.00	- 0.09	- 0.45	- 1.24	- 2.51
Japan	0.01	- 0.03	- 0.13	- 0.23	- 0.27
Germany	0.03	- 0.02	- 0.20	- 0.37	- 0.48
France	- 0.04	- 0.19	- 0.31	- 0.31	- 0.28
Italy	- 0.39	- 0.64	- 0.53	- 0.17	0.10
United Kingdom	0.44	0.90	- 0.25	- 2.27	- 3.55
Canada (%)	- 0.08	- 0.52	- 1.14	- 1.18	- 0.60
Netherlands	- 0.08	- 0.36	- 0.47	- 0.35	- 0.32
Belgium	- 0.13	- 0.51	- 0.84	- 0.80	- 0.55
Spain	- 0.16	- 0.42	- 0.63	- 0.90	- 1.20
Austria	0.02	- 0.01	- 0.05	- 0.05	- 0.03
Switzerland	0.14	0.53	0.24	- 0.35	- 0.33
12. Consumer prices					
United States	- 0.03	- 0.21	- 0.68	- 1.56	- 2.90
Japan	- 0.02	- 0.11	- 0.25	- 0.37	- 0.37
Germany	- 0.03	- 0.14	- 0.31	- 0.45	- 0.55
France	- 0.05	- 0.15	- 0.25	- 0.32	- 0.32
Italy	- 0.48	- 0.64	- 0.53	- 0.17	0.10
United Kingdom	0.89	1.27	- 0.46	- 2.36	- 3.48
Canada (%)	- 0.15	- 0.60	- 0.98	- 1.04	- 0.61
Netherlands	- 0.13	- 0.35	- 0.35	- 0.23	- 0.27
Belgium	- 0.14	- 0.48	- 0.79	- 0.81	- 0.55
Spain	- 0.26	- 0.54	- 0.66	- 0.95	- 1.28
Austria	- 0.02	- 0.04	- 0.05	- 0.04	- 0.02
Switzerland	- 0.03	0.18	0.05	- 0.25	- 0.31

Table II (cont.)

Real economic activity, price developments, fiscal and trade balance

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
13. Unit labour cost					
United States	0.03	0.03	- 0.40	- 1.52	- 3.22
Japan	0.05	0.13	- 0.03	- 0.40	- 0.60
Germany	0.05	- 0.02	- 0.22	- 0.36	- 0.48
France	- 0.04	- 0.13	- 0.26	- 0.36	- 0.38
Italy	- 0.06	- 0.35	- 0.53	- 0.24	0.13
United Kingdom	0.67	1.14	- 0.42	- 2.53	- 3.70
Canada (%)	0.07	0.29	- 0.96	- 2.47	- 1.00
Netherlands	- 0.01	- 0.28	- 0.55	- 0.51	- 0.43
Belgium	- 0.01	- 0.22	- 0.50	- 0.68	- 0.63
Spain	- 0.25	- 0.54	- 0.73	- 1.08	- 1.44
Austria	0.15	0.05	- 0.23	- 0.17	- 0.06
Switzerland	-	-	-	-	-
14. Import prices					
United States	- 0.23	- 1.12	- 2.49	- 4.17	- 6.42
Japan	- 1.07	- 1.96	- 1.48	- 1.20	- 0.97
Germany	- 0.30	- 0.71	- 0.65	- 0.42	- 0.38
France	- 0.45	- 0.82	- 0.60	- 0.39	- 0.27
Italy	- 1.40	- 0.84	- 0.16	- 0.02	- 0.01
United Kingdom	- 0.30	- 0.83	- 1.51	- 2.18	- 2.49
Canada (%)	- 0.57	- 0.86	0.22	- 0.89	- 0.88
Netherlands	- 0.51	- 1.00	- 0.62	- 0.23	- 0.21
Belgium	- 0.33	- 0.76	- 0.66	- 0.39	- 0.32
Spain	- 1.14	- 1.39	- 0.59	- 0.85	- 1.15
Austria	- 0.17	- 0.16	0.01	0.01	0.02
Switzerland	- 1.25	- 1.32	- 0.16	- 0.13	- 0.16
15. Revenues (% of GDP)					
United States	0.03	0.05	0.00	- 0.03	- 0.02
Japan	- 0.01	- 0.03	- 0.07	- 0.09	- 0.04
Germany	- 0.17	- 0.54	- 0.70	- 0.58	- 0.51
France (% of baseline GDP)	0.06	0.10	0.05	0.02	- 0.01
Italy	0.19	0.08	- 0.08	- 0.03	0.12
United Kingdom	0.00	0.00	0.00	0.00	0.00
Canada	-	-	-	-	-
Netherlands	0.00	0.01	0.02	0.02	0.03
Belgium	0.04	0.11	0.17	0.16	0.09
Spain	- 0.02	- 0.01	- 0.00	- 0.02	- 0.01
Austria	0.05	0.13	0.16	0.17	0.18
Switzerland	-	-	-	-	-
16. Primary expenditures (% of GDP)					
United States	0.01	0.10	0.26	0.41	0.51
Japan (total)	0.02	0.11	0.20	0.20	0.11
Germany	0.03	0.03	- 0.11	- 0.32	- 0.46
France (% of baseline GDP)	0.11	0.22	0.12	- 0.02	- 0.06
Italy	0.16	0.24	0.11	0.01	0.00
United Kingdom (total)	0.05	0.18	0.27	0.36	0.41
Canada	0.03	0.14	0.16	- 0.04	- 0.09
Netherlands	0.04	0.08	0.08	0.04	0.02
Belgium	0.05	0.15	0.18	0.05	- 0.06
Spain	0.05	0.06	0.06	0.13	0.11
Austria	0.04	0.11	0.14	0.13	0.12
Switzerland	-	-	-	-	-

Table II (cont.)

Real economic activity, price developments, fiscal and trade balance

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
17. Interest payments (% of GDP)					
United States	0.13	0.29	0.29	0.32	0.38
Japan	-	-	-	-	-
Germany	0.06	0.24	0.28	0.19	0.18
France (% of baseline GDP)	0.14	0.21	0.11	0.08	0.07
Italy	0.31	0.77	0.69	0.38	0.30
United Kingdom	-	-	-	-	-
Canada	0.06	0.05	- 0.55	- 0.46	- 0.29
Netherlands	0.03	0.10	0.13	0.13	0.12
Belgium	0.29	0.42	0.22	0.20	0.16
Spain	- 0.23	- 0.35	- 0.21	- 0.19	- 0.20
Austria	0.03	0.07	0.06	0.05	0.03
Switzerland	-	-	-	-	-
18. Government budget balance (% of GDP)					
United States	- 0.14	- 0.44	- 0.71	- 0.98	- 1.15
Japan	- 0.03	- 0.14	- 0.28	- 0.28	- 0.15
Germany	- 0.27	- 0.82	- 0.87	- 0.45	- 0.23
France (% of baseline GDP)	- 0.19	- 0.33	- 0.17	- 0.05	- 0.02
Italy	- 0.28	- 0.93	- 0.88	- 0.42	- 0.18
United Kingdom	- 0.05	- 0.17	- 0.26	- 0.36	- 0.41
Canada	- 0.09	- 0.12	0.59	0.62	0.40
Netherlands	- 0.03	- 0.12	- 0.19	- 0.16	- 0.12
Belgium	- 0.29	- 0.44	- 0.20	- 0.08	0.01
Spain	- 0.30	- 0.43	- 0.27	- 0.34	- 0.32
Austria	- 0.01	- 0.02	- 0.02	- 0.05	- 0.06
Switzerland	-	-	-	-	-
19. Public sector debt (% of GDP)					
United States	0.09	0.60	1.61	2.99	4.66
Japan	-	-	-	-	-
Germany	0.12	0.72	1.59	2.14	2.36
France (% of baseline GDP)	0.23	0.65	0.80	0.74	0.88
Italy	1.09	2.48	2.73	2.41	2.21
United Kingdom	-	-	-	-	-
Canada	0.20	1.02	1.30	0.34	- 0.06
Netherlands	0.17	0.56	0.79	0.78	0.78
Belgium	0.42	1.39	2.18	2.08	1.40
Spain	0.43	0.99	1.36	1.91	2.38
Austria	0.02	0.07	0.08	0.04	- 0.02
Switzerland	-	-	-	-	-
20. Current account (% of GDP)					
United States	0.02	0.12	0.21	0.19	0.08
Japan	0.00	0.04	0.05	0.02	- 0.02
Germany (% of baseline GDP)	0.15	0.31	0.14	- 0.27	- 0.47
France (% of baseline GDP)	- 0.01	0.06	0.03	- 0.10	- 0.04
Italy	- 0.03	0.01	0.00	0.02	0.12
United Kingdom	0.31	0.52	0.31	0.30	0.46
Canada	- 0.03	- 0.26	- 0.13	0.54	0.41
Netherlands	-	-	-	-	-
Belgium	- 0.01	0.01	0.09	0.09	0.02
Spain	0.17	0.20	0.10	0.11	- 0.07
Austria	0.01	0.07	0.08	0.07	0.07
Switzerland	-	-	-	-	-

Table II (cont.)

Real economic activity, price developments, fiscal and trade balance

Policy experiment: Temporary 1 percentage point increase in short-term interest rates in 1994 and 1995 with endogenous nominal exchange rates[1,2]

	1994	1995	1996	1997	1998
21. Trade balance (% of GDP)					
United States	0.02	0.13	0.22	0.21	0.11
Japan	0.00	0.02	0.04	0.02	- 0.01
Germany (% of baseline GDP)	0.03	0.14	0.14	- 0.17	- 0.39
France (% of baseline GDP)	0.03	0.06	0.03	- 0.10	- 0.04
Italy	0.08	0.13	0.03	0.02	0.10
United Kingdom	0.31	0.51	0.29	0.27	0.41
Canada	- 0.15	- 0.64	- 0.11	1.09	0.45
Netherlands	0.02	0.09	0.13	0.10	0.01
Belgium	- 0.02	0.03	0.12	0.12	0.03
Spain	0.16	0.19	0.10	0.10	- 0.07
Austria	0.02	0.07	0.08	0.07	0.07
Switzerland	-	-	-	-	-
22. Net interest payments abroad (% of GDP)					
United States	0.00	0.00	0.00	0.00	- 0.01
Japan	-	-	-	-	-
Germany	-	-	-	-	-
France	0.09	0.06	- 0.04	- 0.01	0.01
Italy	- 0.16	- 0.14	- 0.03	0.00	0.00
United Kingdom	0.00	0.01	0.03	0.06	0.09
Canada	- 0.01	- 0.06	- 0.05	0.07	0.15
Netherlands	- 0.03	- 0.08	- 0.06	- 0.03	- 0.03
Belgium	0.00	- 0.02	- 0.01	0.00	0.00
Spain	0.01	0.01	- 0.00	- 0.01	- 0.01
Austria	-	-	-	-	-
Switzerland	-	-	-	-	-

Table III.1

Contributions to GDP by transmission channel

(central bank models)

Policy experiment: Temporary 100 basis point increase in short-term interest rates in 1994 and 1995 with endogenous exchange rates[2]

	Total[3]	Domestic channels	of which				Exchange rate channel
			Income/ cash flow	Wealth	Direct interest rate effect	Cost of capital	
First year after shock							
United States[4]	- 0.07	- 0.04	0.06	- 0.01	- 0.03	- 0.06	- 0.01
Japan	- 0.16	- 0.12	- 0.03	- 0.02	-	- 0.07	- 0.05
Germany	- 0.15	- 0.03	0.02	-	- 0.06	0.01	- 0.09
France	- 0.18	- 0.03	0.10	-	0.00	- 0.13	- 0.09
Italy	- 0.32	- 0.12	- 0.01	-	- 0.05	- 0.06	- 0.21
United Kingdom[5]	- 0.35	- 0.32	- 0.11	- 0.17	- 0.04	-	- 0.02
Canada[6]	- 0.22	- 0.11	0.00	- 0.01	- 0.08	- 0.02	- 0.11
Netherlands	- 0.10	- 0.03	0.00	- 0.01	- 0.01	- 0.01	- 0.07
Belgium	- 0.03	0.00	0.01	0.00	- 0.02	0.01	- 0.05
Spain[7]	- 0.05	- 0.02	0.00	- 0.01	- 0.02	0.01	- 0.03
Austria[7]	- 0.08	- 0.02	0.01	0.00	- 0.03	0.00	- 0.06
Switzerland	- 0.11	- 0.01	-	-	-	-	- 0.10
Second year after shock							
United States[4]	- 0.50	- 0.39	0.18	- 0.14	- 0.14	- 0.29	- 0.06
Japan	- 0.70	- 0.58	- 0.12	- 0.11	-	- 0.35	- 0.15
Germany	- 0.37	- 0.10	0.05	-	- 0.14	- 0.01	- 0.24
France	- 0.36	- 0.11	0.07	-	- 0.01	- 0.17	- 0.21
Italy	- 0.53	- 0.29	0.02	-	- 0.10	- 0.21	- 0.24
United Kingdom[5]	- 0.89	- 0.78	- 0.27	- 0.29	- 0.22	-	- 0.11
Canada[6]	- 1.15	- 0.63	- 0.02	- 0.11	- 0.39	- 0.11	- 0.50
Netherlands	- 0.18	- 0.12	- 0.01	- 0.03	- 0.03	- 0.05	- 0.07
Belgium	- 0.12	- 0.02	0.15	0.00	- 0.14	- 0.03	- 0.12
Spain[7]	- 0.02	0.00	0.00	0.02	- 0.02	0.00	- 0.06
Austria[7]	- 0.14	- 0.07	0.01	0.02	- 0.02	- 0.08	- 0.05
Switzerland	- 0.57	- 0.23	-	-	-	-	- 0.34
Third year after shock							
United States[4]	- 1.21	- 0.91	0.26	- 0.41	- 0.22	- 0.54	- 0.26
Japan	- 1.23	- 1.05	- 0.27	- 0.22	-	- 0.56	- 0.23
Germany	- 0.30	- 0.06	0.08	-	- 0.13	- 0.01	- 0.22
France	- 0.20	- 0.05	- 0.00	-	- 0.00	- 0.05	- 0.14
Italy	- 0.22	- 0.21	0.12	-	- 0.05	- 0.28	0.02
United Kingdom[5]	- 0.60	- 0.39	- 0.26	0.05	- 0.18	-	- 0.20
Canada[6]	- 1.28	- 0.87	- 0.03	- 0.29	- 0.40	- 0.15	- 0.31
Netherlands	- 0.15	- 0.14	- 0.01	- 0.03	- 0.02	- 0.08	- 0.02
Belgium	- 0.23	- 0.09	0.25	0.01	- 0.21	- 0.14	- 0.13
Spain[7]	- 0.03	- 0.01	0.00	0.02	- 0.01	- 0.02	- 0.05
Austria[7]	- 0.02	- 0.02	0.00	- 0.01	0.03	- 0.04	0.01
Switzerland	- 1.01	- 0.57	-	-	-	-	- 0.44

Table III.2

Contributions to GDP by transmission channel

(simulation results from the MCM model)

Policy experiment: Temporary 100 basis point increase in short-term interest rates in 1994 and 1995 with endogenous exchange rates

	Total	Domestic channels	of which: Income/ cash flow	of which: Direct interest rate effect	of which: Cost of capital	Exchange rate channel
First year after shock						
United States	- 0.46	- 0.34	0.04	- 0.07	- 0.31	- 0.13
Canada	- 0.65	- 0.27	0.04	- 0.04	- 0.27	- 0.37
France	- 0.68	- 0.33	0.02	- 0.04	- 0.31	- 0.36
Germany	- 0.72	- 0.28	0.08	- 0.07	- 0.29	- 0.45
Italy	- 0.44	- 0.12	0.26	- 0.05	- 0.33	- 0.33
Japan	- 0.61	- 0.40	0.02	- 0.05	- 0.37	- 0.22
United Kingdom	- 0.92	- 0.44	- 0.03	- 0.05	- 0.36	- 0.50
Second year after shock						
United States	- 0.58	- 0.48	0.09	- 0.11	- 0.46	- 0.11
Canada	- 0.61	- 0.28	0.06	- 0.04	- 0.30	- 0.34
France	- 0.70	- 0.39	0.04	- 0.04	- 0.39	- 0.30
Germany	- 0.65	- 0.28	0.12	- 0.07	- 0.33	- 0.37
Italy	- 0.30	- 0.07	0.43	- 0.06	- 0.44	- 0.25
Japan	- 0.81	- 0.62	0.04	- 0.07	- 0.59	- 0.21
United Kingdom	- 1.20	- 0.63	- 0.05	- 0.05	- 0.53	- 0.56
Third year after shock						
United States	- 0.17	- 0.15	0.08	- 0.08	- 0.15	- 0.03
Canada	- 0.05	0.05	0.02	- 0.00	0.03	- 0.10
France	- 0.10	- 0.02	0.02	- 0.01	- 0.03	- 0.08
Germany	- 0.03	0.06	0.05	- 0.01	0.02	- 0.07
Italy	0.11	0.14	0.23	- 0.02	- 0.07	- 0.05
Japan	- 0.31	- 0.24	0.03	- 0.04	- 0.23	- 0.08
United Kingdom	- 0.31	- 0.12	- 0.02	- 0.01	- 0.09	- 0.18

Table IV.1

Contributions to GDP by GDP component

(central bank models)

Policy experiment: Temporary 100 basis point increase in short-term interest rates in 1994 and 1995 with endogenous exchange rates[2]

	Total	Domestic demand	of which: Private consumption	of which: Government expenditure	of which: Private investment	Exports	Imports
First year after shock							
United States	- 0.07	- 0.08	0.00	0.00	- 0.08	0.00	0.01
Japan	- 0.16	- 0.14	- 0.05	0.00	- 0.09	- 0.02	0.00
Germany	- 0.15	- 0.12	- 0.08	0.00	- 0.04	- 0.11	0.08
France	- 0.18	- 0.26	0.04	0.00	- 0.30	- 0.05	0.12
Italy	- 0.32	- 0.35	- 0.08	- 0.01	- 0.26	- 0.07	0.11
United Kingdom[8]	- 0.35	- 0.56	- 0.27	0.00	- 0.29	- 0.06	0.21
Canada[9]	- 0.22	- 0.15	- 0.11	- 0.02	- 0.02	- 0.05	- 0.02
Netherlands	- 0.10	- 0.09	- 0.03	0.00	- 0.06	- 0.03	0.01
Belgium	- 0.03	- 0.03	0.01	-	- 0.04	- 0.05	0.05
Spain	- 0.05	- 0.11	- 0.03	0.02	- 0.10	- 0.07	0.13
Austria	- 0.08	- 0.09	- 0.06	-	- 0.03	- 0.08	0.09
Switzerland	- 0.11	- 0.16	- 0.04	- 0.02	- 0.10	- 0.11	0.17
Second year after shock							
United States	- 0.50	- 0.56	- 0.15	0.01	- 0.42	- 0.04	0.10
Japan	- 0.70	- 0.68	- 0.20	0.02	- 0.50	- 0.06	0.04
Germany	- 0.37	- 0.33	- 0.14	0.02	- 0.21	- 0.26	0.21
France	- 0.36	- 0.48	0.01	- 0.00	- 0.49	- 0.08	0.20
Italy	- 0.53	- 0.70	- 0.19	- 0.01	- 0.50	- 0.09	0.28
United Kingdom[8]	- 0.89	- 1.27	- 0.65	0.00	- 0.62	- 0.19	0.42
Canada[9]	- 1.15	- 0.87	- 0.67	- 0.09	- 0.11	- 0.28	0.00
Netherlands	- 0.18	- 0.27	- 0.10	0.00	- 0.17	0.03	0.06
Belgium	- 0.12	- 0.24	0.01	-	- 0.25	- 0.02	0.15
Spain	- 0.02	- 0.10	0.12	0.02	- 0.24	- 0.15	0.22
Austria	- 0.14	- 0.18	- 0.08	-	- 0.10	- 0.07	0.11
Switzerland	- 0.57	- 1.06	- 0.24	- 0.11	- 0.71	- 0.42	0.90
Third year after shock							
United States	- 1.21	- 1.31	- 0.45	0.01	- 0.87	- 0.14	0.24
Japan	- 1.23	- 1.21	- 0.36	0.04	- 0.89	- 0.08	0.06
Germany	- 0.30	- 0.28	- 0.07	0.03	- 0.24	- 0.18	0.15
France	- 0.20	- 0.17	- 0.03	- 0.00	- 0.14	- 0.04	0.01
Italy	- 0.22	- 0.32	0.00	- 0.01	- 0.31	- 0.06	0.14
United Kingdom[8]	- 0.60	- 0.85	- 0.47	0.00	- 0.38	- 0.20	0.37
Canada[9]	- 1.28	- 1.30	- 1.04	- 0.10	- 0.16	- 0.26	0.28
Netherlands	- 0.15	- 0.36	- 0.13	0.00	- 0.23	0.07	0.15
Belgium	- 0.23	- 0.50	- 0.05	-	- 0.45	0.04	0.22
Spain	- 0.03	- 0.17	0.10	0.01	- 0.28	- 0.09	0.22
Austria	- 0.02	- 0.13	- 0.04	-	- 0.09	0.03	0.07
Switzerland	- 1.01	- 2.24	- 0.50	- 0.18	- 1.56	- 0.51	1.73

Table IV.2

Contributions to GDP by GDP component

(simulation results from the MCM model)

Policy experiment: Temporary 100 basis point increase in short-term interest rates in 1994 and 1995 with endogenous exchange rates					
	Total	**Private consumption**	**Private investment**	**Exports**	**Imports**
First year after shock					
United States	- 0.46	- 0.05	- 0.29	- 0.07	0.05
Canada	- 0.65	- 0.01	- 0.26	- 0.18	0.20
France	- 0.68	- 0.07	- 0.29	- 0.17	0.16
Germany	- 0.72	- 0.06	- 0.28	- 0.23	0.16
Italy	- 0.44	0.20	- 0.29	- 0.17	0.19
Japan	- 0.61	- 0.16	- 0.32	- 0.10	0.03
United Kingdom	- 0.92	- 0.17	- 0.35	- 0.23	0.19
Second year after shock					
United States	- 0.58	- 0.13	- 0.42	- 0.06	- 0.03
Canada	- 0.61	- 0.15	- 0.35	- 0.11	0.00
France	- 0.70	- 0.22	- 0.40	- 0.11	- 0.03
Germany	- 0.65	- 0.20	- 0.36	- 0.15	- 0.06
Italy	- 0.30	0.35	- 0.37	- 0.13	0.15
Japan	- 0.81	- 0.39	- 0.44	- 0.05	- 0.07
United Kingdom	- 1.20	- 0.44	- 0.64	- 0.21	- 0.08
Third year after shock					
United States	- 0.17	- 0.12	- 0.10	- 0.00	- 0.06
Canada	- 0.05	- 0.11	- 0.08	0.01	- 0.14
France	- 0.10	- 0.18	- 0.08	0.01	- 0.15
Germany	- 0.03	- 0.14	- 0.07	0.01	- 0.17
Italy	0.11	0.32	- 0.08	- 0.03	0.10
Japan	- 0.31	- 0.34	- 0.10	0.02	- 0.11
United Kingdom	- 0.31	- 0.34	- 0.24	- 0.03	- 0.29

Table V

The response of domestic demand to a 100 basis point increase in policy-determined interest rates during eight quarters

(domestic channels only)

	First year	**Second year**	**Third year**
United States	- 0.08	- 0.58	- 1.30
Japan	- 0.13	- 0.68	- 1.19
Germany	- 0.10	- 0.22	- 0.13
France	- 0.21	- 0.32	- 0.06
Italy	- 0.21	- 0.56	- 0.43
United Kingdom	- 0.55	- 1.28	- 0.90
Canada	- 0.15	- 0.89	- 1.33
Netherlands	- 0.08	- 0.29	- 0.35
Belgium	- 0.02	- 0.10	- 0.26
Spain	- 0.19	- 0.22	- 0.22

Notes to the tables

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages. See the central bank contributions in this volume for definitions of the variables reported. The reported simulation results are annual averages.

[2] In the French, Dutch and Belgian simulations it is assumed that the nominal exchange rates between the six ERM countries Germany, France, the Netherlands, Denmark, Belgium and Luxembourg remain fixed. As opposed to the BIQM simulation results plotted in the graphs, the decomposition results shown in the tables are for the fully endogenous exchange rate case.

[3] The difference between the total and the sum of the domestic interest rate effects and the exchange rate channel is due to the interaction between the different channels and rounding errors. In the Bundesbank model it also includes the price-gap channel.

[4] In the MPS model the direct interest rate effect on consumption is the cost-of-capital effect on consumer durables spending. In the MTF model of the Bank of England, the direct interest rate effect is on total domestic demand and consequently might include income, substitution and cost-of-capital effects.

[5] In the MTF model of the Bank of England the income/cash-flow channel reflects the effect of interest payments on the retail price index and subsequently on spending. The wealth channel includes the effect of real balances, the capital stock and the net foreign asset position on domestic spending.

[6] The scenario reported is scenario 3 in Hunt et al.: an interest rate increase under inflation targeting, from the steady state. In the QPM model of the Bank of Canada the definition of the channels differs quite substantially from the ones agreed. See the discussion in Section IV of the main text and Hunt et al. If one adds the contribution of the wealth channel to the exchange rate channel and adds a share of the contributions of the cost of capital and income/cash-flow channel to the direct interest rate channel and the exchange rate channel according to their relative importance, the contributions of domestic versus exchange rate channels is respectively -0.09 and -0.13 in the first year after the shock, -0.44 and -0.69 in the second year after the shock and -0.47 and -0.71 in the third year after the shock.

[7] In the Spanish and Austrian models the reported wealth effect primarily works through real money balances.

[8] In the MTF model the decomposition in private consumption and private investment is rather mechanistic, as only total domestic demand is modelled. Moreover, the difference between the total effect on GDP and the sum of the components is due to a factor cost adjustment.

[9] In the QPM model private consumption includes residential construction and inventories, partly explaining the relatively large contribution.

APPENDIX

Summary of points of agreement regarding the policy simulations

The following are the econometric model simulations agreed upon at the 7th-8th September 1994 meeting at the BIS on central bank macroeconometric models and the monetary policy transmission mechanism.

I. THE POLICY EXPERIMENT

The common policy experiment to be conducted for the simulation comparison will be a temporary increase in the policy-controlled interest rates of 100 basis points during two years, after which the policy rates immediately return to baseline.

II. ASSUMPTIONS REGARDING EXCHANGE RATES AND FOREIGN INTEREST RATES

1. The effects of the policy experiment are to be simulated under two assumptions regarding exchange rates:

   (i) with fully endogenous nominal effective exchange rates;

   (ii) with exogenously fixed nominal effective exchange rates.

2. The implicit assumption under 1(ii) is that foreign interest rates also change in a way that is consistent with a fixed nominal effective exchange rate and the domestic interest rate change. The effects of such foreign interest rate changes on foreign output and prices are, however, ignored, except in those cases when these effects are endogenous to the model.

3. The countries that currently participate in the ERM have the option of replacing II.1(i) by assuming fixed nominal exchange rates within the ERM, but allowing non-ERM currencies to adjust.

4. A common procedure for endogenising the exchange rate would increase the comparability of the relative importance of the exchange rate channel across country simulations. One possibility, mentioned at the meeting, is for the ERM countries to adopt the exchange rate profile for the non-ERM currencies used by the Bundesbank. To the extent that this is acceptable to other central banks, they could similarly agree on the same profile for the nominal exchange rate.

III. CHANNELS OF TRANSMISSION

1. The total effect on real output of the simulation experiment under I. is to be decomposed by transmission channel and by GDP component. Each channel can be identified separately by using the full-model (Banca d'Italia) method suggested in the note by E. Mauskopf and S. Siviero. This method consists of simulating the effect of one channel at a time, and comparing the results with the baseline projection. It is preferred over the method in which the different channels are sequentially being shut down (as e.g. in the preliminary decomposition results of the Nederlandsche Bank) or opened up (as e.g. in the preliminary results of the Bank of England). It is also preferred over the method in which each channel is shut down at a time and the results are compared with the full effect simulation (as e.g. in the decomposition results of the Bundesbank). The difference between the total effect and the sum of the individual effects (which is due to interactions between the different channels) are to be reported in the column named "discrepancy".

2. To the extent that the model structure allows for their identification, the following five channels should be reported:

- the *income/cash-flow channel* measures the direct effect of an interest rate increase on net interest payments of the domestic private sector and subsequently on consumption and possibly investment through disposable income and cash-flow terms;
- the *wealth channel* captures the indirect effect of an interest rate increase on consumption through its effect on asset prices (such as stock prices and house prices) and, hence, the value of financial wealth;
- the *direct interest rate channel on consumption* captures the direct interest rate effects on consumption and corresponds to the intertemporal substitution effect, if the income and wealth channels are separately identified. To the extent that asset prices are not endogenously determined, it will also capture wealth effects;
- the *cost-of-capital channel* captures the effect of an interest rate increase on investment either directly or through the cost of capital;
- the *exchange rate channel* works through the effect of interest rates on the nominal exchange rate.

3. To the extent that other channels are important these may be separately reported.

4. As is pointed out in the note by E. Mauskopf and S. Siviero (e.g. p. 15), the full-model decomposition implies that a particular channel can activate some of the other channels. These second-round effects are included in the full effect of that particular channel. For example, a nominal interest rate increase will affect prices and the trade balance through the exchange rate channel. The change in prices due to the exchange rate change could activate the cost-of-capital channel through its effect on the real interest rate, while the deterioration of the trade balance could activate the wealth channel as net foreign assets are decumulated. These second-round effects will then be included in the exchange rate channel.

IV. CHOICE OF THE SIMULATION PERIOD AND BASELINE PROJECTION

1. The simulation period starts in the first quarter of 1994, so that initial conditions are determined by the state of the economies at the end of 1993.

2. The results from the simulations should be provided for a time period of at least five years. Where appropriate, longer-run properties (and simulation results) may be reported.

3. Where alternative initial conditions (e.g. other cyclical starting points, different balance-sheet positions) are viewed as critical to the results, central banks are invited to present additional simulations in order to highlight their effects. Central banks might also present the simulation results for a reduction in the policy interest rate, if it is felt that asymmetries exist with respect to the direction of the policy-induced change in interest rates.

4. Central banks may use their usual methods of determining the future paths of foreign exogenous variables necessary to construct a baseline projection. For the sake of standardisation, however, they may wish to conform to the projections from the IMF's World Economic Outlook.

5. Central bank modellers may maintain the fiscal policy "rules" embedded in their models (e.g. to ensure intertemporal budget solvency), if these fiscal policy rules are felt to accurately reflect the behaviour of the fiscal authorities. Otherwise, they may allow the automatic stabilisers to work and keep the exogenous components of real government non-interest expenditure fixed.

V. REPORTING FORMAT

1. The modelling groups are asked to report the baseline values of the main exogenous variables in Table I and for each simulation experiment the deviations from baseline of the main endogenous variables in Tables II and III. Deviations from baseline should be reported as percentage deviations if the baseline is in levels or an index, and as absolute deviations if the baseline itself is in percentages (indicated by a % sign next to the variable). The values reported in the tables should be average values for the year. Entries that are not relevant should be left blank. Please specify on a separate sheet the exact definition of the reported variables.

2. Table IV reports the contributions to real GDP changes by channel of transmission and by GDP component (see III). These should be reported as contributions to the percentage deviation of real GDP (See, for example, Table IV in the note of 12th August "Brief comments on the simulations experiments" by the Banca d'Italia).

3. In addition, we ask the modelling groups to provide the BIS with a diskette containing the quarterly deviations from baseline of each of the variables in Tables II and III for each of the simulated policy experiments. These files should be organised according to the same tables and could either be of a standard PC spreadsheet type (Lotus, Excel, if Quattro, please save in WK1-format) or a text file with the series in columns and the series names on top. To facilitate the processing of these results, it is asked to use the series names suggested in Tables II and III. The final two digits of the series names should be the identifier of the country: Austria=AT; Belgium=BE; Canada=CA; France=FR; Germany=DE; Italy=IT; Japan=JP; Netherlands=NL; Spain=ES; Switzerland=CH; United Kingdom=GB. For the United States MPS=MP; MCM=MC.

Table I

Baseline values of selected exogenous variables

	1993	**1994**	**1995**	**1996**	**1997**	**1998**
1. Foreign interest rates (%)						
2. Oil prices and other commodity prices						
3. Foreign prices						
4. Foreign output						
5. World trade						
6. Other important exogenous variables						

Note: For 1 to 6 please specify the exact definitions of the reported variables.

Table II

Interest rates, exchange rates and asset prices

Policy experiment[1]					
Deviations from baseline[2]	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%) (NPR..)					
2. Representative (3-month) short-term interest rate (%) (NSR..)					
Representative long-term interest rate (%) (NLR..)					
3. Mortgage rate (%) (NMR..)					
Bank lending rate (%) (NBR..)					
Deposit rate (%) (NDR..)					
4. Real short-term interest rate (%) (RSR..)					
Real long-term interest rate (%) (RLR..)					
User cost of capital (CC1..)					
(CC2..)					
5. Nominal effective exchange rate[3] (NEX..)					
Real effective exchange rate[3] (REX..)					
Important bilateral exchange rates (domestic currency per unit of foreign currency) (BX1..)					
(BX2..)					
6. Stock prices (STP..)					
House prices (HOP..)					
8. Monetary aggregate (M..)					
Total domestic credit (public and private) (DC..)					

Note: For 1 to 8 please specify the exact definitions of the reported variables.

[1] Please specify which policy experiment is simulated. [2] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign). [3] A positive number indicates an appreciation.

Table III

Real economic activity, price developments, fiscal developments and foreign sector

Policy experiment[1]					
Deviations from baseline[2]	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components:[3]					
Real GDP (GDP..)					
Private consumption (CON..)					
Government expenditure (GOC..)					
Private investment (PIN..)					
Residential (RIN..)					
Non-residential (NIN..)					
Inventories (INV..)					
Exports (EXP..)					
Imports (IMP..)					
2. Unemployment rate (%) (URA..)					
3. Real disposable income (RDI..)					
4. GDP deflator (DFL..)					
Consumer prices (CPI..)					
Wages/earnings (WAG..)					
Unit labour cost (ULC..)					
Import prices (IPI..)					
5. Government accounts (% of nominal GDP):					
Revenues (GRE..)					
Primary expenditures (GPE..)					
Interest payments (GIP..)					
Government budget balance[4] (GBA..)					
Public sector debt (DEB..)					
6. Current account (% of nominal GDP)[4] (CA..)					
Trade balance (% of nominal GDP)[4] (TB..)					
Net interest payments abroad (% of GDP) (IPA..)					

Note: For 1 to 6 please specify the exact definition of the reported variables.

[1] See footnote 1 in Table II. [2] See footnote 2 in Table II. [3] All GDP components should be reported as deviations from baseline. [4] A positive number indicates an improvement.

Table IV

Contributions to GDP changes by channel of transmission and by variable

Policy experiment[1]							
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consump-tion**	**Cost of capital**	**Exchange rate**	**Discrep-ancy**[3]
First year after shock							
GDP[2]							
of which:							
Private consumption							
Government expenditure							
Private investment							
Residential							
Non-residential							
Inventories							
Exports							
Imports							
Second year after shock							
GDP[2]							
of which:							
Private consumption							
Government expenditure							
Private investment							
Residential							
Non-residential							
Inventories							
Exports							
Imports							
Third year after shock							
GDP[2]							
of which:							
Private consumption							
Government expenditure							
Private investment							
Residential							
Non-residential							
Inventories							
Exports							
Imports							

Table IV (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment[1]							
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consump-tion**	**Cost of capital**	**Exchange rate**	**Discrep-ancy[3]**
Fourth year after shock							
GDP[2]							
of which:							
Private consumption							
Government expenditure							
Private investment							
Residential							
Non-residential							
Inventories							
Exports							
Imports							
Fifth year after shock							
GDP[2]							
of which:							
Private consumption							
Government expenditure							
Private investment							
Residential							
Non-residential							
Inventories							
Exports							
Imports							
Final year of simulation							
GDP[2]							
of which:							
Private consumption							
Government expenditure							
Private investment							
Residential							
Non-residential							
Inventories							
Exports							
Imports							

[1] See footnote 1 in Table II. [2] In percentage deviation from baseline. [3] Due to interaction between the different channels.

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The monetary policy transmission process in Australia: what do we know?

Glenn Stevens and Jenny Wilkinson[1]

I. INTRODUCTION

This note sketches some aspects of the monetary policy transmission process in Australia. The Reserve Bank of Australia does not at present maintain a fully integrated macroeconometric model.[2] It seemed, however, to be worth recording our ideas about how the monetary transmission mechanism works - the model which we "carry in our heads".

This model is in every important respect a mainstream one. It could be characterised as a standard open economy macro model for output determination in the short run, in which monetary policy changes have real effects. Potential output is more or less invariant to monetary policy, however, and the long-run effect of monetary policy changes are seen exclusively in prices. An expectations-augmented Phillips curve, suitably incorporating movements in traded goods prices, determines inflation. Inflation expectations have a large backward-looking component, but will respond to a change in actual inflation if it persists for a while.

This note draws on some existing research on aspects of the monetary transmission mechanism in Australia. It is by no means an exhaustive treatment. But while the studies referred to are mostly only partial in nature, they do provide useful insights into the effects of monetary policy on the economy; the obvious shortcomings of this approach should, nevertheless, be kept in mind.

II. THE TRANSMISSION CHANNELS

There are several channels through which changes in monetary policy are usually thought to have an effect on an open economy:

- intertemporal substitution - changes to the cost of debt or the return to savings are thought to have some impact on key components of spending - typically business investment and residential investment, and perhaps consumer spending on durables;
- wealth effects - changes in the value of financial and real assets occur with shifts in the interest rate used to discount their expected future returns. This may in turn affect consumption, investment or production decisions;
- cash-flow effects - with increases in nominal interest rates, savers' nominal incomes are increased and debtors' discretionary incomes decline. If borrowers are liquidity constrained - if they cannot borrow more or liquidate assets in order to maintain spending levels in the face of higher interest rates - then their spending would be forced to fall;
- credit-rationing effects - to the extent that higher interest rates are expected to lead to reduced output and profits, and/or reduced collateral values, the perceived riskiness of

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1 The opinions expressed here are those of the authors, and do not necessarily represent those of their employer.

2 There are, of course, macroeconometric models of the Australian economy in use. Two of the best known are the Treasury's TRYM model, and that developed in several incarnations by Chris Murphy, the latest of which is Murphy (1989).

some lending propositions may increase, prompting prudent lenders to curtail credit supply;

- exchange rate effects. Despite the difficulty of getting theoretical models of exchange rate determination to work empirically, a *ceteris paribus* increase in interest rates is usually expected to be associated with a short-term appreciation of the exchange rate. This alters the prices of, and hence the demand/supply balance for, tradables.

What about the effects on the inflation rate? This is, after all, the point of the exercise in implementing a change in monetary policy.

Here are three interrelated channels:

- changes in monetary policy affect activity and hence the output and/or unemployment gap, which in turn affects the course of inflation relative to expectations. This effect might come through changing profit margins and/or higher factor costs (in particular wages);
- changes in interest rates affect the exchange rate, which directly affects the prices of tradable goods. In a very open economy, this may be the dominant channel for monetary policy's effect on prices;
- changes in policy may influence inflation expectations themselves. There seem to be relatively few instances of announced policy tightenings directly affecting expectations without the above channels also working. But for monetary policy to have a lasting impact on inflation without a lasting effect on output, expectations that drive wage and price-setting behaviour must adjust.

III. MONETARY POLICY AND INTEREST RATES

Monetary policy is assumed throughout this analysis to work by affecting short-term interest rates. While on a conceptual basis there is some notional money demand function from which, if we knew its properties, we could read off the change in money associated with any given change in interest rates, little attention is given here to the role of monetary aggregates either in the transmission mechanism or as an intermediate target. This is a departure from earlier approaches in work at the Bank which gave a great deal of emphasis to the money stock as a key driver in the economy.[3] It reflects the pragmatic recognition of difficulties in interpretation of monetary aggregates since financial liberalisation accelerated in the early 1980s, which saw an apparent breakdown of empirical demand for money relationships (see Stevens *et al.* (1987), de Brouwer *et al.* (1993)). This will, no doubt, be a topic of ongoing research; as the effects of liberalisation settle down, a reliable relationship between money and nominal income or prices may re-emerge.

As in most countries, monetary policy in Australia affects directly only the shortest of short-term interest rates - interest rates on overnight funds in the interbank/authorised dealer market. In much of theory, on the other hand, it is long-term interest rates which are thought to be important, particularly for businesses' calculations of their cost of capital, and hence for investment decisions. Monetary policy's effect on these areas is therefore indirect, to the extent that long-term fixed rate debt contracts are important in the financial system.

In Australia, however, more so perhaps than in many economies, floating rate contracts are the dominant form of funding. The vast bulk of household mortgages are at floating rates, as is a large proportion of business loans. While there is a significant share of business financing which is of a fixed rate nature, it is mostly relatively short-term - interest costs tend to be fixed for, at most, a year

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3 A series of models developed in the late 1970s modelled the effect of monetary policy as a process of money demand-supply disequilibrium. See Johnson, Moses and Wymer (1976).

or two using the futures markets for bank-accepted bills. These rates are closely tied to overnight rates or to expectations about what monetary policy will do with overnight rates over the ensuing year or so. There is little in the way of a long-term private debt market - the only large-scale borrower at long-dated fixed interest terms is the government sector. Corporations seeking to borrow long-term largely do so in foreign centres, at rates which Australian monetary policy is unlikely to affect directly.

IV. INTEREST RATES AND ECONOMIC ACTIVITY

While there are several channels through which monetary policy affects economic activity, distinguishing between them empirically is not straightforward. Most recent research uses techniques which either combine several potential effects within one relationship, or which look for one specific channel only; there is little which seeks to quantify each channel separately but simultaneously.

Gruen and Shuetrim (1994), for example, estimate a single equation in which output growth is determined by real short-term interest rates, a weather variable,[4] and world economic growth in a simple error-correction framework.

Though a very simple equation, it tracks growth in the economy reasonably well over the period from the early 1980s to the present, and provides some interesting insights.

Graph 1 shows a simulation of the effect on the level of output of increasing real interest rates by 1% for eight quarters, holding other variables unchanged.[5] It illustrates that the effect of the monetary tightening on output is relatively rapid, peaking after nine quarters, at which point output is just over half of 1% below baseline. After five years most of the effect of the tightening has dissipated. This profile for output is qualitatively quite similar to the profile for some other countries in Gerlach and Smets' (1994) simulation (Figure 3 panel (b)), although the magnitude of the effect of the tightening is somewhat lower than many of their estimates.

After two years, the cumulative loss in output due to the tightening is equal to 0.47% of the initial year's output, and the tightening takes 0.37 percentage points off growth during the second year. In the long run, when output has returned to baseline, the cumulative loss in output is equivalent to 1.4% of a year's output. (In this case the "long run" is about seven years, though the bulk of the loss occurs in the first four years.)

It seems best to think of this as a reduced-form equation incorporating several transmission channels. It would be expected to capture, without distinguishing between, the effects of intertemporal substitution, changes in the exchange rate, and changes in wealth. It may not capture adequately the cash-flow and credit-rationing effects, if nominal interest rates, collateral values and interest rate spreads, which have not been included in the equation, are important aspects of these linkages. What can be said about these channels?

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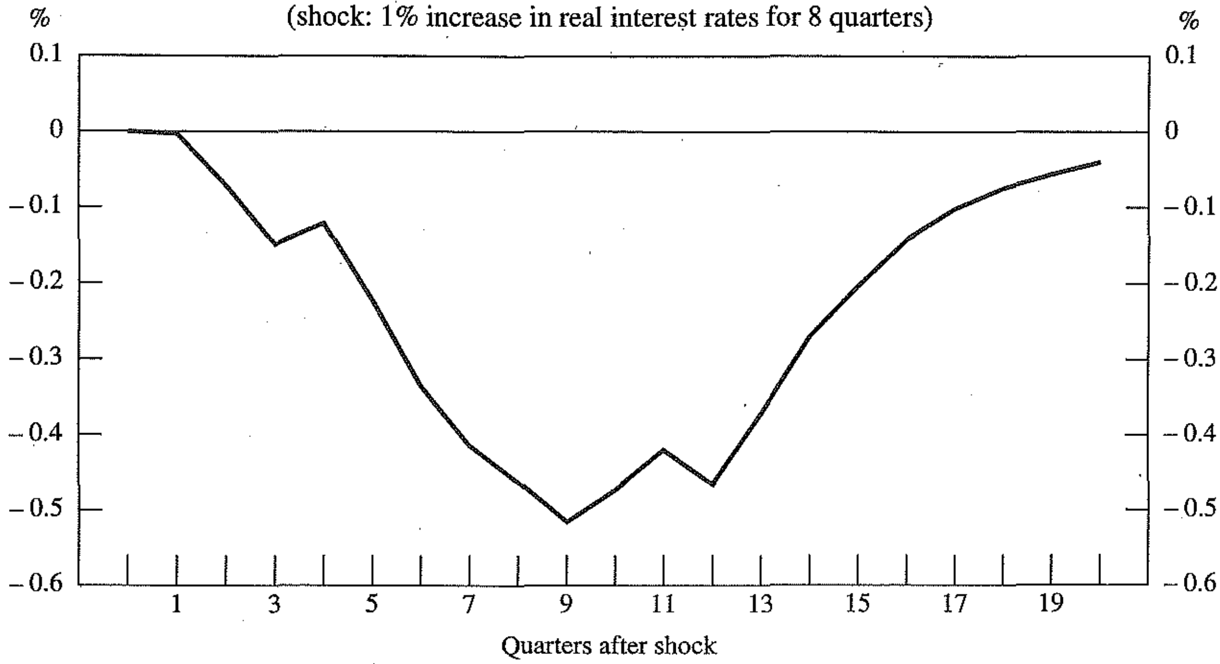
4 The weather variable used is the Southern Oscillation Index, which measures the difference in the sea level barometric pressure between Darwin (in Northern Australia) and Tahiti. This is a good indicator of trade winds over the Southern Pacific Ocean and hence rainfall in Australia, and is used to capture the influence of the weather on agricultural production and on growth in the wider economy.

5 We typically use real interest rates for these purposes, though nominal rates may have some additional importance if cash-flow effects are in operation. This is taken up below.

Graph 1

Real GDP: deviation from baseline

(shock: 1% increase in real interest rates for 8 quarters)



V. WEALTH EFFECTS

We do not have a great deal of knowledge about wealth effects. Two well-known macroeconomic models of the Australian economy - the Treasury's TRYM model and the Murphy model - both include wealth terms, based on the value of dwellings and the capital stock, in their consumption equations, but consumption is not particularly sensitive to policy-induced changes in wealth.

The main wealth changes of the past decade were the share market crash in 1987 - when Australian share prices fell by over 40% over a relatively short period - and the collapse of commercial property prices in 1989-91, when prices for key properties in Sydney fell by as much as 60%. Casual observation suggests that the contractionary effects of the share price fall were rather small. Certainly the economy continued to grow much more robustly than had been expected through 1988 and into 1989, and there were few apparent effects on consumption. Perhaps the reason for this is that the direct holdings of equities by Australians are not especially large; indirect holdings - through pension funds - are substantial, but changes in these asset values may not have much impact on the perceived wealth of the bulk of households, for whom retirement and access to funds is some way off, and therefore consumption may not be affected.

There was certainly very little in the way of a wealth effect through changes in house prices of the type observed in the United Kingdom and some other European countries. There was a substantial rise in house prices in 1988, but little subsequent fall. Unlike these other countries, moreover, the degree of leverage in the financing of the housing stock was rather low. Australian households have had rather conservative levels of debt as a rule, in part because of the very high levels of nominal interest rates, which until quite recently kept mortgage repayment-income ratios rather high. In the absence of a fall in house prices, and with low debt levels, there were few households who found themselves with "negative equity".

It is quite possible, however, that wealth effects may be much more important in the 1990s. The size of pension assets relative to GDP is rising, and nominal interest rates at quite low levels in recent years have seen a large increase in household debt. The full effects of financial liberalisation, including the capacity to borrow against the equity in a house, now seem to be emerging as well, with banks competing aggressively to lend to households. Some households may thus be much more exposed in the future to changes in house values.

The change in *commercial* property prices in the late 1980s may have had a more substantial effect, by working through the balance sheets of banks and others exposed to property loans, and certain highly-geared companies. It is difficult, however, to disentangle all this. The best we can say is that the interaction of asset-price changes, rising interest rates and poor balance-sheet positions did seem to have a dampening effect on economic activity (see below). It is not clear whether this was a once-off event, unlikely to be repeated in future cycles, or whether it is an endemic feature of liberalised financial markets.

VI. CASH-FLOW EFFECTS

Cash-flow effects are similarly difficult to pin down. Nominal interest payments as a ratio to income would be expected to be the key cash-flow constraint in the case of household mortgage decisions. Similar constraints may also work for firms, although changes in the value of collateral could be at least as important.

One quick way of testing for such effects is to include the ratio of interest payments to income in a growth equation, in addition to real interest rates, to see whether there is any improvement in performance. Internal work in the Bank of this nature has found that the additional variables are significant, but the short-term response seems to be perverse - the short lags of nominal interest rates have a *positive* sign. This could be a spurious correlation if, in the initial phase of adjustment, monetary policy is tightening at the same time that a range of other factors are causing borrowers to revise up their expectations about their future income prospects, so that it is only after some time that the combination of changing interest rates and altered expectations begins to have its effect.

The extent to which this cash-flow mechanism works must also be a function of the state of balance sheets. As noted above, Australian households have carried relatively little debt by world standards (see Kennedy and Andersen (1994)), increasing the difficulty of detecting the cash-flow effect empirically. In the case of businesses, balance-sheet conditions do appear to have affected business investment. Following financial deregulation in the 1980s, which saw a substantial increase in competition in the financial sector, many firms increased their leverage, some dramatically so. With the combination of higher interest rates and the slowdown in sales growth in the late 1980s, cash flows declined. Some firms were sufficiently exposed to these cash-flow pressures that they were forced to respond by substantially reducing their outlays, so that fixed investment, as a proportion of GDP, fell to its lowest levels in some 40 years. Mills, Morling and Tease (1994), using panel data, found that companies with high leverage were more responsive to changing economic conditions in terms of their investment expenditure than those with stronger balance sheets. In this way, the effect of monetary policy on the business cycle was heightened.

VII. CREDIT-RATIONING EFFECTS

Credit-rationing effects are difficult to test for, because *ex ante* credit demand and supply cannot be observed. A common approach is to examine the behaviour of interest rate spreads - either between riskless and risky assets, or the interest rate spreads imposed by financial intermediaries. Friedman and Kuttner (1992) found such a "spread" variable (between the Treasury bill rate and the commercial paper rate) was a significant explanator of growth and was an important part of the monetary transmission mechanism for the United States.

In Australia in the early 1990s, the gap between the marginal wholesale cost of funds to banks and bank loan rates may have been important. This gap widened during the recession and the initial stage of recovery, and early indications are that it has begun to narrow in the upswing of the interest rate cycle.

The pattern of spreads is consistent with the idea that lenders do not raise their loan rates by the full extent of their cost of funds, because to do so would leave only the more risky borrowers unlikely to take a loan, and that lenders curtail credit supply instead. In this view, credit-rationing amplifies the effect of monetary policy.

The pattern is also consistent, however, with the idea that in booms, where borrowers' cash flows and collateral values are high, lenders are keener to lend, while in slumps the reverse is true. Thus spreads move in such a way as to *offset*, in part, changes in monetary policy. This was the interpretation of Lowe (1994), who found that, in addition to cash rates, the spread between the business indicator rate and the overnight cash rate was a significant explanator of short-run output growth.

Identification of these effects could also be complicated to some extent by changes in the degree of competition in the financial sector. Lowe (1994) also discusses these issues more fully.

Overall, the evidence on credit-rationing effects *per se* could best be characterised as mixed. It does seem reasonably clear that spreads between intermediaries' funding costs and lending rates matter for the way in which interest rate changes are transmitted to the economy, but it is not clear what the mechanisms are that drive them.

VIII. EXCHANGE RATE EFFECTS

Changes in the exchange rate induced by monetary policy would be expected to affect the short to medium-term evolution of output in the traded sector. The demand for imports responds to exchange rate movements in the expected way, according to Horton and Wilkinson (1989). There is also some evidence that exports of manufactured goods respond to exchange rate changes (Bullock *et al.* (1993)), although this relies on estimation over a period in which a major one-time real exchange rate realignment occurred, and it is less clear what the response to marginal exchange rate changes would be. In the case of both rural and resource exports, it is difficult to isolate a relationship between the exchange rate and trade volumes, given the prevalence of major supply shocks and international price fluctuations. Gruen and Shuetrim (1994) estimate an equation including both the real short-term interest rate and the exchange rate. While this is not their preferred equation (they prefer an equation without an exchange rate term on econometric grounds), it does allow an estimate of the exchange rate effect. This suggests that a 1% increase in the real exchange rate for two years causes a cumulative loss of 0.25% of a year's output over the following two years. So there is plausible evidence that exchange rate changes do matter for economic activity (and prices - see below).

Drawing conclusions about the extent to which monetary policy changes, in particular, move the exchange rate, however, is far less straightforward. While theoretical models typically proceed on the basis of uncovered interest parity, the empirical evidence in favour of this hypothesis is far from clear. In an earlier paper for a BIS economists' meeting, for example, Macfarlane and Tease (1989) found that the standard version of uncovered interest parity was not well supported by the data.

One important reason for this is that exogenous events have sometimes led to exchange rate movements which were resisted with monetary policy. This occurred, for example, in the mid-1980s, when monetary policy was tightened temporarily to support an exchange rate under downward pressure at several key junctures; such episodes of reverse causation frustrate attempts to test empirically uncovered interest parity. A more general way of stating this problem is that the exchange rate and interest rates can be jointly affected by any number of shocks, particularly real as opposed to nominal shocks. A substantial body of work which has emerged on exchange rate determination in Australia suggests, for example, that the most important determinant of the real exchange rate over the medium term is the terms of trade. Conditioning for this, the real *long-term* interest differential between Australia and the major industrialised countries has been found in some studies to be important, whereas short-term real interest differentials are almost always found to be insignificant. Estimates in Gruen and Wilkinson (1992) and Blundell-Wignall, Fahrer and Heath (1993) imply that a 1 percentage point increase in the long real interest differential is associated with a real appreciation of between 2 and 3%. This adjustment occurs relatively rapidly. (Note that it does *not* imply necessarily that uncovered parity holds for long rates.)

Our knowledge of the exchange rate channel of monetary policy transmission is therefore fairly rudimentary. There are two ways we might proceed in arriving at an estimate of the effect.

First, we could assume that uncovered interest parity does hold for short rates, despite the difficulties of confirming that from the data. If we also assume that the temporary tightening in policy is known to be such by the financial markets, then the exchange rate should appreciate immediately from its (assumed) equilibrium by 2%, so that it can depreciate by 1% each year for the two years of the policy change. Using the elasticity from Gruen and Shuetrim above, this would result in a loss of output of about 0.25%, since the exchange rate is on average about 1% higher through the period.

A second procedure would be to impose the expectations hypothesis of the term structure, which would suggest that ten-year rates should rise by 0.2% for a two-year, one percentage point rise in short-term rates. This could be combined with empirical estimates of the effect of long-term interest rate differentials on the exchange rate and effects of the exchange rate on output noted above. The result of this procedure is that a 1 percentage point rise in nominal short-term interest rates which lasts for two years reduces output by about 0.1 to 0.2%.

These estimates suggest that the exchange rate channel would, at most, account for about half the full effect of a monetary tightening, and quite possibly something smaller. In the Treasury's model, exchange rate adjustments account for perhaps a quarter of the total effect of a monetary tightening on output. Numbers like this are plausible in our view. The Australian economy, with imports plus exports around 40% of GDP, is reasonably open compared with, say, the United States, but it is not so open that we would expect the effect of monetary tightenings to come *exclusively* via the exchange rate channel.

IX. MONETARY POLICY AND INFLATION

Similar issues confront attempts to estimate the effect of monetary policy on prices via the exchange rate. Empirical work by Dwyer, Kent and Pease (1993) finds that exchange rate changes are completely passed through to the over-the-dock price of imports within a year. Recent internal work following de Brouwer and Ericsson (1994) finds that a 1% change in over-the-dock prices leads to a 0.36% change in the consumer price level, but only about half of this occurs within two years. This suggests that if a 1% increase in short-term interest rates did raise the average exchange rate over the relevant period by 1%, the domestic price level could be reduced by about 0.2% after two years.

The impact of policy on prices via the output gap is harder to assess. Most standard equations for prices are some variant of a wage mark-up model, with prices based on unit labour costs, traded goods prices and an output gap term. Typically the output gap term has a significant but small coefficient. In our case, a 1 percentage point increase in real short-term interest rates, leading to the loss in output discussed above, is estimated to reduce inflation via the output gap channel by around 0.2 percentage points by around the end of the second year.

On top of this, the fall in output increases unemployment relative to the assumed NAIRU and therefore reduces growth in wages, which reduces price inflation further. With the institutional arrangements in the Australian labour market changing in a fundamental way at present, however, we are not confident we have a good wage equation, nor a good handle on how inflation expectations of wage earners adjust. Wage equations previously published in the literature tend to suggest that the NAIRU in the 1980s was in the 6-8% range, that *changes* in the unemployment rate as well as its level are important, and that "insider" labour market variables matter as well as general labour market conditions.[6] There must also be some uncertainty about whether the NAIRU has changed, and in which direction, in the aftermath of a deep recession and initially slow recovery, changes to the wage bargaining system and a large increase in expenditure on employment subsidies and training.

One way of circumventing these difficulties in articulating all the different channels might be to use the broad "sacrifice ratios" for post-war disinflations summarised in Stevens (1992), which were drawn from several sources and methodologies, since these in a very rough sense should embody the broad characteristics of the short-run Phillips curve. These suggest that a cumulative loss equivalent to 1% of a year's output reduces inflation permanently by somewhere between one-third and two-thirds of a percentage point. This takes several years.

If the interest rate effects on output discussed above are about right, then a 1 percentage point increase in the real interest rate over two years should lead to a reduction in inflation of between 0.5 and 0.9 percentage points in the long run. This occurs via a short-term widening of the output gap which affects actual and hence expected inflation.

Note that this reduction in the rate of inflation is permanent in our view of the world because even backward-looking expectations respond, in time, to lower actual inflation. The key requirement is that the persistence of the imposed policy shock be sufficiently long relative to the time lags embodied in the expectations formation process. In empirical models of Australian price determination, lag lengths are usually up to two years, so that a two-year period of tighter policy, which affects output and hence actual inflation via the short-run Phillips curve for several years, will have a permanent impact on the inflation rate.

The price level is then growing at a different rate compared with the baseline case, in contrast with some of the other model work in the BIS project (e.g. the Bank of Canada model, or the SVAR models in papers by BIS staff). In these models, policy reaction functions embedded implicitly or explicitly within the model essentially undo whatever fall in inflation is brought about by the policy shock, so that the trend increase in the price level in the very long run is unchanged, with prices simply at a lower level.

X. CONCLUSION

This note has outlined some aspects of the process by which monetary policy is thought to affect the Australian economy. The empirical orders of magnitude outlined and the lags involved, while subject to all sorts of qualifications, appear on the whole to accord with common sense and to be not dissimilar to results reported by a number of other countries or other macroeconomic models for Australia. That said, a very wide margin of uncertainty attaches, in our view, to any such estimates.

Our judgement is that intertemporal substitution, cash-flow and exchange rate effects are probably the most important channels of monetary policy's influence on output. We are inclined to put little store in wealth effects *per se* or widespread systematic credit-rationing effects. Two important caveats here are, first, that the *interaction* of asset price changes, balance-sheet positions and an interest rate induced squeeze on cash flows did seem to matter greatly for corporates in the 1980s, and may do so increasingly in the 1990s for households. Second, interest rate spreads do seem to matter, even though there is not widespread agreement on what drives them.

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6 Further discussion of these issues can be found in Stevens (1992) and Reserve Bank (1993).

On inflation, monetary policy seems to work mainly via the output/unemployment gap and the exchange rate in the short term.

In our view, the areas where greatest uncertainty remains are, first, the determinants of inflation expectations, and, second, the linkages between interest rates and the exchange rate.

Ultimately, good monetary policy must rely heavily on affecting expectations. But we know little about this process. Recent events confirm in our view the importance of a country's track record on inflation as a key determinant of inflation expectations, at least those of financial markets. The expectations which drive inflation outcomes more directly, however, are not those of financial markets but of agents who actually set prices and wages. Whether or not these expectations are more easily influenced than those of financial markets is not clear. The way in which changes in inflation expectations feed into the wage-setting process in the context of changing labour market structures is a key near-term issue.

For a small open economy the exchange rate is an important link in the transmission of monetary policy changes both to the real economy and to prices directly. Movements in the exchange rate, however, are also directly influenced by many developments which are not driven by monetary policy. These need to be assessed accurately before a reliable assessment can be made of monetary policy's influence on the economy via the exchange rate channel.

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Transmission processes in the Austrian economy

Heinz Glück[1]

I. INTRODUCTION

The question whether at all and, in the affirmative case, to what extent and via which channels monetary policy actions are transmitted to the real economy is the classical problem of monetary theory and policy. Some recent developments have brought the issue back to the centre of the discussion. Among others, financial innovation, deregulation and liberalisation have rendered relationships, which were held stable before and could therefore be used to deduce at least some rough ideas about how this transmission might work, less reliable. Some countries, for instance, have therefore ceased to target monetary aggregates.

Another impulse for new research on this issue, and especially to compare empirical results among countries, came from the preparatory work for the European Monetary Union (EMU) and for the installation of a common currency in the European Union (EU). Obviously, very different quantitative impacts and channels of transmission between the member countries would make the outcome of a harmonised monetary policy diffuse and unstable. Thus, closer examination of transmission processes in individual countries is necessary. In this context it is also interesting to investigate whether differences in financial structures and different stages of the evolution of the countries' financial markets have an influence on the transmission process, and, if this is the case, whether there will also be a convergence of transmission processes if the individual economies - and their financial structures - converge.

Finally, the currency turbulences of 1992-93 raised the question whether the efficiency of monetary policy instruments to control such disturbances had decreased and whether this might also be caused by changes in financial structures and transmission mechanisms.

In spring 1994, the Bank for International Settlements (BIS) started a project to address some of these questions. Its aim is to compare, in a first step, forms and relative magnitudes of transmission processes in individual countries in reaction to monetary policy changes (especially of changes in policy-controlled interest rates) and to identify different channels of transmission. From this it will eventually be possible to draw some conclusions concerning the questions raised above.

This paper deals with the Austrian results in the context of this project. Section II explains the concept of monetary and exchange rate policy in Austria; Section III describes in short the model used. In Section IV the design of the simulation experiment is explained and the corresponding results are discussed. Section V shows the disaggregation of the overall effects into the relative effects of five transmission channels, and Section VI, finally, draws some conclusions.

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1 The views expressed in this paper are the author's, not necessarily those of the institution with which he is affiliated.

II. THE CONCEPT OF AUSTRIAN MONETARY AND EXCHANGE RATE POLICY

The concept of the monetary and exchange rate policy as used by the Austrian central bank is based primarily on the theoretical reasoning and the empirical results relating to the stabilising potential of fixed exchange rates which can be observed under specific circumstances. Further, it relies on the optimality of fixed rates in an optimum currency area with a country to which high economic interrelationships exist and whose structure is similar to its own, so that shocks generally have similar effects. If this country also follows a stability-oriented monetary policy, its currency can beneficially be used as anchor currency. Essential elements of the concept are also taken from the Scandinavian model of inflation which deals with the transmission of movements of world market prices into a small open economy.

As far as transmission is concerned, it is held that:

- especially the exchange rate exerts the highest influence on prices and wages;
- the small and medium-sized structure of the Austrian economy and the consequent relatively high importance of bank lending point to the probable existence of a credit channel; and
- the endogeneity of money demand following from the exchange rate policy excludes the possibility of a money channel.

The effects of variations of interest rates on the real economy, however, are expected to be small because of the dominance of medium and long-term loans with - to a considerable extent - fixed interest rates. Moreover, some interest subsidies are granted in order to mitigate the effects of high interest. Thus, when judging the profitability of an investment project, the interest rate seems to be of minor importance compared to sales expectations.

III. THE STRUCTURE OF THE MODEL

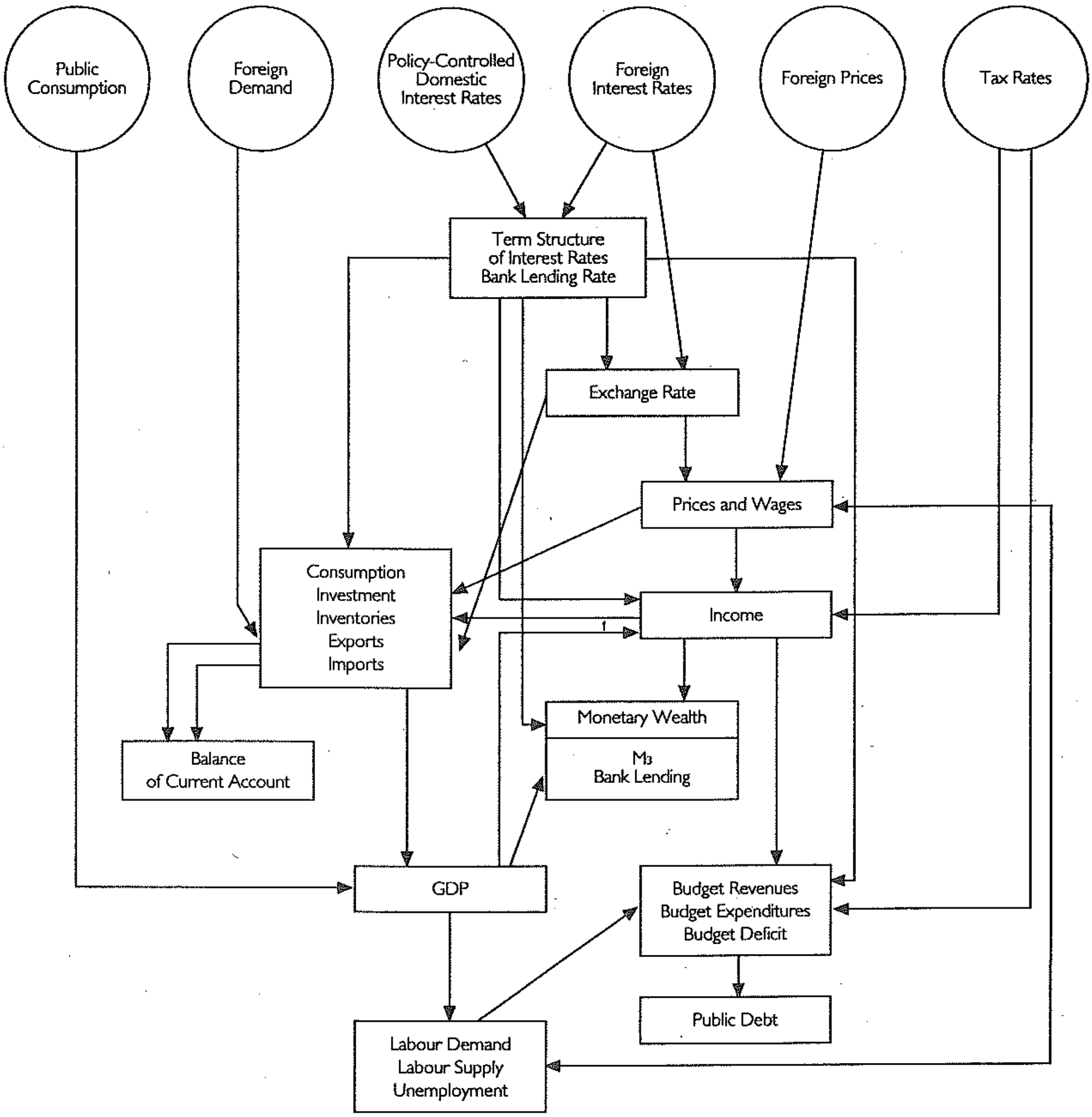
The model which is used for the purpose of the experiment is able to incorporate all the five transmission channels as defined for this exercise by the BIS.

These channels are:

- the income or cash-flow channel, which captures the direct effects of income changes of private households following the rise in interest rates and subsequently on consumption and investment;
- the wealth channel, which measures the indirect effects of an interest rate increase on the value of financial assets and consequently again on consumption and investment;
- the direct interest rate effect on consumption, which shows the reaction of consumption to changes in interest rates, mainly in the bank lending rate, and should also demonstrate the intertemporal substitution as a consequence of higher credit costs;
- the cost-of-capital or substitution channel, which shows the direct effects of higher interest on investment as well as the effects caused by changes in relative factor prices;
- the exchange rate channel, which works through the effects on the nominal exchange rate and consequently on prices and wages and from there on aggregate demand.

The structure of the model is shown in the following diagram. It exhibits a demand-oriented design which seemed most appropriate to deal with the problem under examination. The main line of impulses in the context of monetary policy simulations runs from the policy-controlled domestic and the foreign interest rates to the domestic term structure and the bank lending rate. The relationship between domestic and foreign interest rates influences the exchange rate. This, in turn, together with foreign prices, determines import prices which influence the domestic price and wage level. These aggregates, i.e. domestic interest rates, exchange rate, prices and wages, and the income thus generated, simultaneously determine the demand components, GDP, and income itself. This is the core of the model. The development of the balance of current account, money M_3, bank lending and monetary wealth, the labour market and the fiscal situation can be estimated from this in a straightforward way.

Simplified structure of the model



IV. THE SIMULATION EXPERIMENT

The simulation to be performed represents a standard question posed to each model concerning the effects of monetary policy actions by means of changes in the policy-controlled interest rate; we use here the discount rate. In the concrete case of the BIS experiment, this interest rate should be raised for two consecutive years, i.e. 1994 and 1995, and then return to the initial levels. The effects are to be observed for seven years, i.e. until the year 2000.

The assumed values for the exogenous variables over this period - necessary to produce a baseline scenario - are shown in Table 1. For linear models, as is well known, these values are, of course, not crucial for the simulation results.

Table 1

Baseline values of selected exogenous variables

	1993	1994	1995	1996	1997	1998	1999	2000
Call money rate, Germany	7.5	5.6	5.0	4.8	4.8	4.8	4.8	4.8
Three-month Euro-dollar rate	3.2	4.3	4.2	4.2	4.2	4.2	4.2	4.2
Oil prices: $/barrel	14.7	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Weighted consumer prices of main trading partners, %	3.8	3.1	2.8	2.8	3.0	3.0	3.0	3.0
Weighted real GDP of main trading partners, % ..	- 0.2	2.0	2.4	2.2	2.2	2.2	2.2	2.2
Real domestic public consumption, %	2.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8

These results[2] are shown in Tables I and II. Starting from the interest rates, we observe some initial overshooting for the money market rate, whereas the three-month rate and the long-term rate behave in a smoother way. Until the second year, the change in the discount rate is passed through almost fully to the bank lending rate, and this rise remains quite persistent, though on a lower level.

In view of the small effect on prices (see Table II), the changes in the real interest rates do not differ very much from the nominal ones. The change in the user cost of capital follows quite closely the change in the long-term interest rate, though it is smaller.

As far as the exchange rate is concerned, we follow - as in the estimation period Austria was not yet de jure a member of, but de facto closely linked to the ERM via its exchange rate policy - the assumption of fixed exchange rates vis-à-vis the hard-currency bloc within the ERM, but allowing the others to adjust. In view of this, the appreciation of the nominal (and real) effective exchange rates remains relatively small, as expected.

Very small changes are also exhibited for the real wealth variable, which, by lack of data in our case, only relates to financial wealth[3] and which enters the consumption and residential investment functions. The effects on interest payments, money M_3 and outstanding credit correspond to expectations and need no further comment.

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2 All calculations were performed by the system STS.

3 I owe thanks to Johann Maurer of Creditanstalt-Bankverein for supplying these data.

As far as the effects on the real side of the economy are concerned, we observe that the consequences of the two-year increase in the discount rate by one percentage point amount to only somewhat more than one-tenth of a percentage point reduction in real GDP in the second year of the shock; this effect also, however, dies out very soon. The changes in private consumption are equally small, though more persistent because of the long lags in the wealth effect (see below).

Residential investment reacts modestly as there exist in Austria some special and partly subsidised forms to finance constructions which do not - or only very slowly - react to interest changes. Compared to this, the effects on non-residential investment are considerably higher. The changes in inventories seem very large but, as this aggregate behaves in a very volatile manner and moves around zero, this may not be surprising; the weighted impact on GDP is small.

Exports suffer from the exchange rate appreciation and later also from rising unit labour costs. Imports, on the other hand, do not gain, as they are dampened by shrinking domestic demand. The overall effect on the trade balance and balance of current account remains negligible.

The unemployment rate, surprisingly at first glance, falls marginally in the wake of the discount rate rise. This is due, however, to the well-known fact of labour-hoarding, which has at least in the past been frequently observed in Austria, and to the fact that the factor price relation changes in favour of labour. Thus, despite the fall in real GDP, labour demand remains practically unchanged. On the other hand, the labour supply reacts negatively to the worse economic conditions, so that this phenomenon of a slightly falling unemployment rate comes about.

In the first year, real disposable income rises because of the interest payments and the fall in deflators, but in the following years the reduction in economic activity turns the change into the negative.

Prices are mainly affected by the reduction in import prices following the exchange rate appreciation, which is passed through to the domestic price level; the effects are quite small. Unit labour costs rise in the first two years as GDP falls, and wage rates react only with a time-lag; later on, however, as wages fall, unit labour costs are also reduced.

The results for the government account in terms of nominal GDP are somewhat distorted by the fact that nominal GDP itself changes compared to the baseline scenario. The deviations from this scenario, however, are rather small.

V. DECOMPOSITION OF TRANSMISSION CHANNELS

In the next step, the decomposition of the overall simulation result into the relative contributions of the five transmission channels as described above is tried; in doing so, we follow the "Banca d'Italia method".

The results are shown in Table III. The high complexity of the model, of course, did not allow a "clean" disaggregation with the sum of the individual channels' contributions adding up exactly to the result of the overall simulation. The discrepancies, however, did not become too large; so it seems possible to state the following:

- the income effect obviously tends to be very small;
- the wealth effects operates on rather long lags and gains some relative weight only from the fourth year on;
- on the other hand, the direct interest rate effect on consumption seems to be important only in the first three years, but quickly dies out afterwards;
- the cost-of-capital channel shows effects only from the second year on and then gains considerable relative weight, but fades away in the fourth and fifth years. Not

surprisingly, it shows its largest influence - with the exception of inventories, which, however, have to be handled with care - on non-residential investments;

- the exchange rate effect immediately starts to work with high intensity and seems to be more persistent than the cost-of-capital effect, though in the third and in the fourth years it is clearly dominated by the latter;
- thus, quantitatively, the cost-of-capital and exchange rate channels seem to be the most important transmission channels in the Austrian economy. There are, however, as for the other channels, marked differences in lags and persistence of the effects of these channels.

VI. CONCLUSIONS

In general, the reported results confirm the hitherto prevailing reasoning about the transmission mechanism in Austria.[4] The effects of interest rate changes tend to be relatively small, pointing to some separation between monetary and real sector; this fact, in turn, makes the conduct of the Austrian exchange rate policy easier. The peg of the Austrian schilling to the Deutsche Mark assigns only a secondary role to interest rate policy, and the importance of short-term financial instruments is low. Further, a relatively large share of loans is granted on the basis of subsidised or low-interest schemes. Thus, interest rates cannot be considered as the decisive determinants for consumption and investment in Austria.

Taking this into account, some new insights, however, were gained concerning the relative importance of five transmission channels, which showed the cost-of-capital and the exchange rate channel to have the highest weights.

4 See Pech, H. (1994): "The interest rate policy transmission process - the case of Austria", in: Bank for International Settlements, *National Differences in Interest Rate Transmission*, Basle.

Table I

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Call money	1.10	0.84	- 0.20	0.05	- 0.01	0.00	0.00
Representative three-month interest rate	0.97	0.75	- 0.17	0.04	- 0.01	0.00	0.00
Representative long-term interest rate	0.32	0.37	0.10	0.05	0.02	0.00	0.00
3. Other interest rates (%)							
Bank lending rate	0.65	0.83	0.31	0.18	0.09	0.05	0.02
4. Real interest rates							
Call money (%)	1.12	0.39	- 0.14	0.09	0.01	0.01	0.00
Real long-term interest rate (%)	0.34	0.42	0.15	0.10	0.04	0.02	0.00
User cost of capital	0.15	0.17	0.03	0.02	0.01	0.00	0.00
5. Exchange rates							
Nominal effective exchange rate	0.22	0.15	- 0.06	- 0.01	- 0.02	- 0.02	- 0.02
Real effective exchange rate	0.20	0.11	- 0.12	- 0.06	- 0.04	- 0.03	- 0.02
6. Asset prices and wealth							
Wealth variables in the consumption function (real)	0.07	0.02	- 0.04	0.00	0.00	0.00	0.00
7. Net interest payments							
Household sector) Non-financial enterprises) .... Abroad)	0.86	1.54	1.33	0.82	0.41	0.03	- 0.32
8. Money and credit							
Monetary aggregate (M3)	- 0.61	- 0.18	0.48	- 0.03	0.00	- 0.03	- 0.02
Total domestic credit (public and private)	- 0.03	- 0.42	- 0.48	- 0.07	0.02	0.08	0.09

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.08	- 0.14	- 0.02	0.04	0.01	0.01	0.01
Private consumption	- 0.12	- 0.15	- 0.08	- 0.12	- 0.12	- 0.10	- 0.08
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential investment	0.00	- 0.15	- 0.24	- 0.02	0.08	0.03	0.04
Non-residential investment	- 0.11	- 0.65	- 0.67	- 0.16	- 0.04	0.03	0.06
Inventories	- 2.64	8.53	- 4.33	2.95	1.91	2.13	0.85
Exports	- 0.20	- 0.15	0.06	0.03	0.03	0.02	0.02
Imports	- 0.15	- 0.22	- 0.01	0.06	0.00	0.00	0.00
2. Unemployment rate	- 0.09	- 0.13	- 0.08	- 0.05	- 0.03	- 0.02	- 0.01
3. Real disposable income	0.09	- 0.04	- 0.15	- 0.06	- 0.04	- 0.02	- 0.01
4. Inflation and wages							
GDP deflator	0.02	- 0.01	- 0.05	- 0.05	- 0.03	- 0.01	0.00
Consumer prices	- 0.02	- 0.04	- 0.05	- 0.04	- 0.02	- 0.01	0.00
Wage rate/employee	0.00	- 0.11	- 0.18	- 0.09	- 0.03	0.00	0.01
Unit labour cost	0.15	0.05	- 0.23	- 0.17	- 0.06	- 0.02	0.00
Import prices	- 0.17	- 0.16	0.01	0.01	0.02	0.02	0.02
5. Government accounts (% of nominal GDP)							
Primary expenditures	0.04	0.11	0.14	0.13	0.12	0.12	0.11
Interest payments	0.03	0.07	0.06	0.05	0.03	0.02	0.00
Revenues	0.05	0.13	0.16	0.17	0.18	0.19	0.19
Financial deficit	0.01	0.02	0.02	0.05	0.06	0.07	0.07
Public sector debt	0.02	0.07	0.08	0.04	- 0.02	- 0.08	- 0.15
6. Current account (% of nominal GDP)	0.01	0.07	0.08	0.07	0.07	0.07	0.08
Trade balance	0.02	0.07	0.08	0.07	0.07	0.07	0.07

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table III

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
Percentage deviations from baseline	**Total**	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy**
Real GDP: first year after shock	- 0.08	0.01	0.00	- 0.03	0.00	- 0.06	0.00
Private consumption	- 0.12	0.01	0.00	- 0.11	0.00	0.00	- 0.02
Government expenditure (exogenous)							
Residential investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-residential investment	- 0.11	0.01	0.00	0.00	0.00	- 0.08	- 0.04
Inventories	- 2.64	0.22	0.00	0.00	0.00	- 1.82	- 1.04
Exports	- 0.20	0.00	0.00	0.00	0.00	- 0.19	- 0.01
Imports	- 0.15	0.01	0.00	- 0.05	0.00	- 0.11	0.00
Real GDP: second year after shock	- 0.14	0.01	0.02	- 0.02	- 0.08	- 0.05	- 0.02
Private consumption	- 0.15	0.02	0.02	- 0.08	0.00	0.00	- 0.09
Government expenditure (exogenous)							
Residential investment	- 0.15	0.02	0.00	0.00	- 0.08	- 0.04	- 0.05
Non-residential investment	- 0.65	0.06	0.11	0.00	- 0.58	- 0.05	- 0.19
Inventories	- 8.53	0.34	0.29	0.00	- 7.07	- 1.28	- 0.81
Exports	- 0.15	0.00	0.00	0.00	0.00	- 0.14	- 0.01
Imports	- 0.22	0.03	0.03	- 0.03	- 0.15	- 0.05	- 0.05
Real GDP: third year after shock	- 0.02	0.00	- 0.01	0.03	- 0.04	0.01	- 0.01
Private consumption	- 0.08	0.02	0.01	- 0.04	0.00	0.01	- 0.08
Government expenditure (exogenous)							
Residential investment	- 0.24	0.07	0.00	0.00	- 0.21	- 0.02	- 0.08
Non-residential investment	- 0.67	0.04	- 0.06	0.00	- 0.74	0.06	0.03
Inventories	- 4.33	0.18	- 0.12	0.00	- 4.16	- 0.31	0.08
Exports	0.06	0.00	0.00	0.00	0.00	0.05	0.01
Imports	- 0.01	0.01	- 0.02	0.05	- 0.09	0.06	- 0.02

Table III (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
Percentage deviations from baseline	**Total**	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy**
Real GDP: fourth year after shock	0.04	- 0.01	- 0.03	0.00	0.03	0.01	0.04
Private consumption	- 0.12	0.02	- 0.04	- 0.03	0.00	0.02	- 0.09
Government expenditure (exogenous)							
Residential investment	- 0.02	0.02	- 0.01	0.00	- 0.08	0.04	0.01
Non-residential investment	- 0.16	- 0.03	- 0.18	0.00	- 0.20	0.04	0.21
Inventories	2.95	- 0.11	- 0.57	0.00	3.27	0.00	0.36
Exports	0.03	0.00	0.00	0.00	0.00	0.02	0.01
Imports	0.06	- 0.02	- 0.06	0.01	0.05	0.02	0.06
Real GDP: fifth year after shock	0.01	- 0.01	- 0.01	0.00	0.00	0.01	0.02
Private consumption	- 0.12	0.01	- 0.05	- 0.02	0.00	0.02	- 0.08
Government expenditure (exogenous)							
Residential investment	0.08	0.00	- 0.02	0.00	0.06	0.02	0.02
Non-residential investment	- 0.04	- 0.04	- 0.05	0.00	- 0.06	0.02	0.09
Inventories	1.91	- 0.23	- 0.51	0.00	2.25	0.00	0.40
Exports	0.03	0.00	0.00	0.00	0.00	0.02	0.01
Imports	0.00	- 0.01	- 0.02	0.00	- 0.01	0.01	0.03
Real GDP: final year after shock	0.01	- 0.01	- 0.01	0.00	0.00	0.01	0.02
Private consumption	- 0.10	0.00	- 0.06	- 0.02	0.00	0.02	- 0.04
Government expenditure (exogenous)							
Residential investment	0.03	0.00	- 0.02	0.00	0.02	0.01	0.02
Non-residential investment	0.03	- 0.03	- 0.02	0.00	0.02	0.01	0.05
Inventories	2.13	- 0.48	- 0.45	0.00	2.46	- 0.09	0.60
Exports	0.02	0.00	0.00	0.00	0.00	0.02	0.00
Imports	0.00	- 0.01	0.00	0.00	0.00	0.00	0.01

The effects of monetary policy in the quarterly model of the National Bank of Belgium

K. Burggraeve, P. Butzen and M. Dombrecht[1]

I. INTRODUCTION

The transmission of monetary impulses to the rest of the economy is one of the oldest but also one of the most interesting subjects of monetary theory. The subject can be approached from different angles, such as by using small theoretical models, inspection and description of the financial and real structures of countries. In this paper we use a large-scale quarterly econometric model for the Belgian economy. The model was very recently built at the National Bank of Belgium.

The paper contains a short description of the model's main features, together with a short four-equation textbook version. The latter is especially designed to interpret the results of a number of simulations on the transmission effects of monetary policy in Belgium. These results are part of a simulation comparison project of central bank macroeconometric models conducted at the Bank for International Settlements. The objective of this joint venture is to increase understanding on the effects monetary policy may have on the economy in different countries. It may contribute also to the explanation of possible differences in these effects among countries, e.g. in terms of differences in financial structures. Moreover, by means of simulations, it should be possible to calculate the relative importance of the various channels by which changes in the policy controlled interest rate affect real GDP.

II. THE MONETARY POLICY EXPERIMENT

The policy experiment consists of a temporary increase in the policy controlled interest rate of 100 basis points during eight quarters, after which this interest rate returns to its initial value. A sustained shock was not retained because it could possibly generate explosive results in certain models. The results of the econometric model simulations are compared over a period of five years and this under two assumptions regarding the exchange rates. The first assumption excludes the exchange rate channel and hence keeps the exchange rates of all currencies exogenous. The second assumption treats the case of endogenous exchange rates. The countries which participate in the ERM were free to keep the exchange rates within the ERM fixed and to allow the non-ERM currencies to move as predicted by the Bundesbank econometric model.

Although, like in a concerted action of monetary policy, we simulate a common shock in the short-term interest rates, the simulation exercise is conducted without linkage of the various models. Therefore the impacts of possible imported effects are neglected.

In order to quantify the various channels of transmission, the full-model method, decomposing the full model simulations, was used. The remaining residual between the total and the sum of the decomposed effects is due to the presence of nonlinearities in the model.

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1 The authors are members of the research department of the National Bank of Belgium. They thank V. Périlleux and I. Maes for constructive comments and the members of the NBB modelling group for their cooperation. But the views expressed in this paper remain those of the authors and are not necessarily those of the National Bank of Belgium.

III. THE STRUCTURE OF THE NBB QUARTERLY MODEL

1. Money, monetary policy and interest rates

No money concept, either narrow or broad, has up till now been used as an intermediate objective of monetary policy in Belgium. The role of money in the model is therefore confined to its influence on the liability structure of the balance sheets of financial intermediaries (FI) and of the central bank. The model contains in fact demand equations for three monetary aggregates: M_0 (banknotes and coin), M_1 (M_0 and demand deposits in Belgian francs held by households and companies) and finally M_4BEF (all domestic financial assets up to one year in Belgian francs held by households and companies, including Treasury bills) (for estimation results on some of these money demand functions see Jeanfils, 1994). A change in the demand for broad money, net of base money, affects the short-term liabilities of FI. It will need an adjustment of FI's total assets. If this change in money demand is compensated by an opposite movement in the demand for assets expressed in foreign currencies it will affect domestic short and long-term interest rates and the exchange rate. All this means that money is considered to be demand driven (by transaction and portfolio considerations) and that demand shocks may affect interest and exchange rates.

The ultimate objective of monetary policy is keeping inflation low. In the model, monetary policy is endogenously derived from the maximisation of an objective function. The central bank is assumed to minimise a loss function that is quadratic in the deviations of inflation and of the expected real short-term interest rate from their target values, taken to be the corresponding German variables. The instrument of monetary policy is represented by the nominal short-term interest rate, and because of the openness of the economy, the exchange rate (w.r.t. the Deutsche Mark) appears as an intermediate target of monetary policy. According to this philosophy underlying monetary policy, it seems to be unrealistic to simulate a unilateral interest rate shock in Belgium without any change in the targets of monetary policy. Such a shock would effectively result in a regime shift, having consequences for the first and second moments of the distributions of market participants' expectations of f.e. exchange rates. In order to avoid these complications, the simulation experiment was interpreted in the context of a general temporary increase in short-term interest rates in the EMS countries, more specifically in the member countries of the former Exchange Rate Mechanism (ERM). For the sake of this experiment, the monetary policy reaction function was discarded and the short-term interest rate was considered to be exogenous.

The Deutsche Mark/Belgian franc exchange rate itself is explained in terms of an expected return differential on foreign as compared to domestic assets and of a risk premium represented by the sum of cumulated current account balances and cumulated central bank interventions in the exchange market, multiplied by a variable reflecting time varying variances of market participants' exchange rate expectations. Given the purpose of the current simulation exercise, the exchange rate equation was disconnected from the model, the Belgian franc exchange rates with the ERM currencies were kept constant (given the interpretation of a common interest rate rise), whereas the consequences of this European interest rate move on the Belgian franc exchange rates w.r.t. other countries were supposed to be equal to those simulated in the Bundesbank model.

The government bond yield (net of withholding tax) is estimated simultaneously with the demand for bonds by households and financial intermediaries (the Belgian bond yield equation is discussed in Périlleux and Wouters, 1994). Up till now the demand by non-residents and firms is left unexplained.

2. Financial intermediaries

The propagation of monetary policy impulses is largely carried by the reaction of financial intermediaries (FI). FI set their interest rates on short and long-term deposits and credits in reference to the interbank market rate, to the yield on the secondary market for government bonds and to their desired asset and liability structure. Since the volatility as well as the frequency of changes of rates set by FI are mostly lower than those of the corresponding reference market rates, they have been modelled using non-linear techniques that provide for (estimated) thresholds to be exceeded before FI adjust actual rates to their desired levels.

Since FI set interest rates on a large number of deposits and credits, these balance sheet items are demand-determined. The portfolio allocation decision of the FI is therefore limited to the allocation of the residual between demand-determined liabilities and demand-determined assets among government bonds and a rest term, mainly incorporating Treasury bills. It follows that the model did not test for any potential credit-rationing effects.

3. Households

The consumer maximises an expected intertemporal (but separable) utility function, with weights depending on the time preference and utility depending on the volume of consumption. The instantaneous utility is assumed to be of the isoelastic type. The use of this kind of utility function has some important consequences when modelling consumption and asset allocation: the elasticity of consumption w.r.t. total wealth is unity and the allocation of wealth is of the Markowitz-type and hence independent of wealth itself. The intertemporal consumption path is optimised w.r.t. the budget constraint, linking actual total (human and non-human) real wealth to previous period wealth, the real return on that wealth and real consumption. Wealth and hence consumption are stochastic because the future return on the portfolio is uncertain. The intertemporal maximisation is solved by dynamic stochastic programming. It leads to a consumption function that incorporates the following transmission channels of monetary policy (for more detail on the derivation of household behaviour see Dombrecht and Wouters, 1994):

- a substitution effect: an increase in the rate of interest favours future consumption as compared to current consumption. From the optimisation exercise it follows that only the short-term interest rate (which is considered to be the risk-free return) induces such a substitution effect. Other returns can be represented as the sum of the risk-free rate and a risk premium. It follows from the analysis that the intertemporal substitution effect in consumption is independent of these risk premia. In sum: an increase in the short-term interest rate (which in the model is a weighted average of short-term deposit rates set by the FI) induces a negative intertemporal substitution effect on real consumption expenditures;
- an income effect: the rise in the short-term interest rate stimulates households' interest income from short-term deposits. It also induces a large number of portfolio reallocation effects thereby changing the yields on a number of other assets (including dividend and rent yields) and the costs of debts. Following the short-term interest rate rise, the rates and yields on other assets will go up, thereby exerting upward pressure on the households' portfolio return (which in the model is calculated as a weighted average of their real and financial assets and debts). In sum: the increase in the short-term interest rate induces a positive income effect on real consumption, that is particularly important in a country like Belgium where consumers hold very large amounts of net assets;
- wealth effects: the upward movement of the long-term bond yield, following the rise in the short-term rate, induces portfolio reallocation effects, putting downward pressure on the secondary market prices for shares and dwellings. These depress the market value of household wealth and discourage real consumption expenditure. Furthermore second and higher round effects of changes in interest rates and yields, affecting the net financial surplus of consumers, will change their wealth and hence consumption. In sum: a rise in the short-term interest rate induces a negative wealth effect on consumption.

As mentioned above, the rise in short and long-term interest rates depresses the demand for houses. On the secondary housing market, prices will go down. This exerts a negative "Tobin's-Q-effect" on the supply of new houses and therefore households' investment expenditures decline. This will only be a temporary effect lasting as long as supply reduction meets the lower level of demand, thereby stabilising the prices of existing houses at their original level. At that time households will stop their disinvestments. It follows that the interest rate rise causes a temporary negative substitution effect on households' investment expenditures, resulting from a reallocation in households' portfolios out of real assets in favour of financial assets whose returns have increased.

4. Financial behaviour of the corporate sector

The current version of the model contains only three categories of corporate liabilities: long and short-term credits with the banking system and the issuance of new shares. Both short and long-term credit demand by firms are explained in terms of investment expenditures, the excess of credit costs w.r.t. the market rates, and by their net financial balance. Their demand for new capital is affected by their financial position, the price of shares on the stock exchange and their net financial balance.

5. The supply side

A primary objective of the model is the analysis of the interactions between the financial and real sectors of the economy and especially the analysis of the mechanisms by which monetary policy is transmitted. Hence, a strongly disaggregated structure of the economy was not really a preliminary requirement, but since we were aware of the obvious differences in the structure of production and output markets among sectors, we chose a minimal disaggregation into four production sectors: industry, market services, energy and public services.

The disaggregated approach together with the quarterly nature of the model urged the derivation of quarterly input-output tables. In Belgium the National Institute of Statistics indeed only provides an annual input-output table every fifth year. The corresponding voluminous job was executed taking care that the consistency between the value added and the spending approach of the national accounts in every quarter was preserved.

Leaving the public sector as largely exogenous the three remaining production sectors were modelled in the supply-side section of the NBB model specifying the following factor demands: capital, labour (total amount of man hours worked), materials and energy. Moreover an explicit distinction was made between the fixed factors capital and labour, which cannot be adjusted freely, and the flexible factors materials and energy. On the long-run factor demand equations were imposed the restriction of constancy of the income and price elasticities, the restriction of price homogeneity and the restriction of symmetry of the elasticities of substitution. The dynamic behaviour of the demands for capital and labour can be interpreted as being derived from a stochastic dynamic programming problem incorporating forward-looking expectations. Taking the law of motion of the desired or equilibrium variables as a first or second-order autoregressive process, it can be shown that an error-correction model can be obtained. But it must be admitted that the factor demand equations were not estimated simultaneously with the expectations formation scheme. The short-run demands for the flexible factors incorporate a spillover effect of the temporal disequilibria in capital and labour, which are due to delays in adjustment. In order to obtain total employment per sector, the working hours per person were additionally modelled. This strategy of modelling both labour variables (man-hours worked and working hours) avoids the unrealistic case of all adjustments in labour input taking place solely through employment with no change in the number of hours worked. Moreover for statistical reasons capital (which was found to be integrated of order two) was replaced by investment in the factor demand equations.

The user's cost of capital (UCC) includes the short as well as the long-term interest rate. This reflects the impact of the financial structure of companies that finance investments with long and short-term credits. In industry capital, labour and materials are substitutes. Capital and energy are complementary. In the market services sector a rise in the UCC has no effect on the demand for labour. Capital and energy inputs remain complements. Movements in the interest rate, through their effect on the UCC, cause changes in the demand for factor inputs, reflecting a substitution effect in the transmission channel of monetary policy.

6. The external sector

Import equations were estimated for industrial and energy goods. They are explained in terms of the ratio of domestic and foreign prices and by various final and intermediary demand components.

Export equations were specified for manufactured goods and for services. The exports of energy were kept exogenous. World prices, the own export price and a measure of "world" demand are the main explanatory variables.

7. Wages and prices

According to the supply side of the model also the labour market is assumed to be segmented into the three sectors industry, services and energy. The wage rate is considered to be the outcome of a bargaining process between employers and trade unions. The particular bargaining model that is used here is the so called "right to manage" model. In this framework, both parties negotiate the wage rate and afterwards the employers determine their demand for labour and therefore employment. Such a model seems to correspond to the Belgian reality of collective bargaining.

In the wage bargaining process, each party tries to obtain the highest possible utility over and above a minimum level that can be attained even in the absence of a bargaining agreement. Trade unions represent the population in demand of jobs. Their utility function therefore takes into account the preferences of those actually at work and of those who are unemployed. The firms are supposed to maximise profits, but are constrained by their production technology and by the demand for their output.

The wage equations that were finally estimated took into account automatic wage indexation and were formulated on a per hour basis. The unemployment rate exerts only a moderate influence on wage claims from the end of the 1980s onwards. The influence of the employed ("insiders") on the wage formation process is dominant given the presence of the sector-specific variables. An increase in the tax rates can only partially be shifted to the other party. Producer prices only play a role in the services sector. Gains of productivity induce a less than proportional increase of the real wage.

This kind of wage bargaining leads to real wage stickiness, such that shocks in the demand for labour are mostly translated into employment variations and not into real wage changes.

Prices were modelled according to the disaggregation of the supply side of the model. Since the distinction between domestic and import price statistics on the sectoral level was only available for total demand and not by destination (consumption, investment,...), in a first stage, two domestic prices per sector were specified: an export price and a price for products sold on the domestic market. Domestic firms are indeed supposed to discriminate between output markets. Both price equations include own marginal costs of production and the relevant competitor's price, as well as a tension variable reflecting non constant mark-ups. Some prices (e.g. the price of investment in housing) deserved a specific explanation.

In a second stage, the own domestic price and the import price explain the prices by destination or "buyer prices" by means of a weighted average. These prices are finally the ones used in the distinct allocation processes. VAT and excise duties generally appear at this level. In a general theoretical framework of "pricing to market" also some important import prices were explained in the model. These equations contain the domestic price as competitor price.

The general idea is thus that prices are set in monopolistic competition with mark-ups only moderately affected by tension variables, resulting in relative price stickiness: demand shocks are mainly translated in variations of quantities rather than by changes in mark-ups.

8. The government sector

The government budget constraint, that explains the government's net financial deficit, is used as a starting-point for modelling this sector. There are only a few built-in mechanisms which endogenously reduce the debt/GDP ratio, but overall time consistency on government finances was not imposed.

The government sector, which in fact consists of four main building blocks, is modelled in considerable detail. In what follows a quick overview of those blocks (expenditures, direct taxes, indirect taxes and social security) is given.

Government expenditures are by far the most exogenous part of this sector. Real government consumption is decided upon exogenously. The deflator for the "wage part" is modelled using the wage cost in the services. The deflator for the "purchases of goods" uses the consumer price index. Social and other current transfers to the households (excluding expenditures for unemployment) have been modelled with a simple built-in government reaction function. They are a positive function of GDP with unit elasticity and a negative function of the net financial surplus-GDP ratio. This kind of reaction function has not been found for subsidies, capital transfers and net transfers to the rest of the world. Unemployment expenditures are sensitive to business cycle fluctuations. The total amount of unemployed (derived elsewhere in the model) are (for the time being) exogenously allocated over some very different budget categories (unemployed for less than one year, one to two years, more than two years, temporarily unemployed, partially unemployed, elderly), and real unemployment allocations per person for each category are fixed.

Debt management is also left exogenous for the time being. Interest payments are calculated by applying representative interest rates to the outstanding debt categories (Belgian francs, foreign currency, long-term, short-term).

Direct taxes of individuals, independents and firms have been modelled in considerable detail. The main principle for income taxes (other than capital income) was to explain average tax rates as a positive log-linear function of the income level, a negative function of an index measuring the extent to which tax brackets have been indexed and some function of an index measuring the effect of structural changes (in the tax bracket levels and rates).

Indirect taxes, which have been split up in a number of categories (VAT, registration fees, excise duties, customs taxes and other indirect taxes), have all been modelled in nearly the same way. In all cases a representative (average) tax rate has been applied to the nearest (statistically available) taxable base.

With respect to the social security receipts, a lot of special policy measures have troubled the relatively clear and straightforward way in which employers', employees' and independents' contributions could be explained before. For that reason this part is only estimated since 1986 (avoiding an overdose of institutional dummies). Social contributions have in all cases been modelled as implicit contribution rates that are functions of the official rates.

The remaining elements of the government budget constraint, such as capital taxes and non-fiscal and non-parafiscal revenues, are left exogenous.

9. The treatment of expectations in the model

The treatment in the model of agents' behaviour is mostly derived from micro-underpinnings, implying intertemporal optimisation under dynamic constraints. One of the advantages of such an approach is the appearance of agents' expectations from their maximising behaviour. This observation has, of course, to be completed by a story about the way agents are supposed to form their expectations. A number of alternatives are available among which model consistent - rational expectations and adaptive expectations. In this section we indicate a number of places where in the model expectations have a potentially important role to play and how they have been treated.

In the household sector, consumption depends on the riskless return and the expected return on the portfolio, including financial assets and debts, shares and real estate. It also depends on expected labour income. It has been assumed that consumers, for the sake of their expectation formation, consider dividend yield, rent yield, interest rates, the market prices of assets and labour income to be generated by stochastic processes that are close to random walks with possible drift factors. In that case expected values are best approximated by actual values after allowing for drift.

Consumers' portfolio allocation behaviour of total wealth depends on expected risk premia (expected returns in excess of the risk-free rate) and the variance and covariances of expected returns. These second moments are held constant. The riskless interest rate is a weighted average of short-term interest rates, and the expected returns on risk-bearing wealth items are treated in the same way as they appear in the total expected return on the household portfolio.

Households' demand for government bonds is part of their portfolio allocation decision. It implies that the factors that ultimately explain the nominal government bond yield contain, among others, the elements that are present in the households' allocation process. Among them the expected nominal exchange rate, particularly against the Deutsche Mark, is important. These expectations are supposed to be reflected by the anticipated inflation differential between Belgium and Germany, assuming again that inflation expectations are derived from a random walk process. Foreign nominal shocks are known to generate considerable effects on domestic prices in a small open economy such as Belgium. If such shocks are specific to the Belgian economy, they will feed into inflation differentials and will be reflected in nominal long-term yield differentials. The monetary authorities will of course apprehend the same information and will therefore react (by increasing the short-term interest rate differential) in order to stabilise the exchange rate. Specific foreign nominal shocks are therefore seen to cause an upward or downward movement (dependent on the direction of the shock) of both long-term and short-term interest rates. Not only foreign, but also domestic shocks may generate inflation. An increase in real wage differentials may disturb inflation differentials and, through the inflation cum exchange rate expectations, will generate interest rate increases. If furthermore competitiveness deteriorates, the current account surplus declines and therefore exerts adverse effects on the Belgian franc risk premium in the exchange market. The exchange rate will tend to depreciate, necessitating the monetary authorities to raise short-term interest rates, a movement which long-term rates are bound to follow partially. In all of these cases nominal interest rates and inflation will be severely affected.

Wage formation does not depend on inflationary expectations. The reason lies with the traditional wage indexation system in Belgium. Wage bargaining is set in real terms and nominal wages quickly respond to changes in the observed price level (except in those periods when government interventions completely or partially neutralise the wage indexation mechanism). Profit maximisation under imperfect competition leads firms to set prices as mark-ups over costs. Mark-ups show weak dependence on domestic market conditions implying that demand shocks cause relatively large output adjustment and relatively small price variations.

10. The role of the financial structure

It is well-known that the financial structure is a crucial element in the transmission process of monetary impulses. Its presence in the model reaches far beyond the magnitude of the simple interest rate effects on the demand for money, on domestic absorption and on capital flows in traditional open economy IS/LM models.

The financial behaviour of the private non-banking sector is based on a portfolio approach. The resulting portfolio composition of households' net assets plays an important role in the riskless interest rate (responsible for the intertemporal substitution effect on consumption), which is a weighted average (with weights corresponding to the short end of the portfolio structure) of net short-term assets. Also the total return on the portfolio (which is responsible for the capital income effect in consumption) is conceived as a weighted average of all return or cost components taking into account the portfolio composition as it follows from households' optimal portfolio allocation. Belgian households hold large net assets (responsible for the wealth effect in consumption). The volatility of its market value largely depends on fluctuations of house and share prices. These prices follow from the portfolio allocation behaviour and from supply conditions. Also its composition depends on the portfolio allocation decisions made by the household sector. The global size of net wealth at book value is derived from the households' budget constraint.

Of course a large counterpart of net household wealth is net government debt (it should be noted that the net position w.r.t. the rest of the world is equally considerably positive). It follows that the large net creditor position of households weakens the interest rate transmission channel on consumption (because the income effect, being quantitatively important, may compensate the substitution and wealth channels of interest rate movements). But the overall effect very much depends on the reaction of the government to changes in its financial balance following interest rate shocks. If f.e. larger interest payments induce public authorities to save on other expenditure categories or to raise taxes, disposable labour income is adversely affected and may depress consumption to a degree that depends on the marginal propensity to consume out of labour income, where the latter may be larger than the propensity to consume out of capital income. Therefore even with the same total disposable income before and after the shock, consumption may in this case be negatively affected. Due to the particular assumption on expectation formation, households will not react to such a scenario in advance.

Financial intermediation is another important link between financial and real markets. One substantial element is the difference between market rates (on both the money and the capital markets) and the rates on deposits and lending practised by the banking system and faced by the households and firms. For some of those interest rates a substantial gap may occur w.r.t. (wholesale) market rates. Therefore the model contains a detailed analysis of the interest rate fixing by FI on a large set of financial instruments. These interest rates therefore help to explain the portfolio structure of households and the debt structure of companies (the latter in conjunction with the share price index, influencing their decisions to issue more capital). The direct financing by firms on the money and capital markets (e.g. commercial paper, bonds), although increasing in recent years, remains relatively unimportant. Therefore especially interest rates set by FI play a role in the investment decisions of households and companies.

Interest rates, however, are not the only potential financial factors explaining investment decisions. Another relates to credit rationing. Lenders may, instead of deciding on an interest rate rise, constrain credit for several reasons such as moral hazard (an increase in the borrowing cost may induce borrowers to increase the riskiness of the investment project) or because of adverse selection (with high interest rates, relatively risk-averse borrowers withdraw from the credit market, leading to a reduction in the quality of the loan portfolio of lenders). In both cases the resulting increased default risk may actually reduce the lenders' expected return on their credit portfolio. This type of credit-rationing effect is not included in the model. On the contrary the interest rate setting functions on credit instruments supplied by FI are mostly a positive function of credit demand by potential borrowers. But the model does contain a number of other elements related to yet another possible influence of the financial structure. This channel operates through the effects that quality of balance sheets and burden of debts may exert on risk premia incorporated in the final borrowing cost. The observed interest rates on credit instruments mostly correspond to those granted to prime borrowers, excluding therefore a large part of the premium related to the creditworthiness of any particular debtor. Some of these effects have been included in terms of a negative debt burden effect (mortgage loans related to the market value of the housing stock) on the demand for real estate and therefore on housing investment decisions. Also a profitability effect was included in the investment decisions of firms to account for the primary source of internal finance. In recessions therefore observed interest rates may fall, but the risk premium may well increase, thereby reducing the favourable impact that market interest rate reductions may have on investment expenditures.

11. A textbook version of the model

Although the model contains more than 500 equations, about half of them behavioural, it is attempted in this section to summarise the model in a much shorter, sort of textbook version. This reduced stylised version is not unique, in the sense that it takes into account some of the main characteristics of the simulation experiment.

In the goods market, supply is characterised by constant returns to scale in an environment of imperfect competition, whereas mark-ups over marginal costs react only moderately to changes in demand. These settings lead to the familiar observation that demand shocks are mainly translated, not into price changes, but rather in output adjustments.

Endogenous real demand for output originates in private consumption and investment expenditures. Real private consumption depends negatively on the real short-term rate of interest (substitution effect) and positively on the real (mainly long-term) portfolio return. The main element in the latter is the yield on government bonds, which affects consumption in opposing directions (a positive income effect and a negative wealth effect), but its net influence is positive. Private investment, both through the cost of capital for firms and through the housing market for individuals, depends negatively on the real long rate of interest. Furthermore, in this stylised version of the model, the exchange rate does not enter as an argument in aggregate demand because non-ERM exchange rate variations are less important for competitiveness and because we trust that including deviations from relative purchasing power parity as an argument in aggregate demand would complicate calculations but would not change the main conclusions. Finally, we did not impose time consistency on the government budget (the No Ponzi Game condition). Aggregate demand can therefore be described in the following semi-reduced form equation:

$$y_t = -a\left[i_t - \underset{t}{E}\left(P_{t+1} - P_t\right)\right] + br_t + z_t \qquad (1)$$

In what follows, all variables are in natural logs, except interest rates

where:
- y = real demand
- i = nominal short-term interest rate
- E = expectations operator
- P = output price level
- r = real long-term yield
- z = a number of exogenous demand stimuli related to the real government account and to real world demand

The real long-term bond yield is derived from supply and demand, the latter being cast in a portfolio framework, where domestic short-term assets and foreign bonds are substitutes to domestic bonds. It can be shown that this approach leads to the following expression for the real yield on domestic bonds:

$$r_t = (1-c)i_t + c\left[r_t * + \underset{t}{E}\left(P^*_{t+1} - P^*_t\right)\right] + c\left[\underset{t}{E}\left(S_{t+1}\right) - S_t\right] - \left[\underset{t}{E}\left(P_{t+1}\right) - P_t\right] + dRP_t \qquad (2)$$

with $0 < c < 1$

In what follows, asterisks (*) refer to foreign variables

where: S = exchange rate (price of foreign currency in terms of domestic currency)
RP= risk premium

Inflation is generated by both domestic (wages and a tension variable) and foreign origins (exchange rate and world prices).

$$P_t - P_{t-1} = e\left(W_t - W_{t-1}\right) + (1-e)\left[\left(S_t - S_{t-1}\right) + \left(P^*_t - P^*_{t-1}\right)\right] + fy_t \qquad (3)$$

where: W = nominal wage

Wages are fully indexed and the real wage rate is kept exogenous:

$$W_t - W_{t-1} = \left(P_t - P_{t-1}\right) + \left(v_t - v_{t-1}\right) \qquad (4)$$

where v = real wage rate

Exchange rate movements are related to relative purchasing power and to interest rates. The link between exchange rate changes and interest rate levels implies that interest rates do not only exert short-term portfolio reallocation effects, but also long-lasting flow effects as demonstrated in Wouters and Dombrecht (1992):

$$S_t - S_{t-1} = g\left[\left(P_t - P_{t-1}\right) - \left(P^*_t - P^*_{t-1}\right)\right] - hi_t \qquad (5)$$

with $0 < g < 1$

In the simulation experiment it is assumed that the monetary authorities peg the short-term interest rate, hence:

$$i_t = \bar{i} \qquad (6)$$

Finally, on expectation formation (in this case mainly concerning prices and exchange rates), it is assumed that economic agents consider future exchange rate movements to be related to inflation differentials, and the inflation rate itself to be generated by a random walk process:

$$\Pi_t = P_t - P_{t-1} = \Pi_{t-1} + \mu_t \qquad (7)$$

where: Π = inflation rate
μ = a random error

such that future inflation and exchange rates are predicted as:

$$\underset{t}{E}\left(\Pi_{t+1}\right) = \underset{t}{E}\left(P_{t+1}\right) - P_t = \Pi_t \qquad (8)$$

$$\underset{t}{E}\left(S_{t+1}\right) - S_t = \Pi_t - \Pi^*_t \qquad (9)$$

After making appropriate substitutions and holding real wages and foreign prices constant, the model can further be reduced to four equations in four endogenous variables: the real domestic long-term interest rate (r), domestic real output (y), domestic inflation rate (Π) and exchange rate movements $\left(S^\circ_t\right)$:

Model 1

$$r_t = (1-c)\bar{i} + cr_t^* - (1-c)\Pi_t$$

$$y_t = -a\bar{i} + a\Pi_t + br_t + z_t$$

$$\Pi_t = e\Pi_t + (1-e)S_t^\circ + fy_t$$

$$S_t^\circ = g\Pi_t - h\bar{i}$$

Setting $\alpha = a - b(1 - c)$, the following reduced form can be derived:

Model 2

$$r_t = \frac{(1-c)\left[(1-e)(1-g+h)\right]\bar{i} - (1-c)fz_t + c\left[(1-e)(1-g) - af\right]r_t^*}{(1-e)(1-g) - f\alpha}$$

$$y_t = \frac{-(1-e)\alpha(1-g-h)\bar{i} + (1-e)(1-g)z_t + (1-e)(1-g)bcr_t^*}{(1-e)(1-g) - f\alpha}$$

$$\Pi_t = \frac{-\left[(1-e)h + f\alpha\right]\bar{i} + fz_t + bfcr_t^*}{(1-e)(1-g) - f\alpha}$$

$$S_t^\circ = \frac{-\left[(1-e)h + f(g-h)\alpha\right]\bar{i} + fgz_t + bfgcr_t^*}{(1-e)(1-g) - f\alpha}$$

with $\alpha = a - b\,(1 - c)$

What can this model tell us about the effects of a permanent rise in the, otherwise pegged, nominal short-term (European - ERM) interest rate? The initial impact effects of such an interest rate increase are:

- tendency for the long-term real interest rate to rise;
- unfavourable effect on output;
- appreciation of the exchange rates with respect to non-ERM countries;
- tendency for the inflation rate to decline.

This policy is however potentially unstable (see for example the discussion in Blanchard and Fisher, 1989, Chapter 11, and Hunt, O'Reilly and Tetlow, 1994). The higher nominal interest rate together with the lower inflation rate make the real rate go up. The resulting deflationary effect on output and the appreciation of the exchange rate further decreases inflation and consequently raises further the real rate of interest, thereby reinforcing the deflationary effects on output, etc. In this case, the economy is trapped in a never-ending deflationary spiral.

Such an unstable outcome is not unavoidable in the model described above. One of the reasons is the positive income effect of the rise in the real long-term rate on consumption expenditures. One of the stability conditions of the model is given by

$$(1 - e)(1 - g) > f[a - b(1 - c)]$$

If the parameters f and a, measuring respectively the influence of the tension variable on inflation and the substitution effect in consumption, are not too large or conversely if the parameter b, measuring the net real interest rate effect on demand (which is positive due to a large income effect on consumption) is sufficiently strong, an interest rate pegging policy will not be unstable.

What remains true in this model is that:

- the monetary authority can control the inflation rate but not the price level. Since the latter contains a unit root, it can go anywhere;
- the monetary authorities can control exchange rate movements, but not the exchange rate level. The only way is to follow an objective of exchange rate stability. The interest rate rule required to stabilise the exchange rate can be derived from the reduced-form model as (we only consider exogenous shocks related to z):

$$\bar{i} = \frac{f.g}{(1-e)+f(g-h)\alpha} z_t \tag{10}$$

but this interest rate policy implies the following rate of inflation:

$$\Pi_t = \frac{f.h}{(1-e)h+f(g-h)\alpha} z_t \tag{11}$$

It would therefore seem that in this case control over the inflation rate is lost;

- conversely it can be derived that a policy rule designed to obtain zero inflation implies losing control over the exchange rate and even over exchange rate movements. These results are probably due to the hypothesis that the real exchange rate is in the long run not necessarily constant. This may be somewhat surprising but empirical evidence shows that purchasing power parity theory only holds in the very long run, if it holds at all.

If the inflation target is a zero rate of inflation, then the short-term interest rate should follow the following policy rule:

$$\bar{i} = \frac{f}{(1-e)h+f\alpha} z_t \tag{12}$$

from which it follows that relatively large values for z imply relatively high short-term interest rates.

The fixed exchange rates version of the model has the following reduced form:

<u>Model 3</u>

$$r_t = \frac{\left[(1-e)(1-c)+afc\right]\bar{i}+\left[1-e-af\right]cr_t^* - fz_t}{1-e-f(a-b)}$$

$$y_t = \frac{-(1-e)\alpha\bar{i}+(1-e)z_t+(1-e)bcr_t^*}{1-e-f(a-b)}$$

$$\Pi_t = \frac{-f\alpha\bar{i}+fz_t+bfcr_t^*}{1-e-f(a-b)}$$

with $\alpha = a - b\ (1 - c)$

IV. DISCUSSION OF THE SIMULATION RESULTS

1. Main effects of a temporary interest rate rise

The simulation results reported in Tables I.1-II.2 refer to a temporary increase in the short-term nominal interest rate during two years and a return to its previous level from the third year onwards. The results in Tables I.1 and II.1 were obtained under the hypothesis that all non-ERM exchange rates react to the change in the policy-controlled interest rate. The underlying assumption is that Belgium follows a coordinated increase in short-term ERM interest rates and that therefore their mutual exchange rates do not change. To enhance comparability of results obtained by other country models, we have imposed the trajectories of the ERM exchange rates with non-ERM countries from their simulated values in the Bundesbank model. In Tables I.2 and II.2, on the other hand, the underlying hypothesis is constancy of all (both ERM and non-ERM) exchange rates. It is therefore rather compatible with a coordinated world wide increase in the short-term rate of interest. It should be stressed, however, that the reported results do not include feed-back effects from changes in interest rates in other countries on f.e. world trade and from there on aggregate demand. Inclusion of such effects would indeed necessitate the use of a world model. In what follows the results of Tables I.1/II.1 and I.2/II.2 will be referred to as respectively the floating exchange rate (FLEX) and the fixed exchange rate (FIX) case.

The main results of the temporary increase in the short-term rate of interest can be summarised as follows:

- 25% of the increase in the short rate is translated in the long rate (yield on government bonds). The other rates of interest do not necessarily follow proportionally the market rate movements, due to the existence of threshold effects. Obviously an increase in the interbank rate with 100 basis points was not sufficient to move the rate on savings deposits;
- share and housing prices react negatively to the upward movement of interest rates. Supply in these markets (respectively supply of new shares by firms and supply of new houses) will react only with considerable delay. These delays, together with the changes in demand emanating from price effects on dividend and rent yields, cause cyclical adjustment processes in these markets;
- the effects on real GDP are in both cases (FLEX and FIX) very modest. According to the simple textbook version of the model, this is to be expected if (capital) income and substitution effects in consumption tend to compensate each other. And indeed the consumption effects seem to confirm this. It should be stressed, however, that time consistency was not imposed on the government budget deficit. If the public sector were to maintain a balanced budget all the time, the results might have been different;
- the moderate deflationary effects come from private investment, and more specifically from negative short-term effects on housing investment. Increasing long-term interest rates depress demand and prices of dwellings on the secondary market, discouraging investment in new houses. The reduced demand for houses will only be met by reduced supply through disinvestment (depreciation), bringing back prices of dwellings to original levels. This can take a lot of time, with the result that the policy simulated here induces the start of a housing cycle. Simulations with a permanent interest rate shock over a long time period reveal the occurrence of such a cycle which does not seem to dampen. In a way it is to be expected that such inherent cyclical tendencies in these markets may be reinforced by the policy measure studied here, which is itself part of a cycle: first an increase followed by a decrease in the rate of interest. Due to considerable lags in supply adjustments in the housing market, the latter starts a cyclical adjustment very similar to the well-known cobweb cycle;

- even in the FLEX case, the effects on exports are extremely modest, whereas the decline in real imports is mainly due to reduced investment expenditures. The overall effect on the current account is negligible;
- the short-term positive effect on real disposable income originates from increased interest income;
- weak effects on real output imply absence of any unemployment effects;
- weak effects on real output also imply only insubstantial domestic tension effects on inflation. This explains absence of price effects in the FIX case, whereas in the FLEX case price effects originate from exchange rate movements;
- because of higher interest payments on government debt, the government budget balance and public sector debt (both expressed in pct. of GDP) deteriorate.

2. Decomposition by transmission channels

The total effect of the temporary rise in the policy-controlled rate of interest on real GDP and on its components is decomposed into five transmission channels. The method used corresponds to the full - model methodology discussed in Mauskopf and Siviero (1994). The results are reported in Tables III.1 and III.2 respectively for the FLEX and FIX cases.

Given the temporary nature of the shock, we concentrate the discussion on the second and third year effects. Furthermore, we only discuss the FLEX case because it is the more general one. The main findings can be summarised as follows:

- the positive income effect on real GDP mainly stems from the positive capital income effect on consumption (due to the massive net asset position of Belgian households), which is partially offset by a rise in imports;
- there appears to be a small negative wealth effect on consumption, caused by the decline in share and house prices (market value effect). It is compensated by a positive wealth effect on housing investment. This effect comes from the reduced demand for mortgage loans, following the rise in the interest cost on these liabilities, but thereby reducing the households' debt ratio. The latter's improvement tends to cushion the decline in household investment;
- the direct effect on consumption channel measures an intertemporal substitution effect: with higher interest rates actual consumption is postponed in favour of future consumption. This also entails a deflationary effect on investment;
- the cost of capital channel is measured as an interest rate effect on investment, which is negative as expected;
- because the intra-ERM exchange rates remain fixed, exchange rate changes have only very moderate effects on international trade. The exchange rate channel is in this exercise therefore mainly a price channel. The decline in domestic currency import prices puts all domestic prices under downward pressure. It follows that real variables, such as real disposable income and real wealth, are not much affected (both the numerators and the denominators decline). The reduced rate of inflation induces, however, a higher real rate of interest which discourages investment expenditures and therefore real GDP;
- the overall picture reveals that the wealth channel is relatively unimportant in this exercise. The income and substitution effects on consumption are strong but tend to compensate each other. The cost of capital and the exchange rate effect are complementary in that they both tend to augment the real rate of interest and therefore depress investment. Their combined effects explain the total effects on real GDP. It should be stressed that these conclusions are specific to the kind of shock that has been studied here.

V. CONCLUSIONS

The purpose of this exercise was to analyse the transmission process of a 1% rise in the policy-controlled short-term interest rate in Belgium. It is part of a joint study by the G-10 central banks under the presidency of the Bank for International Settlements.

The objective of monetary policy in Belgium is low inflation. It is implemented through an intermediate exchange rate target: the Belgian franc is pegged to the Deutsche Mark. Under these settings a unilateral change in the short-term interest rate does not make much sense. It would boil down to not less than a regime shift. Therefore we interpreted the experiment as a coordinated rise in short-term interest rates in the member countries of the former European Exchange Rate Mechanism (ERM). As a consequence we only considered effects on exchange rates with non-ERM countries. To increase comparability of the results, the effects on non-ERM exchange rates simulated by the Bundesbank model were imposed on our simulations. In a second exercise we kept all exchange rates fixed.

The simulated increase in the short-term interest rate was a temporary upward movement of 100 basis points It is sustained for two years whereafter the interest rate returns to its previous level. The reason for considering a temporary shock is to avoid explosive outcomes connected with a permanent increase in interest rates. In Belgium such a policy would *ceteris paribus* give rise to an explosive snowball effect on interest payments on government debt. Such an outcome would occur due to the fact that we did not impose time consistency on government behaviour. Under certain sets of parameters explosive outcomes may occur for other reasons as well (continuing increase in the real rate of interest catching the economy in a never-ending deflationary spiral).

The paper includes a description of the main segments of the model, including a more formal textbook version which may be useful to interpret some of the simulation outcomes. These results indicate that the upward movement in short and long-term interest rates following the monetary authorities' policy action causes negative substitution effects on consumption, that, however, are compensated by positive income effects. The combined negative cost of capital and exchange rate effects cause an overall very moderate deflationary effect on real GDP. The results do indicate that large autonomous policy induced swings in short-term rates may cause long cycles originating in the housing market and propagating themselves in all GDP components, as well as in real GDP itself. It should be repeated, however, that the results were obtained by not imposing time consistency of government behaviour. If the public sector were to compensate the adverse effects on its financial balance following the rise in interest rates, it would have to save on other than interest expenses and/or raise taxes. In that case the temporary deflationary effects would have been stronger.

The exercise described in this paper was one of the first simulation experiments with the quarterly NBB model. Because of its young age, it is expected to incorporate recent advances in macroeconomic knowledge and in econometric practice. It also takes into account the most important structural characteristics of the Belgian economy. On the other hand, because of its young age, it may be potentially vulnerable to a number of serious or hopefully less serious child diseases. One of the obvious ways to proceed is to engage in a large number of useful and meaningful simulation experiments, such as these in the framework of this BIS project, to detect and to correct possible shortcomings.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)					
Deviations from baseline[1]	**Period 1**	**Period 2**	**Period 3**	**Period 4**	**Period 5**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Representative three-month interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.20	0.23	- 0.02	0.00	0.12
3. Other interest rates (%)					
Mortgage rate	0.11	0.31	- 0.01	- 0.06	0.04
Bank lending rate	0.75	0.95	0.21	0.00	- 0.01
Deposit rate	0.05	0.08	0.02	- 0.02	0.02
4. Real interest rates					
Real short-term interest rate (%)	1.14	1.34	0.31	0.02	- 0.26
Real long-term interest rate (%)	0.35	0.57	0.28	0.02	- 0.14
User cost of capital	0.56	0.53	- 0.17	- 0.28	- 0.28
	0.52	0.45	- 0.25	- 0.36	- 0.32
5. Exchange rates					
Nominal effective exchange rate[2]	0.37	0.76	0.56	0.32	0.32
6. Asset prices					
Stock prices	- 0.49	- 0.83	- 0.56	- 1.04	- 1.75
House prices	- 0.46	- 1.93	- 3.35	- 2.86	- 1.09
7. Money and credit					
Monetary aggregate	- 0.19	- 0.68	- 0.96	- 0.88	- 0.90
Total domestic credit (public and private)	- 0.42	- 0.68	- 0.62	- 0.54	- 0.06

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates an appreciation.

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in interest rates (all exchange rates exogenous)					
Deviations from baseline*	**Period 1**	**Period 2**	**Period 3**	**Period 4**	**Period 5**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Representative three-month interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.42	0.10	- 0.02	0.00
3. Other interest rates (%)					
Mortgage rate	0.13	0.38	0.13	0.02	- 0.02
Bank lending rate	0.75	0.95	0.21	0.00	- 0.01
Deposit rate	0.17	0.32	0.16	0.01	0.00
4. Real interest rates					
Real short-term interest rate (%)	1.00	1.00	0.00	0.00	- 0.01
Real long-term interest rate (%)	0.28	0.42	0.10	- 0.01	0.00
User cost of capital	0.60	0.66	0.05	- 0.01	0.00
	0.56	0.61	0.04	- 0.01	0.00
5. Exchange rates					
6. Asset prices					
Stock prices	- 0.96	- 1.77	- 1.01	- 0.32	- 0.15
House prices	- 0.22	- 0.77	- 1.31	- 0.80	0.09
7. Money and credit					
Monetary aggregate	- 0.13	- 0.56	- 0.74	- 0.44	- 0.21
Total domestic credit (public and private)	- 0.14	0.38	0.62	0.22	0.21

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)					
Deviations from baseline[1]	**Period 1**	**Period 2**	**Period 3**	**Period 4**	**Period 5**
1. Real GDP and its components	- 0.03	- 0.12	- 0.23	- 0.15	0.02
Real GDP					
Private consumption	0.01	0.02	- 0.07	- 0.10	0.00
Government expenditure					
Private investment	- 0.34	- 1.67	- 2.72	- 1.68	- 0.25
Residential	- 0.86	- 4.27	- 7.12	- 4.02	0.88
Non-residential	- 0.19	- 0.75	- 1.15	- 0.96	- 0.64
Inventories					
Exports	- 0.07	- 0.03	0.05	0.03	0.00
Imports	- 0.07	- 0.18	- 0.26	- 0.19	- 0.08
2. Unemployment rate (%)	0.00	0.01	0.05	0.07	0.04
3. Real disposable income	0.30	0.25	- 0.06	- 0.13	- 0.01
4. Inflation and wages					
GDP deflator	- 0.13	- 0.51	- 0.84	- 0.80	- 0.55
Consumer prices	- 0.14	- 0.48	- 0.79	- 0.81	- 0.55
Wages per hour	- 0.05	- 0.34	- 0.73	- 0.84	- 0.60
Unit labour cost	- 0.01	- 0.22	- 0.50	- 0.68	- 0.63
Import prices	- 0.33	- 0.76	- 0.66	- 0.39	- 0.32
5. Government accounts (% of nominal GDP)					
Revenues	0.04	0.11	0.17	0.16	0.09
Primary expenditures	0.05	0.15	0.18	0.05	- 0.06
Interest payments	0.29	0.42	0.22	0.20	0.16
Government budget balance[2]	- 0.29	- 0.44	- 0.20	- 0.08	0.01
Public sector debt	0.42	1.39	2.18	2.08	1.40
6. Current account (% of nominal GDP)[2]	- 0.01	0.01	0.09	0.09	0.02
Trade balance	- 0.02	0.03	0.12	0.12	0.03
Net interest payments abroad	0.00	- 0.02	- 0.01	0.00	0.00

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates an improvement.

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in interest rates (all exchange rates exogenous)					
Deviations from baseline[1]	**Period 1**	**Period 2**	**Period 3**	**Period 4**	**Period 5**
1. Real GDP and its components	0.00	- 0.01	- 0.11	- 0.09	- 0.01
Real GDP					
Private consumption	0.00	0.01	- 0.06	- 0.09	- 0.03
Government expenditure					
Private investment	- 0.16	- 0.77	- 1.37	- 0.62	0.10
Residential	- 0.32	- 1.62	- 3.36	- 1.32	0.89
Non-residential	- 0.11	- 0.46	- 0.66	- 0.41	- 0.17
Inventories					
Exports	0.00	0.00	0.00	0.00	- 0.02
Imports	- 0.03	- 0.12	- 0.18	- 0.08	- 0.01
2. Unemployment rate (%)	- 0.01	- 0.01	0.01	0.03	0.02
3. Real disposable income	0.35	0.36	- 0.03	- 0.14	- 0.02
4. Inflation and wages					
GDP deflator	- 0.01	- 0.03	- 0.04	0.01	0.04
Consumer prices	0.00	0.00	0.00	0.00	0.00
Wages per hour	0.01	0.01	- 0.01	- 0.05	- 0.02
Unit labour cost	0.00	0.02	0.09	0.04	0.00
Import prices	0.00	0.00	0.00	- 0.01	0.00
5. Government accounts (% of nominal GDP)					
Revenues	0.00	0.02	0.05	0.04	0.02
Primary expenditures	0.00	0.00	0.01	- 0.01	- 0.03
Interest payments	0.28	0.37	0.15	0.14	0.13
Government budget balance[2]	- 0.27	- 0.35	- 0.11	- 0.09	- 0.07
Public sector debt	0.19	0.57	0.85	0.82	0.71
6. Current account (% of nominal GDP)[2]	0.00	0.03	0.11	0.10	0.03
Trade balance	0.00	0.05	0.09	0.08	0.01
Net interest payments abroad	0.00	- 0.02	0.00	0.00	0.01

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates an improvement.

Table III.1

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)							
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy[2]**
Real GDP: first year after shock[1]	- 0.03	0.01	0.00	- 0.02	0.01	- 0.05	0.02
of which:							
Private consumption	0.01	0.03	0.00	- 0.03	0.01	0.00	0.01
Government expenditure							
Private investment	- 0.04	0.00	0.00	0.00	- 0.03	- 0.03	0.01
Residential private investment	*- 0.02*	*0.00*	*0.00*	*0.00*	*- 0.01*	*- 0.02*	*0.01*
Non-residential private investment	*- 0.02*	*0.00*	*0.00*	*0.00*	*- 0.01*	*- 0.01*	*0.00*
Exports	- 0.05	0.00	0.00	0.00	0.00	- 0.06	0.01
Imports	- 0.05	0.01	0.00	- 0.01	- 0.03	- 0.04	0.01
Real GDP: second year after shock[1]	- 0.12	0.15	0.00	- 0.14	- 0.03	- 0.12	0.01
of which:							
Private consumption	0.01	0.26	- 0.01	- 0.24	0.00	- 0.01	0.01
Government expenditure							
Private investment	- 0.25	0.02	0.01	- 0.02	- 0.15	- 0.15	0.03
Residential private investment	*- 0.17*	*0.00*	*0.01*	*- 0.01*	*- 0.09*	*- 0.11*	*0.02*
Non-residential private investment	*- 0.08*	*0.02*	*0.00*	*- 0.02*	*- 0.06*	*- 0.04*	*0.01*
Exports	- 0.02	0.00	0.00	0.00	0.00	- 0.03	0.01
Imports	- 0.15	0.14	0.00	- 0.13	- 0.11	- 0.07	0.03
Real GDP: third year after shock[1]	- 0.23	0.25	0.01	- 0.21	- 0.14	- 0.13	- 0.01
of which:							
Private consumption	- 0.05	0.38	- 0.02	- 0.33	- 0.02	- 0.01	- 0.06
Government expenditure							
Private investment	- 0.45	0.10	0.05	- 0.09	- 0.31	- 0.27	0.07
Residential private investment	*- 0.31*	*0.06*	*0.04*	*- 0.05*	*- 0.22*	*- 0.19*	*0.05*
Non-residential private investment	*- 0.14*	*0.04*	*0.00*	*- 0.04*	*- 0.09*	*- 0.08*	*0.02*
Exports	0.04	- 0.01	0.00	0.01	0.01	0.04	- 0.01
Imports	- 0.22	0.23	0.01	- 0.20	- 0.18	- 0.10	0.02

Table III.1 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption	Cost of capital	Exchange rate	Discrepancy[2]
Real GDP: fourth year after shock[1]	- 0.15	0.20	0.03	- 0.11	- 0.12	- 0.08	- 0.07
of which:							
Private consumption	- 0.06	0.20	0.01	- 0.09	- 0.01	0.00	- 0.17
Government expenditure							
Private investment	- 0.28	0.22	0.07	- 0.15	- 0.22	- 0.27	0.08
Residential private investment	*- 0.16*	*0.15*	*0.06*	*- 0.10*	*- 0.16*	*- 0.16*	*0.04*
Non-residential private investment	*- 0.12*	*0.07*	*0.01*	*- 0.05*	*- 0.06*	*- 0.12*	*0.04*
Exports	0.02	- 0.03	0.00	0.03	0.02	0.02	- 0.01
Imports	- 0.17	0.19	0.04	- 0.10	- 0.10	- 0.17	- 0.03
Real GDP: fifth year after shock[1]	0.02	0.12	0.04	0.01	- 0.05	0.03	- 0.13
of which:							
Private consumption	0.00	0.07	0.02	0.07	0.00	0.01	- 0.17
Government expenditure							
Private investment	- 0.04	0.24	0.06	- 0.11	- 0.09	- 0.13	- 0.02
Residential private investment	*0.04*	*0.17*	*0.06*	*- 0.06*	*- 0.06*	*- 0.01*	*- 0.05*
Non-residential private investment	*- 0.08*	*0.08*	*0.01*	*- 0.04*	*- 0.03*	*- 0.12*	*0.03*
Exports	0.00	- 0.05	0.00	0.04	- 0.02	0.02	0.01
Imports	- 0.07	0.14	0.04	- 0.01	- 0.05	- 0.12	- 0.06
Real GDP: final year after shock[1]	- 0.18	- 0.01	- 0.02	- 0.07	- 0.02	- 0.05	- 0.02
of which:							
Private consumption	- 0.20	0.13	- 0.01	- 0.05	0.00	- 0.01	- 0.25
Government expenditure							
Private investment	0.04	- 0.35	- 0.03	- 0.01	0.01	0.12	0.31
Residential private investment	*- 0.02*	*- 0.26*	*- 0.03*	*- 0.02*	*0.00*	*0.08*	*0.21*
Non-residential private investment	*0.06*	*- 0.09*	*0.00*	*0.00*	*0.01*	*0.04*	*0.10*
Exports	- 0.05	0.08	0.00	- 0.02	0.00	- 0.07	- 0.04
Imports	- 0.02	- 0.13	- 0.02	- 0.02	0.02	0.08	0.05

[1] Due to rounding errors, the contribution of variables may not add to the total effect. [2] Due to interaction between the different channels.

Table III.2

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (all exchange rates exogenous)

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Discrepancy[2]**
Real GDP: first year after shock[1]	0.00	0.01	0.00	- 0.02	0.01	- 0.01
of which:						
Private consumption	0.00	0.03	0.00	- 0.03	0.01	0.00
Government expenditure						
Private investment	- 0.02	0.00	0.00	0.00	- 0.03	0.00
Residential private investment	*- 0.01*	*0.00*	*0.00*	*0.00*	*- 0.01*	*0.00*
Non-residential private investment	*- 0.01*	*0.00*	*0.00*	*0.00*	*- 0.01*	*0.00*
Exports	0.00	0.00	0.00	0.00	0.00	0.00
Imports	- 0.02	0.01	0.00	- 0.01	- 0.03	0.01
Real GDP: second year after shock[1]	- 0.01	0.15	0.00	- 0.14	- 0.03	0.01
of which:						
Private consumption	0.01	0.26	- 0.01	- 0.24	0.00	0.00
Government expenditure						
Private investment	- 0.11	0.02	0.01	- 0.02	- 0.15	0.02
Residential private investment	*- 0.06*	*0.00*	*0.01*	*- 0.01*	*- 0.09*	*0.02*
Non-residential private investment	*- 0.05*	*0.02*	*0.00*	*- 0.02*	*- 0.06*	*0.00*
Exports	0.00	0.00	0.00	0.00	0.00	0.00
Imports	- 0.09	0.14	0.00	- 0.13	- 0.11	0.01
Real GDP: third year after shock[1]	- 0.11	0.25	0.01	- 0.21	- 0.14	- 0.02
of which:						
Private consumption	- 0.04	0.38	- 0.02	- 0.33	- 0.02	- 0.06
Government expenditure						
Private investment	- 0.22	0.10	0.05	- 0.09	- 0.31	0.03
Residential private investment	*- 0.14*	*0.06*	*0.04*	*- 0.05*	*- 0.22*	*0.03*
Non-residential private investment	*- 0.08*	*0.04*	*0.00*	*- 0.04*	*- 0.09*	*0.00*
Exports	0.00	- 0.01	0.00	0.01	0.01	- 0.01
Imports	- 0.15	0.23	0.01	- 0.20	- 0.18	- 0.01

Table III.2 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (all exchange rates exogenous)

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Discrepancy[2]**
Real GDP: fourth year after shock[1]	- 0.09	0.20	0.03	- 0.11	- 0.12	- 0.10
of which:						
Private consumption	- 0.06	0.20	0.01	- 0.09	- 0.01	- 0.17
Government expenditure						
Private investment	- 0.10	0.22	0.07	- 0.15	- 0.22	- 0.02
Residential private investment	*- 0.05*	*0.15*	*0.06*	*- 0.10*	*- 0.16*	*- 0.01*
Non-residential private investment	*- 0.05*	*0.07*	*0.01*	*- 0.05*	*- 0.06*	*- 0.01*
Exports	0.00	- 0.03	0.00	0.03	0.02	- 0.01
Imports	- 0.07	0.19	0.04	- 0.10	- 0.10	- 0.09
Real GDP: fifth year after shock[1]	- 0.01	0.12	0.04	0.01	- 0.05	- 0.13
of which:						
Private consumption	- 0.02	0.07	0.02	0.07	0.00	- 0.18
Government expenditure						
Private investment	0.02	0.24	0.06	- 0.11	- 0.09	- 0.09
Residential private investment	*0.04*	*0.17*	*0.06*	*- 0.06*	*- 0.06*	*- 0.06*
Non-residential private investment	*- 0.02*	*0.08*	*0.01*	*- 0.04*	*- 0.03*	*- 0.03*
Exports	- 0.02	- 0.05	0.00	0.04	- 0.02	0.01
Imports	0.00	0.14	0.04	- 0.01	- 0.05	- 0.11
Real GDP: final year after shock[1]	- 0.07	- 0.01	- 0.02	- 0.07	- 0.02	0.05
of which:						
Private consumption	- 0.06	0.13	- 0.01	- 0.05	0.00	- 0.12
Government expenditure						
Private investment	- 0.03	- 0.35	- 0.03	- 0.01	0.01	0.36
Residential private investment	*- 0.03*	*- 0.26*	*- 0.03*	*- 0.02*	*0.00*	*0.27*
Non-residential private investment	*0.00*	*- 0.09*	*0.00*	*0.00*	*0.01*	*0.08*
Exports	0.00	· 0.08	0.00	- 0.02	0.00	- 0.06
Imports	- 0.03	- 0.13	- 0.02	- 0.02	0.02	0.12

[1] Due to rounding errors, the contributions of variables may not add to the total effect. [2] Due to interaction between the different channels.

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The monetary transmission mechanism and policy formulation in Canada: an overview

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I. INTRODUCTION

The purpose of this paper is to bring together a number of recent contributions to the literature on the monetary transmission mechanism in Canada, as well as to interpret them from a policy-making perspective. It will contribute to the last step in a sequence of research initiatives undertaken by the G-10 central banks under the auspices of the BIS in an effort to reach a satisfactory mutual understanding of how and why monetary policy decisions are taken.

Taking a policy-maker's perspective is helpful to reaching an understanding of the monetary transmission mechanism, not least because there is a layer of considerations that can change the ultimate policy decisions relative to what would seem to be consistent with the underlying economic analysis. There are two major factors that could result in such a difference between "policy advice" and "policy outcomes."

Firstly, there is an important distinction to be drawn between strategic decision-making and tactical decision-making. In short, the optimal policy strategy may be tactically unfeasible, at least in the short term. Thus, one can think of the rigorous economic analysis and the associated optimal policy strategy as providing a framework for discussion of the practicalities or tactics involved in achieving that strategy.

Secondly, in some countries there may be institutional reasons why the ultimate policy decisions are not taken entirely on the basis of projections and/or the underlying economic analysis prepared by the staff. This sort of discrepancy may have to do with the trade-offs over various elements of any set of goals which a central bank sees itself as pursuing. Or, there may be an explicit distinction drawn between those that do the economic analysis and those that make the decisions.

In Canada, both of these broad factors come into play. It is the "staff" of the central bank who provide "policy advice" on the basis of their formal understanding of the transmission mechanism (an understanding that is largely accepted by management) and the economic outlook, and it is "management" that combines this advice with their own understanding and deliberations to reach decisions about both strategy and tactics. Yet, in some countries the separation between "staff" and "management" appears to be even greater than this - as in the United States, for example.

The remainder of the paper is organised as follows. In Section II we present in broad terms the shared Bank of Canada staff-management understanding of the macroeconomy and the various ways in which policy influences the main macro variables. Then, Sections III and IV turn to interest rates specifically, discussing the empirical evidence on which rates seem to matter most to the macroeconomy and how those rates are connected to the day-to-day policy instruments available to the Bank of Canada. Section V provides a brief summary of a couple of secondary channels by which monetary policy may affect real economic decisions. Section VI then brings these matters together and discusses how our understanding of the transmission mechanism is integrated into the policy process in Canada. The paper ends with some brief concluding remarks.

II. THE CANADIAN MONETARY TRANSMISSION MECHANISM IN THE ABSTRACT[1]

While it is of course risky to generalise, it is probably fair to say that the shared view of the Bank staff and management is "mainstream." That is to say, the economy's real macro variables emerge from the interaction of aggregate demand and supply, with the former dependent on real interest rates and the real exchange rate and the latter being described by a technology- and population-driven trend over the long term, while being influenced by nominal surprises interacting with labour market decisions in the short term. The economy's nominal variables, accordingly, respond to excess demand or supply in the short term, but settle on tracks generated by trend monetary expansion and trend real growth over the long term. Money is believed to be neutral in the long run, but not super neutral.

The Bank staff summarise this view in a model called QPM, for Quarterly Projection Model.[2] A model provides a convenient formalisation that ensures that the staff's analysis is both internally consistent and time consistent, in the broad sense of the terms. In this model, aggregate demand depends on (a) the level of real interest rates, which are conceptualised as affecting decisions to invest in real physical capital and housing, as well as consumption spending; (b) the level of the real exchange rate, which is conceptualised as affecting exports and imports in the usual ways; (c) the level of foreign output; and (d) a fiscal impulse variable. Canada is a small open economy, so the equilibrium real rate of interest is tied to the world rate in the long term; this means that aggregate demand is ultimately brought into line with aggregate supply by movements in the real exchange rate. In the short term, aggregate supply depends to some extent on how well prices fit the expectations of businesses and labour market participants, with positive price surprises bringing forth more output and negative surprises doing the opposite. With these private sector plans comes a certain need for liquidity, for which one can substitute the term "money" provided that one does not immediately translate that abstract notion into a concrete measure of money supply. The central bank has its influence on the economy by supplying more or less liquidity than the economy demands.

Accordingly, the policy transmission mechanism may be sketched in the abstract as follows. The central bank has the goal of price stability in the longer term, with well defined inflation-control targets on the way to that goal. It assesses current and prospective conditions to determine how the interaction of aggregate demand and supply will generate a path for prices consistent with those targets. If there is an inconsistency between what is likely to occur and the Bank's targets, it will undertake actions to alter monetary conditions - a weighted average of the short-term interest rate and trade-weighted exchange rate, which is the open-economy equivalent to the real rate of interest in the closed economy.[3] In an open economy, tightening monetary conditions puts upward pressure on interest rates, which in turn puts upward pressure on the real exchange rate through interest parity conditions. The result is some combination of higher interest rates and a stronger currency that is difficult in practice to predict or to control. However, both a stronger real exchange rate and a higher real rate of interest will act to moderate aggregate demand in the economy, through the channels mentioned above. In any case, with an easing in aggregate demand, a gap emerges between aggregate demand and aggregate supply or, perhaps, a previous situation of excess demand is alleviated, and inflation moves to its targeted rate. Typically, the lag between changing monetary conditions and seeing evidence of the desired result on inflation is one to two years.

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1 A more detailed discussion may be found in Duguay (1994). For a discussion of how broad features of the reduced-form model worked in the early 1990s see Longworth and Poloz (1992).

2 The properties of the model are illustrated in Hunt, O'Reilly and Tetlow (1994). The current version of the model is super neutral by construction, but the next working version will incorporate formally the belief that there are significant economic costs associated with positive inflation.

3 For a discussion of the development of this concept at the Bank of Canada see Freedman (1994).

Formalising this view in the context of an explicit model also enables the staff to impose certain properties on their economic framework, properties that are theoretically desirable but difficult to insert into an economic analysis that is more piecemeal. At the Bank of Canada these are: (a) dynamic stability with consistent stock-flow equilibrium in the long run; (b) expectations at least partially forward-looking and, ultimately, fully model-consistent; and (c) a non-linear inflation process, so that excess demand puts more and quicker upward pressure on inflation than a similar amount of excess supply puts downward pressure. Estimating the parameters of such a model while ensuring that such a complex range of properties was maintained would be a formidable task. Instead, QPM is calibrated - its parameters are imposed based on a large body of empirical evidence and on the macro properties that are desired. Finally, the trend component of aggregate supply (potential output) is treated as an unobserved stochastic variable; this entails using multiple sources of information to filter fluctuations in real output and attribute some output variation to aggregate demand and some to aggregate supply. Given the extent of our uncertainty about this crucial concept, this approach is seen to be risk avoiding, on average.

All things considered, these properties are believed to give the underlying analysis more credibility and make it more useful to the policy-maker. The model may then be used not only to generate a formal outlook for the economy, but to simulate a variety of alternative policy responses to new information. The endogeneity of expectations, in particular, is believed to limit the framework's vulnerability to the Lucas Critique.

III. WHICH INTEREST RATES MATTER THE MOST FOR AGGREGATE DEMAND?

The empirical evidence in Canada is that short-term interest rates matter the most for aggregate demand. The evidence is basically from four sources:

- reduced-form equations for changes in output, as well as for changes in exchange rates, in which interest rates of various maturities are important explanatory variables;
- reduced-form equations for changes in output using the term spread;
- evidence from household and business balance sheets; and
- evidence from the components of aggregate demand that move first in the business cycle.

In this section we examine each of these four sources of evidence in turn.

1. Interest rates of various maturities in reduced-form equations

Over the past few years a number of Bank researchers have estimated reduced-form equations for the percentage change in real output as a function of distributed lags on changes in real exchange rates, real commodity prices, real foreign activity, fiscal variables, and real interest rates (short and long). (Such equations are to be found, for example, in Duguay (1992, 1994).) The typical findings from these equations has been that real short-term interest rates (generally represented by 90-day commercial paper rates) have a significant negative impact on output while the estimated effect of real long-term interest rates is positive.

Work on reduced-form exchange rate equations has also generally found that 90-day interest rate differentials perform the best in models where the other important variables are relative domestic and foreign price levels and real commodity prices (see, for example, Amano and van Norden (1994)).

2. The term structure and real activity

Cozier and Tkacz (1994) examined the significance of term structure variables (e.g., short-term rates minus long-term rates) in indicator models for the percentage change in real activity for various forecasting horizons. At both the one-quarter and four-quarter horizons the best model fits the percentage change in output with the spread between the 30-day commercial paper rate[4] and the ten-year-and-over bond yield (with a negative sign) as well as a four-quarter moving average of the 90-day commercial paper rate (with a negative sign).[5] We would interpret these results as again placing the emphasis on real short-term rates. Broadly speaking, the term structure variable may be capturing some combination of real short-term rates (with the long-term rate typically capturing inflation expectations)[6] and current real short-term rates relative to future real short-term rates, which in turn embody the notion of a natural real rate. (See Clinton (1994-95) for a further discussion.)

It should be noted that similar evidence of this type was used in deciding that the key operational interest rate variable in QPM would be the difference between a three-month rate and a ten-year rate.

3. Evidence from balance sheets

Households

Almost all of the $416 billion of household liabilities at the end of 1993 bore interest rates with maturities of five years or less. (The small amount of exceptions would largely relate to mortgages with seven or ten-year interest rates.) Three quarters of these household liabilities were in the form of mortgages, which, although they have an amortisation period of twenty-five to thirty years, bear interest rates with much shorter terms. In regards to interest rate preference, most first-time home buyers (who tend to be risk averse on average) lean towards mortgages bearing five-year interest rates, whereas those rolling over mortgages tend to opt for six-month or one-year terms.

The $584 billion of direct interest-bearing household assets (i.e. excluding those of insurance companies or pension claims) at the end of 1993 were divided as follows:

- demand and savings deposits (floating rates): $171 billion;
- short-term debt claims (including through mutual funds): $75 billion;
- short-term and medium-term fixed-term deposits: $287 billion;
- medium-term debt claims (including through mutual funds): $24 billion;
- long-term debt claims (including through mutual funds): $26 billion.

Since at least 20% of the fixed-term deposits likely have an original term of one year or less, over half of all interest-bearing household assets likely have an original term of one year or less. This would tend to suggest that shorter-term interest rates may be the most important in consumption-savings decisions.[7]

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4 The 30-day commercial paper rate worked marginally better than the 90-day commercial paper rate.

5 Over the sample period, most of the variance in the spreads comes from the variance in the short-term rate.

6 In periods where movements in long-term rates are dominated by movements in risk premia related to uncertainty about debts, deficits, and political situations, the term spread variable might be expected to perform poorly.

7 Although a rise in interest rates will have a positive income effect for the household sector, it appears to be dominated by the substitution effect and the effect that arises because debtors are much more sensitive to interest rates than creditors - in part because they may be liquidity constrained.

Non-financial enterprises

Apart from accounts receivable, non-financial enterprises held only $78 billion of interest-bearing assets at the end of 1993. Of these, $36 billion were in deposits, $16 billion in short-term debt claims and $26 billion in medium and long-term debt claims.

Of $1,269 billion in liabilities of non-financial enterprises (approximate market value), 59% was accounted for by the market value of equity. Interest-bearing claims (excluding accounts payable) accounted for 24% ($309 billion). Of this, $100 billion was in short-term form, $44.4 in mortgages (mostly bearing interest rates with medium-term maturities) and $164.5 in medium and long-term debt claims. The average term to maturity of corporate securities issued in 1993 was 14.8 years.

These data suggest that longer-term interest rates may be more important relative to shorter-term rates for investment decisions than for consumption-saving decisions.

4. Investment through the business cycle

Even though business fixed investment would be expected to be more sensitive to longer-term interest rates than shorter-term interest rates, it appears to be driven much more by the accelerator than by cost-of-capital (or interest rate) considerations. In most business cycles, growth in investment has been preceded by growth in exports (which are exchange rate sensitive) and consumption and housing (which are sensitive to short and medium-term interest rates).[8]

IV. TRANSMISSION THROUGH THE TERM STRUCTURE

1. Monetary policy operations

As noted in Section II, to achieve its inflation-control targets the Bank of Canada influences monetary conditions. These it measures by a monetary conditions index which is effectively a weighted average of the 90-day commercial paper rate and the trade-weighted exchange rate (see Freedman (1994)). Influence over monetary conditions begins with a cash setting aimed at overnight interest rates. For example, by transferring government balances from the Bank of Canada to directly clearing financial institutions, the supply of settlement balances is set above that desired by these institutions. This puts downward pressure on the overnight rate. If the overnight rate moves outside the desired range during active money market hours (i.e., generally during morning hours Eastern time) the Bank undertakes buy-back (repo or reverse-repo) operations to return the rate to the desired range.[9,10]

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8 Cozier and Tkacz (1994) show that the response of business fixed investment to the term spread is much slower than that of consumption.

9 Since the middle of 1994 the Bank has had a well-defined 50 basis point target range for the overnight rate at each point in time. For a description of buy-back operations see Clinton and Fettig (1989).

10 The negative impact on interest rates from a positive cash (or "reserves") surprise is known in the economic literatures as the liquidity effect (see, for example, for the United States, Christiano and Eichenbaum (1992) and Pagan and Robertson (1994)). Fung and Gupta (1994) have shown the existence of this effect in Canada. Further, they show in the context of a vector autoregression that a positive cash surprise leads to an increase in output.

Since 90-day rates are considered more important than overnight rates in terms of their influence on administered rates[11] and output, the short-term operational range set for the overnight rate (as well as the specific rate aimed at within that range), is strongly influenced by the current behaviour of the 90-day rate. Thus if financial market disturbances or expectations of higher future overnight rates are pushing up 90-day rates, the overnight rate might be lowered to offset these expectations. Accordingly, in the short run there can be a negative correlation between 90-day rates and overnight rates. Racette et al. (1994) illustrate this in the context of a shock to 90-day rates in a weekly vector autoregression with financial variables.

Finally, it should be noted that open market operations in the cash three-month Treasury bill[12] or the coincident-to-when-issued Treasury bill can be used to limit movements in that rate.

2. The term structure of market interest rates

Although the term structure of interest rates is strongly influenced by the world real-term structure of interest rates, risk premiums related to government debts and deficits, and domestic inflation expectations, it has generally been true in the past that a rise in nominal domestic short-term rates has translated into a rise in nominal domestic rates all along the term structure (see, for example, the equation and discussion in Clinton and Howard (1994)). One would expect, however, that this is due to the typical shocks experienced in the past. To the extent that a rise in short-term interest rates causes markets to raise their estimate of the probability of keeping future inflation with the inflation-control bands, longer-term nominal interest rates may tend to fall in the future or at least not rise.

3. Administered interest rates

Clinton and Howard (1994) conclude that there has been an essentially stable relationship between administered interest rates (i.e. rates set by deposit-taking financial institutions on loans and deposits) and market rates of similar maturities. Moreover the long-run relationship is one in which the changes in administered rates move one-for-one with the changes in similar market rates. And the adjustment (with the exception of term-deposit and mortgage rates) is quite rapid - indeed much more rapid than in the United States.

V. OTHER POSSIBLE MONETARY TRANSMISSION CHANNELS

There are two other channels of monetary policy transmission that are not incorporated into our current view about the major channels of transmission, but that perhaps bear a closer look. They are the disequilibrium money channel and the credit market channel. Views about the importance of these channels might colour one's views of the effects of changes in interest rates at the margin.

1. The disequilibrium money channel

The disequilibrium money view holds that money supply can differ from desired money demand in the short run, and that the difference between the two can affect the dynamic path of output

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11 Part of the influence of 90-day rates may come from the fact that the Bank Rate is set at 25 basis points above the 90-day Treasury bill rate at its weekly tender. See K. Fettig (1994).

12 A coincident-to-when-issued Treasury bill is a Treasury bill with an original maturity of six months or twelve months which will have exactly three months residual maturity at the time of the next tender.

and prices. It has been recognised that much of the earlier empirical work in this area was on very shaky econometric ground. Laidler and Robson (1994) have attempted to set forth a restatement of the theory in this area and to test it empirically for Canada. Using forecasted real growth as a proxy for the Wicksellian real rate of interest, their preliminary results show that the effects of private sector bank borrowing on M_1 and of excess cash balances on spending are important. However, it remains to be seen how robust these empirical findings are.

2. The credit channel

There has recently been considerable interest in the credit market as a potentially important channel in the transmission of monetary policy. Hubbard (1994) and Ceccheti (1994) have surveyed this literature as it applies to the United States. Racette, Raynauld and Sigouin (1994) have surveyed the US and Canadian literature. Two main channels, which are not necessarily independent, have been identified: a financial condition ("low net worth") channel and a bank lending channel.

Financial condition channel

The financial condition channel holds that a monetary tightening or easing may have a differential effect on firms or households given their initial financial condition. At the disaggregated level this means that firms or households with low net worth relative to desired investment or durables purchases will be hit harder by a monetary tightening and helped more by a monetary easing. At the macro level this could imply that a monetary tightening could have more of an effect on demand if the average level of debt were higher than normal, profits were much lower than normal or if a decline in asset or goods prices had reduced the value of collateral (bond, investment goods, inventories or housing.) This literature can be seen to be related to earlier literature on liquidity-constrained households and on debt deflation (King, 1994).

This channel arises because of capital market "imperfections." Financial intermediaries and bond-rating agencies perform monitoring functions. They use the existing financial condition of a firm or household to measure the probability of repayment. Firms or households that have low net worth relative to the value of a project or purchase may be unable to obtain credit from a financial intermediary or - in the case of firms large enough to issue shares or bonds - may receive a rating that is too low to make their project worth financing. (Note that this is irrespective of the expected future return on the new project or purchase.)

A tightening in monetary policy would raise debt servicing costs (immediately on floating rate debt and over time on existing debt) and through its effects on asset and goods prices could reduce the value of collateral. The former could reduce the expected future profit flows and thus net worth, while the latter reduces net worth directly. If the distribution of initial net worth across firms or households was initially distributed around a low average level (rather than a high average level) one could conjecture that a given rise in interest rates would lead to a greater percentage of firms (or households) no longer having access to new intermediated credit or new bond issues. It might be important to take account of such a non-linearity of the effect of interest rates (or an interactive effect of interest rates with balance sheet variables) on output in making policy if it proved to be significant.

In Canada, as in the United States, the current evidence is at a disaggregated level rather than at the macro level, although if recessions are a proxy for low net worth Schaller (1994) has shown that the effect of interest rates on output are more pronounced during recessions than during other periods. Schaller and Ng (1994) and Schaller (1993) have shown that firms that are in a weak position to communicate private information (and therefore are more likely to be reliant on intermediated credit) show a greater sensitivity of investment to cash flow than other firms. Moreover, Schaller (1994) shows that these same firms have investment that is more sensitive to shocks to net worth.

Kuszczak and Orcheson (1994) have shown in cross-section (by industry and asset class) time-series data that firms with assets between $1 and $5 million appear to have their inventories and intermediated credit more strongly affected by monetary tightening than firms with assets over $10 million. This could result from a "low net worth" channel in conjunction with a limited recourse to capital markets.

Lafleur and Barker (1994) document some of the major financial ratios that the six major Canadian banks examine before granting loans to large enterprises. Chief among the financial ratios that the authors identify are the following: the interest-coverage ratio, the liquidity ratio, and the debt-to-equity ratio. If one assumes that these ratios play a large role in decisions to grant new credit to firms of all sizes there is a direct channel whereby access to new loans could be cut off by falling collateral prices, low net worth or rising interest payments on existing debt.

Overall, the work on the financial conditions channel shows promise. Further work in the area is worth pursuing.

Bank lending channel

The other major credit channel that has been identified is the bank lending channel. This channel has to do with whether the non-price terms and conditions of bank loans or the spreads of loan rates over market rates are directly affected by monetary policy. If they are, then those firms and households that are totally dependent on banks for their marginal source of finance will be affected by more than the direct rise in market interest rates.

Spreads of administered interest rates over market rates do not appear to widen in periods of tight money in Canada. Nor does there appear to have been much variance since 1982 in the spread between 90-day commercial paper rates and 90-day Treasury bill rates, a variable which, when it widens in the United States, has been taken to indicate that borrowers have been denied funds at the banks and that large borrowers have moved to the commercial paper market. Raynauld and Sigouin (1993), as reported in Racette et al. (1994), show that a twenty basis point shock to the 90-day Treasury bill rate tends to produce only a one basis point increase in the spread of the commercial paper rate over Treasury bill rates. Deposit rates take some weeks to catch up to the increase in market rates and then surpass the increase in Treasury bill rates by only two basis points.[13]

A survey of the six major banks by Lafleur and Barker (1994) has shown that their official policy is not to change their non-price terms and conditions for loans as a function of the business cycle. Moreover, they suggest that a borrower's situation has to be quite bad for existing loans to be cut back or called. However, anecdotal evidence would suggest that in sectors where collateral values have become very uncertain because of an economic downturn (commercial real estate and property development) or environmental considerations (dry cleaning), policy has tended to discourage the growth of loans in that sector.

Montplaisir et al. (1994) have examined some of the proxy variables suggested by the existing US literature on the macro effects of the bank lending channel and have not found significant effects on Canadian output.

Overall the evidence to date is that the bank lending channel has not been an important macro channel of monetary policy transmission in Canada.

13 Furthermore, a typical interest rate shock is associated with an increase in loans, likely because the monetary authorities are responding to a demand shock.

VI. POLICY FORMULATION: THE ROAD FROM ANALYSIS TO ACTION

With the above discussion in mind, we are now in a position to describe briefly how the views on the transmission mechanism are reflected in the policy process in Canada. A fuller discussion is provided in Duguay and Poloz (1994).

The Staff model contains a policy reaction function which, given all the other variables in the model including the exchange rate, sets a path for interest rates that will bring inflation into line with the announced inflation-control targets. Thus, policy in the model is fully endogenous. The staff undertake quarterly to update the starting point for the model, making any alterations to the steady state solution as appropriate, given their analysis of the starting point shocks, and then run the model well out into the future. What emerges, then, is a path for monetary conditions which summarises the staff's view on what is needed from policy in order to achieve the Bank's inflation-control objectives.

This analysis is presented to management each quarter, and the short-term path is updated continuously between projection exercises.[14] For instance, the staff's advice regarding policy might be contingent on real growth in the current quarter being, say 3% at an annual rate. Once the projection is done, the specialists go back to monitoring the plethora of economic indicators that become available and, through the quarter, provide a continuous analysis of how well their story is holding up. To simplify, suppose that circumstances suggest that the economy is now growing at 5% rather than 3%; then the staff will revise their "monitoring" in verbal reports to management, who in turn will begin to shade their policy decisions in the direction indicated - in effect, anticipating the shift in policy advice that will soon be forthcoming from the staff. Throughout both the projection and monitoring exercises each change in view, no matter how subtle, is subjected to scrutiny and debate.

With this advice from the staff in the background, then, management has a consistent framework within which to discuss their options. Some may disagree with some of the assumptions made by the staff, including the staff's assessment of risks to the projection, in which case an alternative scenario will be provided by applying shocks to the model. The staff are not asked to change their view, but to illustrate the implications of a change in assumption in order to provide more information. Management may bring a number of other pieces of information to the table concerning the base case projection.

There is also staff/management interaction on the tactical dimension mentioned in the introduction. The staff outlook may call for a path for monetary conditions that seems very difficult to achieve, tactically speaking. For example, the model might call for a sudden decline in interest rates that, in the event, could be misinterpreted by the market as a fundamental change in policy and result in a path for the exchange rate - and therefore monetary conditions - that differs substantially from what the staff are predicting. Accordingly, tactical considerations might cause some slippage - perhaps in terms of timing only, but possibly in magnitude - between what the staff advise and what management decides. This slippage, then, would be a form of a changed starting point when it comes time to set out a new economic projection next quarter.

VII. CONCLUDING REMARKS

In this paper we have given a brief overview of the Bank of Canada's views on the monetary transmission mechanism, where they come from and how they are integrated into the policy process.

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14 Over time, the model and its calibration can also be changed on the basis of new findings.

1. Theory, empirical evidence and policy

The staff at the Bank of Canada make use of a formal model (QPM) that reflects mainstream thinking in providing policy advice to their management. Economic theory provides the basis for the interest rate and exchange rate channels used in the model, as well as the long-run equilibrium conditions. Empirical evidence, including that from reduced forms, has been used to calibrate the short to medium-term properties of the model.

The role of the model in the policy process is central and explicit. Management makes use of the model in reaching an understanding of the risks to the outlook, and treats its output seriously as a starting point for their discussion of policy options.

The core policy transmission mechanism is believed to run from settlement balances to overnight interest rates, then to short-term money market rates and rates along the yield curve. Statistically, changes in the stance of monetary policy tend to be captured best by changes in the slope of the yield curve. It is at this latter level of detail that the QPM model structure first captures the effects of policy decisions. The exchange rate will also normally react to a change in policy stance, making the concept of monetary conditions crucial to measuring changes in the stance of policy and its likely effect. A change in monetary conditions has a significant impact on output over four to six quarters, and then on inflation by six to eight quarters after the change. The effects captured directly in the QPM model may be augmented or moderated by judgement coming from other circumstances or channels, such as terms and conditions for the granting of credit, the balance-sheet positions of the household and firms sectors, the behaviour of asset prices, and so on. There is in fact a multitude of factors that are considered when forming judgements at the margin, including the recent behaviour of the monetary aggregates.

2. The role of financial structure

The Canadian financial structure (in particular, the structure of household and firm balance sheets) is one factor that suggests that shorter-term interest rates are likely to be more important than longer-term rates. And the market-oriented nature of the economy (including the absence of significant capital controls, credit controls, interest rate controls and the like) suggests that policy is transmitted largely through interest rates and exchange rates, rather than through quantities. However, the micro-level evidence in favour of a financial conditions (low net worth) channel suggests that there may be qualifications to the basic underlying story.

The growth in the use of derivatives does not appear to have had a significant impact on the transmission mechanism. And there should be no presumption that the recent growth in mutual funds and mortgage-backed securities will either. However, any financial innovation that reduces the high shadow cost of finance faced by low-net-worth firms may have some effect. Presumably, such an innovation would have to involve some reduction in the cost of monitoring.

Research into the transmission mechanism continues. It will be especially important to learn more about any important non-linearities (including interactive effects between interest rates and existing debt stocks) that are present in the economy. To this end, more examination of the financial conditions credit channel appears to be warranted.

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Transmission channels for monetary policy in the Bank of Canada's Quarterly Projection Model (QPM): some simulation experiments

Ben Hunt, Brian O'Reilly and Robert Tetlow

I. INTRODUCTION

This note presents some simulation results from the Bank of Canada's model for policy simulation and projection, called the Quarterly Projection Model (henceforth, QPM).[1] The simulations were conducted for the model comparison part of a larger exercise, sponsored by the Bank for International Settlements, to examine monetary policy transmission channels.[2] The objective of the larger exercise is to increase cross-country understanding of monetary policy transmission channels in each of the participating member countries as an aid to discussions on monetary policy formulation and implementation.

We begin with a discussion of the simulations requested and the way they were implemented. Section III provides a thumbnail sketch of the construction of QPM. Section IV discusses the extent to which the financial structure of the Canadian economy plays a role in the generation or interpretation of the simulation results. Section V sketches the dynamic story and outlines the decomposition of the transmission channels, by channel and by sector, for a limited number of experiments. Detail on the decomposition methodology is provided in an appendix. Section VI discusses the methodology and philosophy of QPM with a comparison to traditional macroeconometric models. From this discussion we hope to increase the understanding of why the experiments requested are not as simple to conduct or interpret as might seem to be the case. The seventh section sums up and concludes.

II. THE EXPERIMENTS

1. The proposed experiments

The proposed core policy experiment involves a temporary increase in the policy-controlled interest rate of 100 basis points for two years imposed on an economy with initial conditions as in 1994. The simulations are to be conducted under both flexible and fixed exchange rate regimes. The results are to be decomposed into monetary policy transmission channels such as: income/cash flow, wealth, direct interest rate effect on consumption, cost of capital, and exchange rate, with provision for a discrepancy column if everything does not add up exactly.

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1 QPM was constructed by Douglas Laxton and Robert Tetlow under the guidance of David Rose and was brought into service for the Bank's quarterly projection exercise in September of 1993. A complete documentation of the steady state of the model is available, see R. Black, D. Laxton, D. Rose and R. Tetlow, The Bank of Canada's New Quarterly Projection Model, Part 1, The Steady-State Model: SSQPM, Technical Report No. 72 (1994), Bank of Canada, Ottawa, K1A 0G9. A more complete documentation of the full dynamic model and its properties is expected to be available shortly.

2 For an overview of Canada's contribution, see D. Longworth and S. Poloz, "The Monetary Transmission Mechanism and Policy Formulation in Canada: An Overview", Bank of Canada Memorandum (1994), Bank of Canada, Ottawa, K1A 0G9.

2. Implementation of the experiments

We have broadened and redefined to some extent the requested experiments in several ways. Firstly, we conduct our shocks from two different base-case scenarios, steady state and excess supply. The *steady-state control* allows us to isolate model responses unadulterated by the specifics of initial conditions. In general, the specific steady-state levels chosen will not alter the dynamics story arising from transitory shocks.[3] The *excess-supply control* was constructed artificially to broadly reflect the starting point disequilibrium used in our current projection exercises.[4] For Canada, those features include: (i) excess supply (about 4% of potential output initially); (ii) interest rates slightly above their steady-state levels; (iii) inflation below the targeted level; (iv) government debt as a proportion of nominal income higher than the targeted level; and (v) net foreign liabilities larger than the level that is desired by the private sector.[5]

Secondly, we conduct experiments where *interest rates increase* and where they *decrease*, so as to illustrate the implications of the model's non-linear price equations. Thirdly, we interpret the "fixed exchange rate" scenarios in a way that is more meaningful in the context of QPM by conducting the interest-rate experiments from initial conditions of steady state under (nominal) *exchange rate targeting.*

We view the latter approach as an interim step in that to do simulations properly under a fixed (and targeting) exchange rate regime some parts of QPM should be recoded and the model recalibrated.[6] Hence, care should be taken not to impute too much to the results from the experiments assuming an exchange rate targeting regime.

Table 1 summarizes the six simulations considered, four under flexible exchange rates (inflation targeting) and two under exchange rate targeting. In the latter case, simulations were only done from initial conditions of steady state. The target inflation rate used in the model for both the steady-state and excess-supply controls is 2%, although, since the version of the model used is neutral, this choice is arbitrary.[7] Naturally in the excess-supply control, the targeted and actual inflation rates generally differ in the near term in reflection of the disequilibria and imperfect monetary control mechanism.

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3 For completeness though, we note that the following steady-state assumptions were used: government to nominal income ratio of 0.5; net foreign asset to income ratio of -0.38; natural rate of unemployment of 8.2%; nominal short-term interest rate of 5.8%; nominal long-term interest rate of 6.4%; steady-state inflation (domestic and foreign) of 2%; and a potential growth rate of 2 1/3% (Table A in the Appendix of selected exogenous variables).

4 We use an artificial control for this second base case rather than an actual recent projection so that the results of our experiments would not depend on any particular idiosyncrasy of the projection. This precaution ensures that our results will be broadly applicable to any similar circumstances and that they can be meaningfully compared to those conducted from the steady-state control.

5 These latter two points are not objective facts but have been part of the working hypothesis used in the Bank of Canada's Staff Economic Projection over the past year. The notion of desired level of net foreign assets comes from the economic theory of optimisation by households and is discussed in Section III.

6 QPM has been constructed to be robust to the Lucas Critique. However, our difficulty in doing the fixed exchange rate simulations even when adapted to the policy approach used in QPM may be another sign of its strength. When the policy regime is dramatically different to those allowed for in building the model, the model makes it clear that the user may be making unreasonable demands. This was particularly obvious when trying to construct the excess supply control for the exchange rate targeting regime.

7 2% is the mid-point of the 1 to 3% range that the Government of Canada and the Bank of Canada have established for inflation until 1998 and we have chosen to use it because it is the closest approximation that we have to an official target for the medium term at this time.

Table 1

QPM simulation scenarios by number

Direction of shock to interest rates	Reference number for scenario		
	Flexible exchange rate regime (inflation targeting)		Exchange rate targeting regime
	Excess-supply control	Steady-state control	Steady-state control
Increase	Scenario # 1	Scenario # 3	Scenario # 5
Decrease	Scenario # 2	Scenario # 4	Scenario # 6

Note that we view Scenario # 1 as providing the most useful results for the overall objective of this exercise. Its results are considered more relevant than those from the exchange rate targeting simulations for understanding Canadian monetary policy transmission channels as represented in QPM. This is so because a flexible exchange rate regime is much more consistent with the coding and calibration of QPM than is an exchange rate target regime.

However, we discuss the results of Scenario # 5 to provide some response to the request to do a simulation under a fixed exchange rate. As to other experiments, their results will be discussed in the text only to the extent that they contribute insights on the transmission of monetary policy in QPM. Results for all scenarios are provided in the tables and charts at the end of the paper.

To obtain a clearer notion of how a targeting regime is implemented in QPM, consider the following monetary policy rule, from which the rules used in this paper are special cases.[8]

$$\begin{aligned} R1_t - R40_t &= \lambda_1(R1_{t-1} - R40_{t-1}) + \lambda_2\left[(\Pi_{t+6} + \Pi_{t+7})/2 - \Pi^T\right] \\ &+ \quad \lambda_3\left[(S_{t+6} + S_{t+7})/2 - S^T\right] \end{aligned} \tag{1}$$

where R1 is a one-quarter nominal interest rate (specifically, the 90-day commercial paper rate), R40 is a ten-year government bond rate, Π is inflation as measured by the year-over-year change in the consumer price index excluding food and energy prices, and S is the log of the nominal exchange rate.

In scenarios 1 to 4, we use the settings $\{\lambda_1, \lambda_2, \lambda_3\} = \{0.3, 1.5, 0\}$. These are the same settings that are used in the Bank's quarterly projection exercises. In scenarios 5 and 6, the parameter settings are $\{\lambda_1, \lambda_2, \lambda_3\} = \{0, 0, 5\}$. This specification of the policy rule calls for the authority to move the nominal exchange rate to a particular level (as opposed to a growth rate) with a targeting horizon of six-to-seven quarters ahead.

III. A THUMBNAIL SKETCH OF THE STRUCTURE OF QPM[9]

QPM models the behavior of households, firms, foreigners, a fiscal authority (consolidating all levels of the public sector) and a monetary authority. The decisions of these agents

8 Some constant terms have been dropped from this equation and the notation has been simplified from what is used in the model.

9 The contents of this section, with some changes, are taken directly from Section 2 in Don Coletti, Ben Hunt, David Rose and Robert Tetlow, "Some Dynamic Properties of QPM", paper prepared for presentation on QPM at meetings of the Canadian Economic Association, University of Calgary, Calgary, Alberta, June 1994.

interact to determine the ultimate levels of four key stocks and they, in turn, are key determinants of the associated flows, such as consumption spending, saving, investment spending, government spending and revenues, and the external balance. There is a formal stock/flow accounting framework which ensures full consistency among all variables, both in long-run equilibrium and along the dynamic adjustment path.

1. The model is dynamically stable with a consistent stock-flow equilibrium

There are four key stocks in the model: government bonds, physical capital, the stock of household financial wealth and net foreign assets. The steady-state levels of the stocks are derived from economic theory and the model has mechanisms that make flow spending validate the steady-state conditions. The required steady-state flows are identified and assured by relative prices.

- In the case of government, there is no behavioral theory. Rather, we take the level of debt to be a policy choice and make taxes, net of transfers, adjust to satisfy the government's long-run financing constraint.
- For capital, the desired level comes from the level of available labor and the relative price of capital services, based on the usual marginal analysis of maximization of the present value of the firm along a neoclassical growth path. The real interest rate that underlies the cost of capital is tied closely to conditions in world markets, but the real wage adjusts such that eventually there is full employment of labor, given the desired level of capital. Investment spending adapts to assure both that there is the right level of capital in the long run, relative to output, and that it is sustained along the growth path.
- For net foreign assets, the desired level comes from the household sector's desired level of wealth, which, in turn, comes from a trade-off of the gains from consuming sooner against the costs of consuming less later, owing to the higher debt service implied by borrowing. The basic theory applied is the Yaari-Blanchard-Buiter-Weil model of overlapping generations with an assumption of expected mortality. The key price is the real exchange rate, which must adapt to set the trade balance at a level consistent with the required debt service.

The household budget constraint reflects the necessity to provide the resources to sustain stock equilibria, including the provision for capital depreciation. Note that the model does not provide a complete description of world asset allocation. The fact that Canada is a net debtor is taken as an empirical fact, which can be rationalized within the theory as a higher rate of time preference in Canada than in the rest of the world.

2. Monetary policy is endogenously determined and forward-looking

An endogenous monetary policy reaction function calls for the monetary authority to adjust its instrument, the 90-day paper rate, to bring a nominal variable to its targeted level subject to certain constraints. The instrument is controlled to achieve an operational target on the slope of the yield curve. In the normal course of work on projections at the Bank of Canada, inflation is the target variable. In this paper, we also use a rule that targets the nominal exchange rate.

Among the factors that constrain the authority from hitting its inflation target at all points in time are (i) the "planning horizon" of the monetary authority; the model's reaction function has the monetary authority looking ahead six to seven quarters in setting its instrument in the current quarter in recognition of the time lag between instrument setting and movements in target variables; (ii) a mild smoothness constraint, which tempers movements of the instrument itself; and (iii) the intrinsic structure of the rest of the model. Higher levels of the instrument, all else held constant, will reduce aggregate demand, but with a lag of a year or more to peak effects.

A second channel through which monetary policy normally operates is the exchange rate. The nominal value of the Canadian dollar, measured against an index of six other currencies, is governed by the familiar uncovered interest parity condition. This means that when the monetary authority raises the level of its instrument and this results in an increase in nominal short-term interest rates relative to foreign rates, the dollar will generally appreciate in the short run. This has a direct (downward) effect on consumer prices through the price of imported consumer goods and a slower, indirect (downward) effect on prices through the effect on the trade balance and hence on aggregate demand. For the fixed-exchange rate scenarios it is assumed that foreign and domestic interest rates move similarly and, hence, the uncovered interest parity condition is switched off.

A third important channel through which monetary policy works is expectations. The forward-looking aspects of the inflation process in QPM give expectations a quasi-independent role. This means that when the monetary authority responds to a shock affecting its targeted variables, an early response reduces the magnitude of the necessary policy response.

3. Intrinsic versus expectational dynamics

Generally speaking, the dynamics of variables are modeled as being driven by a mixture of expectational and intrinsic dynamics. Intrinsic dynamics are those that arise from the existence of adjustment costs, generally interpreted. Dynamics coming from expectations are overlaid on the intrinsic dynamics.

4. Forward-looking expectations

Expectations in QPM are modeled as a weighted average of a backward-looking component and a forward-looking component. For real variables, the forward-looking component is based on the model-consistent solution for the variable, but with an effect from the steady-state condition. For nominal variables, only the model-consistent part appears, a formulation that avoids self-fulfilling policy successes. Normally, a substantial weight is given to the backward-looking component of expectations; for example, this weight is 75% in the case of expected inflation.

5. QPM has a non-linear structure

Our research has shown evidence of asymmetric effects of excess demand on prices and on the basis of this work, we have included a non-linear structure in QPM.[10] The price equations, which collectively act as a "Phillips curve," are coded so that excess demand has larger and faster effects to increase inflation than excess supply has to reduce inflation.

6. Possible major changes to QPM over the next year

Recent research efforts on the comparative statics of the steady-state version of QPM, in particular on government debt and deficits and on non-superneutralities, have pointed the way for substantive changes to QPM over the next year. The work on government debt indicated that a connection between the level and change in government debt relative to GDP and the level of risk premia on the stock of government bonds and the stock of net foreign liabilities might be usefully

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10 For a more complete discussion see: D. Laxton, D. Rose and R. Tetlow, "Monetary Policy, Uncertainty and the Presumption of Linearity", Bank of Canada Technical Report No. 63 (1993), and D. Laxton, D. Rose and R. Tetlow, "Is the Canadian Phillips Curve Non-linear?", Bank of Canada Working Paper 93-7 (1993), Bank of Canada, Ottawa, K1A 0G9.

incorporated in the basic model.[11] The work on non-superneutralities found them to be quite large, suggesting that work on including them in the model should be pursued with some sense of immediacy.[12]

IV. THE ROLE OF THE FINANCIAL STRUCTURE

As can be seen from the sketch above, QPM is a relatively small model that abstracts from the micro-sectoral details of the Canadian economy. As a result, the Canadian financial structure is not explicitly modeled nor is its contribution to the dynamics of the model discernible in any unequivocal manner. There are a number of ways, though, in which the effect of the financial structure has been implicitly captured in the model both in terms of the functional form of some of the key macroeconomic relationships and in the calibration of the model.

Canada has had few restrictions on credit or on interest rates so that there is no apparent need, based on purely institutional considerations, to have credit-rationing variables anywhere in the model. In addition, there has been a greater homogenization of assets and liabilities among the different sectors of the financial market so that there is less effect on key macroeconomic series from developments in only one sector of the financial market. Interest rates are sufficient to balance supply and demand in the financial markets. Similarly, on the external side, Canada has had no capital controls so that the uncovered interest parity relationship (with a risk premium term) seems to be a necessary part of any description of the Canadian economy.

As to calibration, it has been done so that the model, as much as is possible, captures the essential short-run dynamics of the Canadian economy relevant for policy analysis. This approach has been implemented by having the model reproduce a mixture of properties from reduced-form econometric models and various stylized facts taken from the data. To the extent that Canada's financial structure has affected the dynamics of the economy's response, this will be reflected implicitly in the model. For example, the lag between changes in the monetary instrument and changes in aggregate demand includes, among other things, the workings of the transmission through the portfolios of financial institutions.

V. THE DECOMPOSITION OF TRANSMISSION CHANNELS FOR SELECTED SCENARIOS

With respect to the approach to be used for decomposing transmission channels, the organizers of the model comparison project expressed a preference for simulating one channel at a time and comparing the results to the baseline projection. In the QPM decompositions using this approach, the discrepancy is very small in the first two or three years, which are probably the years of most relevance to the intent of the experiment, given the dramatic change in policy that occurs in all of the scenarios considered once the QPM reaction function is allowed to work. In order to see if the rankings of contribution by transmission channel changes in the short term, we have also undertaken

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11 See T. Macklem, D. Rose and R. Tetlow, "Government Debts and Deficits in Canada: A Macro Simulation Analysis", in W.B.P. Robson and W.M. Scarth, eds., Deficit Reduction: What Pain, What Gain? Policy Study 23, C.D. Howe Institute (1994): 231-272.

12 A judgment that we did not understand these non-superneutralities well enough, especially their quantitative importance, led us to leave them aside in the initial phases of model development. More recent work has provided some insights; see R. Black, T. Macklem and S. Poloz, "Non-Superneutralities and Some Results of Disinflation: A Quantitative General-Equilibrium Analysis", in Economic Behaviour and Policy Choice Under Price Stability, proceedings of a conference held at the Bank of Canada, October 1993 (1994): 477-516, Bank of Canada, Ottawa, K1A 0G9.

the decomposition exercise for some scenarios by sequentially turning off channels in the order suggested by the structure of QPM.[13]

We focus initially on the core, requested simulation - the temporary interest rate increase from initial conditions of excess supply under a monetary policy regime of inflation targeting (flexible exchange rate regime). We feel that this simulation demonstrates the monetary policy transmission channels, as adequately as they can be demonstrated in a model like QPM. The implications of the non-linear Phillips Curve for the results are brought out when we compare two other sets of simulations, an interest rate increase and decrease from a steady-state control under a regime of inflation targeting. We then summarize the results for an exchange rate targeting simulation - the temporary interest rate increase from initial conditions of steady state under a monetary policy regime of exchange rate targeting.

1. Flexible exchange rate regime (inflation targeting regime)

Flexible exchange rate regime: the dynamic story

The positive interest rate shock (Scenario # 1) requires the monetary authority to raise the policy-determined interest rate 100 basis points for two years at the beginning of the simulation period. This brings about an appreciation of the Canadian dollar. This tightening of monetary conditions depresses output and inflation. Excess supply increases, and inflation declines by roughly one percentage point by year three and is well below its 2% target rate.

When the shock ends, the endogenous monetary policy reaction function in QPM moves to ease monetary conditions in order to return inflation to its 2% target level. This easing manifests itself, in part, in a decline in the nominal short-term interest rate, to a trough of some 2¾ percentage points below its control level in year three, the first year after the shock is removed, and, in part, in a decline in the exchange value of the dollar from year two to year three. The nominal value of the dollar falls by nearly a percentage point in year three, before appreciating once again thereafter.

More importantly, the real exchange rate falls below baseline levels for five years. This is the same length of time that real interest rates are below their baseline levels. The resultant easing in real monetary conditions supports the recovery in aggregate demand and in price inflation towards its target level. The latter adjustment occurs both through the effects of aggregate demand on prices and through the pass-through of rising import prices into consumer prices.

The recovery comes with a delay, though, as the level of output remains below control in year three despite the easing in policy on account of the economy's intrinsic adjustment costs. The economy stays in excess supply for over three years in total. In the longer run, the dollar arrives at a new, higher level supported by the permanently lower relative domestic price level. The real exchange rate returns to equilibrium at the same time as the nominal exchange rate stabilizes. In the end, the net impact of the shock on cumulative output is marginally negative (the loss in output brought on by the initial shock is not fully recouped). This is a manifestation of the non-linear Phillips Curve in QPM in conjunction with initial conditions of excess supply.

Flexible exchange rate regime: decomposition by transmission channel[14]

With respect to the ranking of transmission channels during the first two years, the exchange rate channel is the most important one followed by the direct-interest-effect-on-consumption channel. In year three, the rankings reverse. The wealth channel builds to a peak negative effect in

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13 See the appendix for more detail on how we isolate the different channels using both approaches.

14 QPM uses a consumable income concept - the level of national income that is available for consumption once provision has been made for taxes, maintaining financial asset stocks at their desired levels and for capital formation. There are both backward-looking and forward-looking representations of this term in the consumption equation.

year three but only turns positive in year five even though monetary policy begins to ease in year three. The cost of capital/accelerator effect is small throughout the period for which results are provided. As for the income/cash-flow channel, it makes the smallest contribution since the shock is perceived as temporary and agents have considerable ability to smooth consumption over time.

The time profile of the contribution of the channels, too, is consistent with our priors. Flow channels respond relatively quickly to the shock and its unwinding, while stock channels take somewhat longer to respond to changed circumstances, both when the shock is imposed, and when it is unwound.

Over the time horizon used here, we believe that the decomposition approach recommended by the BIS shows plausible results, especially during the years in which the interest rate shock is imposed. Alternatively, we have decomposed these channels sequentially and found essentially the same ranking for the initial years.

Flexible exchange rate regime: decomposition by GDP component

All components of aggregate demand contribute to the initial decline of aggregate demand below equilibrium levels. The increase in interest rates reduces consumption (broadly defined to include residential construction and inventories) directly and immediately. Wealth exerts an increasingly large negative effect with its peak in year three, reflecting the fact that the dynamics of wealth are driven by the response of net foreign assets. As the trade balance deteriorates, owing to the increase in the value of the Canadian dollar, net foreign assets decline leading agents to reduce consumption in order to restore their wealth position. Government expenditures decline slightly as the model replicates the procyclical behavior of government expenditures in the Canadian data. Investment falls below its baseline level due to the decline in expected output and the rising cost of capital (the cost of capital/accelerator channel). Note that the latter effect is only implicit in the dynamics of the investment response, which represent the "typical" cyclical behavior of investment.[15]

2. Expository simulations

To demonstrate the effect of the non-linear Phillips Curve in QPM we compare the results of positive and negative interest rate shocks from initial conditions of steady state.

Expository simulations: the dynamic story

The dynamic story for the model response under a positive interest rate shock from initial conditions of steady state (Scenario # 3) is very similar to that described above for the same shock from initial conditions of excess supply. In both cases the positive interest rate shock is counter to what is required to attain the inflation target given the state of the economy as represented in the respective control simulations.

During the first three years, the positive and negative interest rate scenarios from steady state (Scenarios # 3 and # 4) show virtually the same picture, except for a sign change and the movement in inflation. However, after year three the results change, reflecting the effect of the non-linearity in the Phillips Curve.

As a consequence of the non-linearity, inflation accelerates over 1½ percentage points under the negative interest-rate shock compared to the deceleration of 1 percentage point under the positive shock. As a result, once the shock ends the monetary authority must raise interest rates by more than they were allowed to drop in the positive rate scenario, in order to contain incipient inflation pressure. This requires substantially more of an output decline than the increase required to

15 The cost-of capital channel in the dynamic model is currently turned off until research on quantifying its effect is completed. This extension to the model is expected to occur in early 1995.

unwind the positive interest rate shock. Once the economy has returned to equilibrium, the cumulative output gap is negative.

Expository simulations: decomposition by transmission channel

From an overall perspective, the rankings of the transmission channels have not changed in any significant manner.

Expository simulations: decomposition by GDP component

There is virtually the same sectoral picture for the first three years, except for a sign change, as for the positive interest rate shock. The stronger monetary policy reaction following the negative interest rate shock can be seen in year four where the direct-interest-rate-effect-on-consumption channel is large enough to offset the wealth effect on consumption so that private consumption contributes to the desired movement in output as opposed to resisting it as under the positive interest rate shock.

3. An exchange rate targeting regime

The presence of forward-looking expectations in QPM means that fixing exchange rates is not straightforward. QPM is calibrated for conditions of a managed float of exchange rates. In a regime where nominal exchange rates are literally fixed, one would expect that forward-looking agents would alter their forecasting rules to reflect the absence, for example, of exchange rate pass-through into consumer prices. To address these and other issues properly in QPM would require a time-consuming recoding and recalibration of the model that would be unlikely to provide useful lessons for a monetary policy that operates under a flexible exchange rate regime. However, as a first approximation, we have conducted experiments targeting the nominal exchange rate and turning off the interest rate parity condition in the exchange rate equation.[16]

Switching off the interest parity condition is a means to implement the implicit assumption that foreign and domestic interest rates change identically, as suggested by the BIS staff for the fixed exchange rate scenario.[17] Note that we also allow the exchange rate to shift 1%, a move that is consistent with the exchange rate moving within a target band. The artificial nature of this approach, in combination with the caveats regarding model structure and calibration already mentioned, should make it clear that the results are not useful for inferring the relative merits of a fixed exchange rate regime. Even the ordinal rankings contained in the decomposition may be different from what would result if QPM was modified to be fully consistent with a targeting exchange rate regime.

An exchange rate targeting regime: the dynamic story

On impact, the increase in interest rates (Scenario # 5) leads the nominal exchange rate to appreciate because of the effect of a lower (expected) domestic price level on the expected nominal exchange rate. The higher value of the Canadian dollar puts direct downward pressure on prices via

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16 Earlier experiments, undertaken by a colleague, attempting to peg the nominal exchange rate showed continuous cycling in the face of a very small, one-quarter demand shock. Taken in conjunction with our own preliminary experiments, these results just confirmed for us that pegging the nominal exchange rate was not a useful way to proceed.

17 To some extent, we are doing the opposite of what some of the European participants in this exercise had to do to implement the flexible rate regime. They had to add an exchange rate equation with uncovered interest parity. Note that in our initial approach, documented in our paper of 29th August, we performed the fixed exchange rate experiments with the uncovered-interest-rate-parity condition maintained. The result was substantially more volatility in the nominal exchange rate in the short term and the need to impose a larger shift term.

lower domestic prices for imported goods. As a result of lower prices, the increase in the real interest rate is more than that for the nominal short-term rate during the two years of the shock. By the second year, the value of the Canadian dollar has risen by about 0.2% relative to an index of six other currencies, and output is just under ½% below baseline (and steady-state) levels. Lower output is comprised of lower levels of each of consumption, investment, and government spending. Consistent with lower aggregate demand overall, import volumes are down slightly in spite of the effect of the appreciation of the dollar on import prices. This implies that both the (nominal) trade balance and the current account balance move into small surplus positions.

In year three, the shock is reversed. Short-term nominal interest rates plunge sharply. Notwithstanding the large and rapid monetary policy response to the shock, excess demand only emerges in year four. The temporary boom in year four is required to attain the domestic price level necessary to support the targeted level of the exchange rate.

By the ninth year, the economy has not yet returned to equilibrium, but is not far off; the real exchange rate is fluctuating very close to its steady-state level, as is the real interest rate. The nominal exchange rate differs from its original steady-state level by around 1%, very close to its targeted level change.

An exchange rate targeting regime: decomposition by transmission channel

For exposition purposes, the decomposition has been done for the domestic channels only so that any remaining transmission from the exchange rate channel, arising from the targeting approach, has been allocated to the residual category.[18] With only domestic channels at work, the main transmission channel becomes that of the direct-interest-rate effect on consumption. The wealth and cost-of-capital channels take turns at second place and the income/cash-flow channel continues to make the smallest contribution.

An exchange rate targeting regime: decomposition by GDP component

By component, private consumption makes the largest contribution to the change in real GDP and is partially offset by the trade balance. The latter is the most obvious manifestation of assuming a fixed exchange rate regime as in the comparable simulation assuming a flexible exchange rate regime the trade balance makes an important supporting contribution to the response of real GDP.

VI. SOME REMARKS ON MODELS AND METHODOLOGY

For models, like QPM, that characterize policy explicitly in terms of its goals rather than its instruments and that have forward-looking expectations, the proposed experiments are problematic in two areas: the exogeneity (or endogeneity) of policy instruments and expectations formation.

The experiments are intended to show the implications of disturbances to policy-controlled interest rates on real and nominal variables. This is a sensible exercise in the context of a standard forecasting model where the instruments are exogenous and the outcomes of instrument settings are endogenous. The philosophy of QPM, however, is different in that it views the job of the monetary authority as being that of responding to shocks from exogenous sources in order to move nominal target variables to their desired levels. This led the model builders to endogenize the monetary policy instrument and exogenize the target. That is, to represent policy with an endogenous monetary policy reaction function so that in policy simulations and in projection scenarios, the interest rates that arise from the exercise are those that are necessary to bring the target variable to its desired level, subject to various constraints.

18 A comparison of the discrepancy (residual) as between Scenario # 3 and Scenario # 5 suggests that this approach is reasonable.

The endogeneity of the monetary policy rule in QPM and the implementation of the QPM experiment via the "policy-controlled interest rate" means that one interpretation of the experiment might be that it asks us to consider the implications of a "policy error." The monetary authority is, in the baseline scenario, following an (constrained) optimal path, given the monetary policy reaction function, but then decides to increase (or decrease) interest rates for two years. This implies that the monetary authority initiates the shock rather than simply responds to shocks from outside the policy mechanism. In using its policy instrument to initiate the shock, the authority is obviously not free, at the same time, to respond to the resulting deviation of the target variable from its desired level. Once the shock is over, the endogeneity of the policy rule then compels the authority to undo the damage it has wrought.[19] Our simulation results reflect this feature of the experiment and must be interpreted in this light.[20]

Assumptions regarding expectations formation also affect the interpretation of the experiments considered here. Under adaptive expectations, simulation results are recursive in time, meaning that the value of an endogenous variable at time t+1 is independent of variables dated at t+2 or later. Under expectations formation that is explicitly forward-looking, this property does not hold. This has several implications in our simulations where the economy is being subjected to a shock and the monetary authority is not being allowed to react until the shock is over. This delay allows inflationary (or disinflationary) pressures to become ingrained in agents' expectations. One implication of forward-looking expectations, therefore, is that the monetary policy response necessary to re-establish control over inflation (or the nominal exchange rate) once the shock is over can sometimes be severe. A second implication is that the decomposition of a simulation into its contributing channels is dependent on the way or order in which it is done.[21]

VII. SUMMARY AND CONCLUSIONS

This paper has examined the results of simulation experiments where the Bank of Canada's Quarterly Projection Model (QPM) was subjected to positive and negative interest-rate disturbances of 100 basis points, lasting for two years, under varying initial conditions and two different exchange rate regimes. The experiments were undertaken as part of a model comparison exercise sponsored by the Bank for International Settlements to see how central bank models represent monetary transmission channels. The results of the model comparison exercise are one input into a broader exercise to increase cross-country understanding of monetary policy transmission channels in each of the participating member countries as an aid to discussions on monetary policy formulation and implementation.

Initial conditions considered were a base case of excess supply constructed artificially to resemble economic conditions in Canada in early 1994 and a pure steady state, where all variables are growing at constant rates, stocks and target variables are at their desired levels and expectations are realized. Results were presented on a shock-minus-control basis for key variables and on a contribution basis by five possible monetary transmission channels.

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19 Note that this implies that the policy-controlled interest rate return to control immediately following the end of the two-year shock period as dictated by the BIS experiment guidelines. To compel QPM to do this would be explosive since there would be no nominal anchor to the system.

20 From the perspective of QPM, a more meaningful experiment would have elicited the monetary policy response necessary to maintain a certain monetary policy objective in response to shocks originating from, say, nominal exchange rate changes, foreign demand shifts, domestic tax changes and various other disturbances of an exogenous nature.

21 Adaptive expectations is not sufficient for a decomposition to be unique and independent of the order in which the decomposition is done. The model must also be linear.

The core simulation under the inflation targeting (flexible exchange rate) regime - a positive shock to the policy instrument from initial conditions of excess supply - simply produces additional excess supply to which the monetary authority responds, when it can, by easing money conditions in order to return inflation to its 2% equilibrium value. With respect to transmission channels, the exchange rate channel is the most important in the first two years and works mainly through the external sector. The next most important channel is that of the direct interest rate effect on consumption and, as might be expected it works mainly through the private consumption component of output.

The implications of QPM's non-linear Phillips curve are shown by comparing the results of the positive and negative interest rate shocks from initial conditions of steady state. They exhibit similar magnitudes of response and similar relative contributions for the transmission channels for the first two years, a period over which the monetary authority, being the source of the shock, cannot respond. Once the monetary authority becomes free to respond in year three, differences begin to emerge as a consequence of the model's non-linear Phillips curve. Returning inflation to its target level after the stimulative effect of a negative interest rate shock requires a substantially larger decline in output than the increase needed to unwind the effect of the positive interest rate shock.

The mechanisms through which monetary policy works under exchange rate targeting are similar to those of inflation targeting absent the exchange rate channel, except for two significant points. First, while in practice seeking a level target is likely to be a tougher challenge this issue is minimized here by the way we implemented the shock. Second, instead of inflation directly determining monetary policy reactions, under exchange rate targeting, it is the effect of movements in the domestic price level on the nominal exchange rate combined with the consequent variations in the real exchange rate that matter.

APPENDIX

Decomposition of the results of the policy experiment[22]

The results of the policy experiment are decomposed into five channels: wealth; cost of capital; income/cash-flow; exchange rate; and direct interest rate effect on consumption with provision for a discrepancy or residual channel. We outline below, for each channel in turn, what was done and the reasoning behind it. Note that in order to isolate different channels, we held interest rates or other variables at their shock paths for the length of time that we judged relevant.

The recommended approach: one channel at a time

- The wealth channel was turned off by setting the net foreign asset (NFA) gap in the consumption equation at its control path for the five-year decomposition period, then allowing it to be switched back to the actual NFA gap gradually over the following ten quarters. Interest rates were held at their shock path for the initial eight quarters, and then allowed to move endogenously to prevent policy from becoming completely inappropriate given the movement in prices. Investment was tuned to its shock path to prevent it from responding to the reduced output gap resulting from the removal of the wealth effect.
- Because the cost-of-capital effect in QPM is captured using a simple accelerator effect, investment was tuned to its control path for the first five years to capture this effect.[23] Again, interest rates were held at their shock path for the initial eight quarters, and then allowed to move endogenously.
- To capture the income/cash-flow effect, disposable income in QPM was set to its control path so movements in labor income and taxes would not be passed through to the forward-looking component in consumption. Interest rates were held at their shock path for the initial eight quarters, and then allowed to move endogenously. Investment was tuned to its shock path to prevent it from responding to the reduced output gap resulting from the removal of the income/cash-flow effect.
- The exchange rate effect was captured by holding both the nominal and real exchange rates at their control path. In order to prevent the endogenous response of interest rates from feeding through to consumption, the relevant term in the consumption equation was set to its shock path. Further, to prevent the wealth effect from being double counted, the NFA gap appearing in the consumption equation was also set to its shock path. Investment was also tuned to its shock path.
- The direct effect of interest rates on consumption was captured by holding the slope of the yield curve in the consumption equation at its control path. The NFA gap in the consumption equation was set at its shock path. The nominal and real exchange rates were tuned to their shock paths and investment was tuned to its shock path.

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22 For a discussion of the issues involved, see E. Mauskopf and S. Siviero, "Two Methods of Ranking the Transmission Channels of Monetary Policy", Mimeograph, Bank for International Settlements (1994).

23 The cost-of-capital channel in QPM is currently turned off until research on quantifying its effect is completed.

An alternative approach: sequential decomposition

In the sequential approach, the model is coded so that the impact of the interest rate shock can be turned off in each of the five main channels to be examined. However, rather than simulate the model with only one particular channel turned on at a time, the full model was simulated and the channels sequentially turned off. The structure of the model also suggested a logical order in which the channels should be turned off.

- The first channel that was turned off was the income/cash-flow channel (disposable income). QPM embodies a permanent income type concept which affects current consumption via its forward-looking component. A shock of the nature considered here alters the forward-looking component of consumption through changes in the future path of labor income and direct taxes (disposable income). Owing to the fact that this shock is temporary and its effects are smoothed via standard QPM expectations formulation, it is necessary to turn this channel off when the economy is exhibiting its maximum deviation from the control path in order to show any significant impact from this shock.
- The second channel to shut off using this approach is the cost of capital. Empirically, it is very difficult to find a role for the cost of capital in investment, therefore, QPM was calibrated using a simple accelerator approach to broadly replicate the cyclical behavior of investment in the Canadian time series data. In other words, the level of the output gap was used to proxy for the cost of capital and other effects. Again, in order to properly capture this effect it was necessary to calculate its impact while the shock was disturbing output from its control path.
- In the dynamic version of QPM, agents' decisions regarding wealth holdings are all resolved through net foreign assets. Accordingly, the impact of the interest rate shock on wealth comes through the effect that interest rates have on the exchange rate which then flows into the current account balance which cumulates into NFA. In order to capture the complete wealth effect, it was logical to turn off the wealth channel before turning off the exchange rate channel.
- The structure of the model offered little guidance as to which of the remaining two channels should be turned off next. It was decided to shut the direct-interest-rate-effect-on-consumption channel off last.

Table A

Baseline values of selected exogenous variables

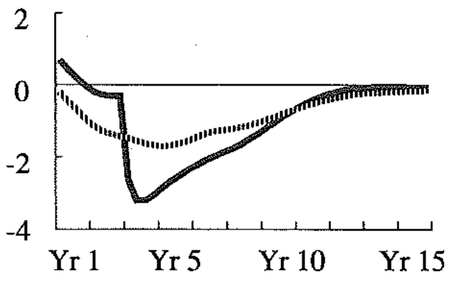
	Year 1	Year 2	Year 3	Year 4	Year 5	Steady state
Scenarios 1-2						
Foreign short-term interest rates (%)	5.82	6.17	6.18	6.16	6.17	5.42
Oil prices and other commodity prices*	2.55	3.49	3.50	3.25	3.00	2.00
Foreign prices*	2.55	3.49	3.50	3.25	3.00	2.00
Foreign output gap	0.12	- 0.24	- 0.68	- 0.62	- 0.19	0.00
Scenarios 3-6						
Foreign short-term interest rates (%)	5.42	5.42	5.42	5.42	5.42	5.42
Oil prices and other commodity prices*	2.00	2.00	2.00	2.00	2.00	2.00
Foreign prices*	2.00	2.00	2.00	2.00	2.00	2.00
Foreign output gap	0.00	0.00	0.00	0.00	0.00	0.00

* Year-on-year percentage change.

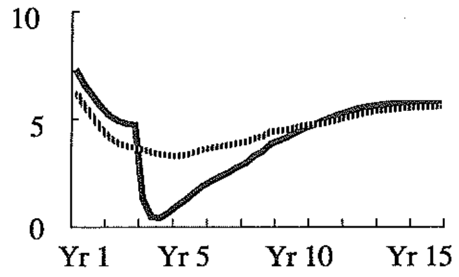
Scenario 1

An interest rate increase under inflation targeting, from initial conditions of excess supply

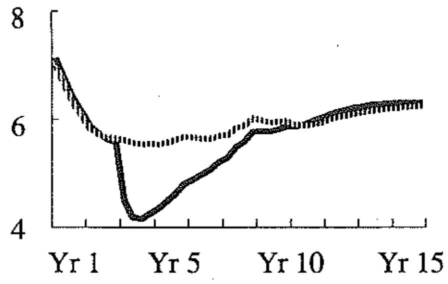
Slope of the Yield Curve



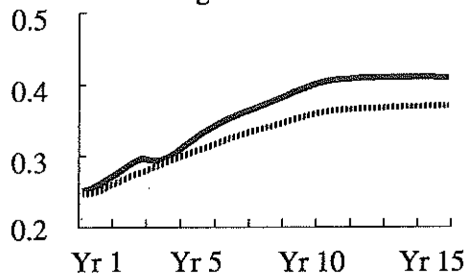
90-Day Commercial Paper Rate



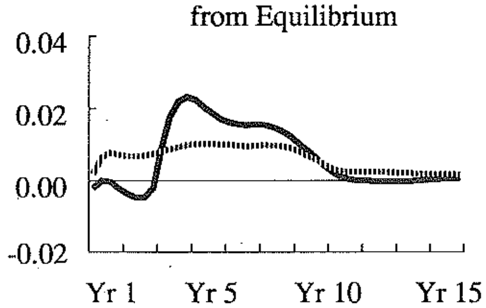
Nominal Long Bond Rate



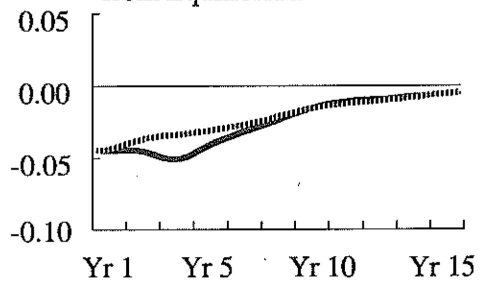
Log of the Nominal Exchange Rate



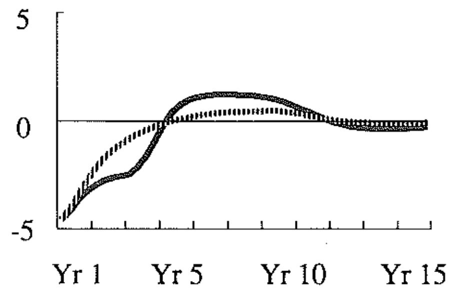
Deviation of the Real Exchange Rate from Equilibrium



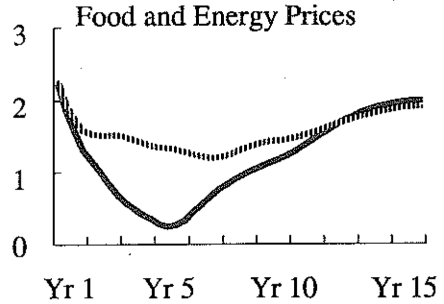
Deviation of Net Foreign Assets Ratio from Equilibrium



Deviation of Output from Equilibrium



Year-Over-Year Change in CPI Excluding Food and Energy Prices



Note: The solid line is the shock, and the dashed line the control.

Table I.1

Interest rates, exchange rates and asset prices

Scenario 1: An interest rate increase under inflation targeting, from initial conditions of excess supply						
Deviations from baseline	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Policy-controlled interest rate (%)	1.00	1.03	- 2.73	- 1.99	- 1.34	0.00
2. Market-determined interest rates (%)						
Intermediate target	0.89	1.03	- 1.44	- 0.96	- 0.71	- 0.00
Long-term interest rate	0.11	- 0.00	- 1.29	- 1.04	- 0.63	0.00
3. Other interest rates (%)						
4. Real interest rate						
Real short-term interest rate (%)	1.10	1.61	- 1.56	- 0.85	- 0.73	0.00
5. Exchange rates						
Nominal effective exchange rate	0.78	1.69	0.83	1.98	2.94	4.00
Real effective exchange rate	0.70	1.09	- 0.89	- 0.94	- 0.59	0.00
6. Asset prices						
7. Money and credit						

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Scenario 1: An interest rate increase under inflation targeting, from initial conditions of excess supply						
Deviations from baseline (all in % change except where otherwise stated)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Real GDP and its components						
Real GDP	- 0.22	- 1.17	- 1.31	0.39	0.84	0.00
Private consumption	- 0.17	- 1.00	- 1.59	- 0.47	0.24	0.00
Government expenditure	- 0.09	- 0.46	- 0.50	0.18	0.34	0.00
Private investment	- 0.12	- 0.83	- 1.15	- 0.10	1.79	0.00
Exports	- 0.13	- 0.75	- 0.68	0.78	0.84	0.00
Imports	0.05	- 0.02	- 0.73	- 0.98	- 0.11	0.00
2. Unemployment rate (%)	0.10	0.46	0.75	0.33	- 0.25	0.00
3. Real disposable income						
4. Inflation and wages (%)						
GDP deflator	- 0.08	- 0.52	- 1.14	- 1.18	- 0.61	0.00
Consumer prices (excl. food & energy) ...	- 0.15	- 0.60	- 0.97	- 1.04	- 0.61	0.00
Wages/earnings	- 0.04	- 0.27	- 0.77	- 1.26	- 1.23	0.00
Unit labour costs	0.07	0.29	- 0.93	- 2.46	- 1.03	0.00
Import prices	- 0.58	- 0.87	0.25	- 0.87	- 0.88	0.00
5. Government accounts (% of nominal GDP)						
Primary expenditures	0.03	0.14	0.16	- 0.04	- 0.10	0.00
Interest payments	0.07	0.05	- 0.61	- 0.50	- 0.31	0.00
Revenues	0.02	0.14	0.23	0.11	0.03	0.00
Government budget balance	0.10	0.11	- 0.66	- 0.67	- 0.43	0.00
Public sector debt	0.22	1.12	1.41	0.36	- 0.08	0.00
6. Current account (% of nominal GDP)	- 0.04	- 0.27	- 0.13	0.59	0.47	0.00
Trade balance	- 0.05	- 0.19	- 0.02	0.38	0.19	0.00
Net interest payments abroad	- 0.02	- 0.08	- 0.06	0.07	0.17	0.00

Table III.1

Contributions to GDP changes by channel of transmission and by variable

Scenario 1: An interest rate increase under inflation targeting, from initial conditions of excess supply

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital/ accelerator**	**Exchange rate**	**Residual**
Real GDP: first year after shock*	**- 0.22**	**- 0.00**	**- 0.01**	**- 0.08**	**- 0.02**	**- 0.11**	**- 0.01**
of which:							
Private consumption	- 0.12	- 0.00	- 0.01	- 0.10	- 0.00	0.02	- 0.01
Government expenditure	- 0.02	- 0.00	- 0.00	- 0.01	- 0.00	- 0.01	- 0.00
Private investment	- 0.02	0.00	0.00	0.00	- 0.02	0.00	0.00
Exports	- 0.05	- 0.00	- 0.00	- 0.00	- 0.00	- 0.05	0.00
Imports	0.02	- 0.00	- 0.00	- 0.03	- 0.01	0.06	- 0.00
Real GDP: second year after shock*	**- 1.17**	**- 0.02**	**- 0.17**	**- 0.39**	**- 0.11**	**- 0.55**	**0.07**
of which:							
Private consumption	- 0.68	- 0.02	- 0.23	- 0.52	- 0.03	0.02	0.10
Government expenditure	- 0.09	- 0.00	- 0.01	- 0.03	- 0.01	- 0.04	0.01
Private investment	- 0.11	0.00	0.00	0.00	- 0.11	0.00	0.00
Exports	- 0.29	- 0.00	0.00	- 0.00	- 0.00	- 0.29	- 0.00
Imports	- 0.01	- 0.01	- 0.07	- 0.16	- 0.04	0.24	0.03
Real GDP: third year after shock*	**- 1.31**	**- 0.03**	**- 0.34**	**- 0.41**	**- 0.16**	**- 0.34**	**- 0.03**
of which:							
Private consumption	- 1.08	- 0.06	- 0.57	- 0.54	- 0.06	0.04	0.11
Government expenditure	- 0.10	- 0.00	- 0.03	- 0.03	- 0.01	- 0.03	- 0.00
Private investment	- 0.16	0.00	0.00	0.00	- 0.16	0.00	- 0.00
Exports	- 0.26	0.00	0.04	0.00	- 0.00	- 0.25	- 0.05
Imports	- 0.29	- 0.02	- 0.22	- 0.16	- 0.07	0.09	0.09

Table III.1 (cont.)

Contributions to GDP changes by channel of transmission and by variable

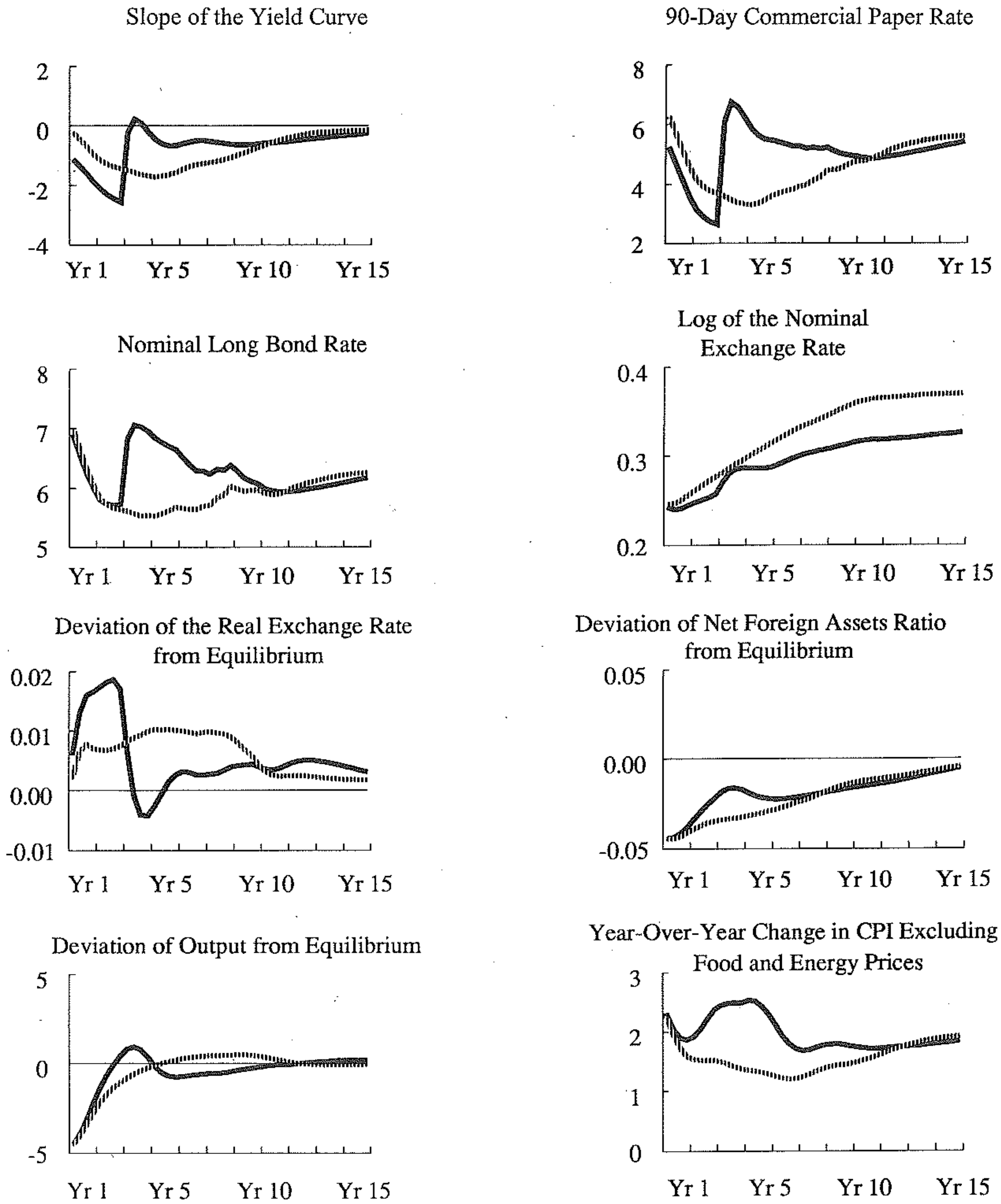
Scenario 1: An interest rate increase under inflation targeting, from initial conditions of excess supply

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital/ Accelerator**	**Exchange rate**	**Residual**
Real GDP: fourth year after shock*	**0.39**	**- 0.00**	**- 0.12**	**0.30**	**- 0.01**	**0.59**	**- 0.36**
of which:							
Private consumption	- 0.32	- 0.04	- 0.55	0.40	- 0.03	- 0.08	- 0.01
Government expenditure	0.04	- 0.00	- 0.01	0.02	0.00	0.05	- 0.03
Private investment	- 0.01	- 0.00	- 0.00	- 0.00	- 0.01	- 0.00	0.00
Exports	0.30	0.02	0.16	0.00	0.01	0.31	- 0.19
Imports	- 0.39	- 0.02	- 0.28	0.12	- 0.02	- 0.31	0.14
Real GDP: fifth year after shock*	**0.84**	**0.02**	**0.06**	**0.48**	**0.14**	**0.46**	**- 0.33**
of which:							
Private consumption	0.16	0.01	- 0.29	0.64	- 0.01	- 0.10	- 0.09
Government expenditure	0.07	0.00	0.00	0.04	0.01	0.04	- 0.03
Private investment	0.25	0.00	0.00	0.00	0.25	0.00	- 0.00
Exports	0.32	0.01	0.16	0.00	- 0.02	0.32	- 0.16
Imports	- 0.05	- 0.00	- 0.18	0.19	0.09	- 0.20	0.05
Real GDP: steady state*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**- 0.00**
of which:							
Private consumption	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Scenario 2

An interest rate decrease under inflation targeting, from initial conditions of excess supply



Note: The solid line is the shock, and the dashed line the control.

Table I.2

Interest rates, exchange rates and asset prices

Scenario 2: An interest rate decrease under inflation targeting, from initial conditions of excess supply						
Deviations from baseline	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Policy-controlled interest rate (%)	- 1.00	- 1.02	2.95	2.18	1.52	0.00
2. Market-determined interest rates (%)						
Intermediate target	- 0.92	- 1.05	1.55	1.04	0.81	0.00
Long-term interest rate	- 0.08	0.03	1.40	1.14	0.71	0.00
3. Other interest rates (%)						
4. Real interest rate						
Real short-term interest rate (%)	- 1.10	- 1.60	1.66	0.93	0.84	0.00
5. Exchange rates						
Nominal effective exchange rate	- 0.78	- 1.67	- 0.81	- 2.02	- 2.95	- 4.40
Real effective exchange rate	- 0.70	- 1.08	0.98	1.01	0.70	0.00
6. Asset prices						
7. Money and credit						

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Scenario 2: An interest rate decrease under inflation targeting, from initial conditions of excess supply						
Deviations from baseline (all in % change except where otherwise stated)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Real GDP and its components						
Real GDP	0.22	1.18	1.29	- 0.52	- 0.99	0.00
Private consumption	0.17	1.03	1.59	0.35	- 0.40	0.00
Government expenditure	0.09	0.46	0.49	- 0.23	- 0.40	0.00
Private investment	0.12	0.81	1.10	- 0.03	- 2.00	0.00
Exports	0.13	0.76	0.67	- 0.84	- 0.90	0.00
Imports	- 0.05	0.02	0.74	0.96	0.05	0.00
2. Unemployment rate (%)	- 0.10	- 0.46	- 0.75	- 0.28	0.35	0.00
3. Real disposable income						
4. Inflation and wages (%)						
GDP deflator	0.08	0.53	1.22	1.27	0.66	0.00
Consumer prices (excl. food & energy)	0.15	0.61	1.04	1.12	0.66	0.00
Wages/earnings	0.04	0.27	0.80	1.34	1.31	0.00
Unit labour costs	- 0.07	- 0.29	1.00	2.64	1.09	0.00
Import prices	0.59	0.88	- 0.23	0.95	0.91	0.00
5. Government accounts (% of nominal GDP)						
Primary expenditures	- 0.03	- 0.14	- 0.16	0.06	0.12	0.00
Interest payments	- 0.05	- 0.03	0.62	0.54	0.36	0.00
Revenues	- 0.02	- 0.14	- 0.22	- 0.10	- 0.01	0.00
Government budget balance	- 0.09	- 0.10	0.67	0.72	0.47	0.00
Public sector debt	- 0.21	- 1.09	- 1.34	- 0.27	0.20	0.00
6. Current account (% of nominal GDP)	0.04	0.27	0.12	- 0.60	- 0.49	0.00
Trade balance	0.05	0.19	0.01	- 0.37	- 0.17	0.00
Net interest payments abroad	0.02	0.07	0.06	- 0.08	- 0.19	0.00

Table III.2

Contributions to GDP changes by channel of transmission and by variable

Scenario 2: An interest rate decrease under inflation targeting, from initial conditions of excess supply

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital/ accelerator**	**Exchange rate**	**Residual**
Real GDP: first year after shock*	**0.22**	**0.00**	**0.01**	**0.08**	**0.02**	**0.11**	**0.00**
of which:							
Private consumption	0.12	0.00	0.01	0.11	0.00	- 0.01	0.01
Government expenditure	0.02	0.00	0.00	0.01	0.00	0.01	0.00
Private investment	0.02	0.00	0.00	0.00	0.02	0.00	0.00
Exports	0.05	0.00	0.00	- 0.00	0.00	0.05	- 0.00
Imports	- 0.02	0.00	0.00	0.03	0.01	- 0.06	0.00
Real GDP: second year after shock*	**1.18**	**0.02**	**0.08**	**0.41**	**0.11**	**0.46**	**0.11**
of which:							
Private consumption	0.69	0.02	0.11	0.54	0.03	- 0.15	0.15
Government expenditure	0.09	0.00	0.01	0.03	0.01	0.04	0.01
Private investment	0.11	0.00	0.00	0.00	0.11	0.00	0.00
Exports	0.30	- 0.00	- 0.00	0.00	0.00	0.29	0.00
Imports	0.01	0.01	0.03	0.16	0.04	- 0.28	0.05
Real GDP: third year after shock*	**1.29**	**0.03**	**0.28**	**0.41**	**0.15**	**0.25**	**0.16**
of which:							
Private consumption	1.08	0.05	0.48	0.54	0.05	- 0.14	0.09
Government expenditure	0.10	0.00	0.02	0.03	0.01	0.02	0.01
Private investment	0.15	- 0.00	- 0.00	- 0.00	0.15	- 0.00	0.00
Exports	0.26	- 0.00	- 0.03	- 0.00	0.00	0.25	0.04
Imports	0.30	0.02	0.18	0.16	0.07	- 0.12	- 0.02

Table III.2 (cont.)

Contributions to GDP changes by channel of transmission and by variable

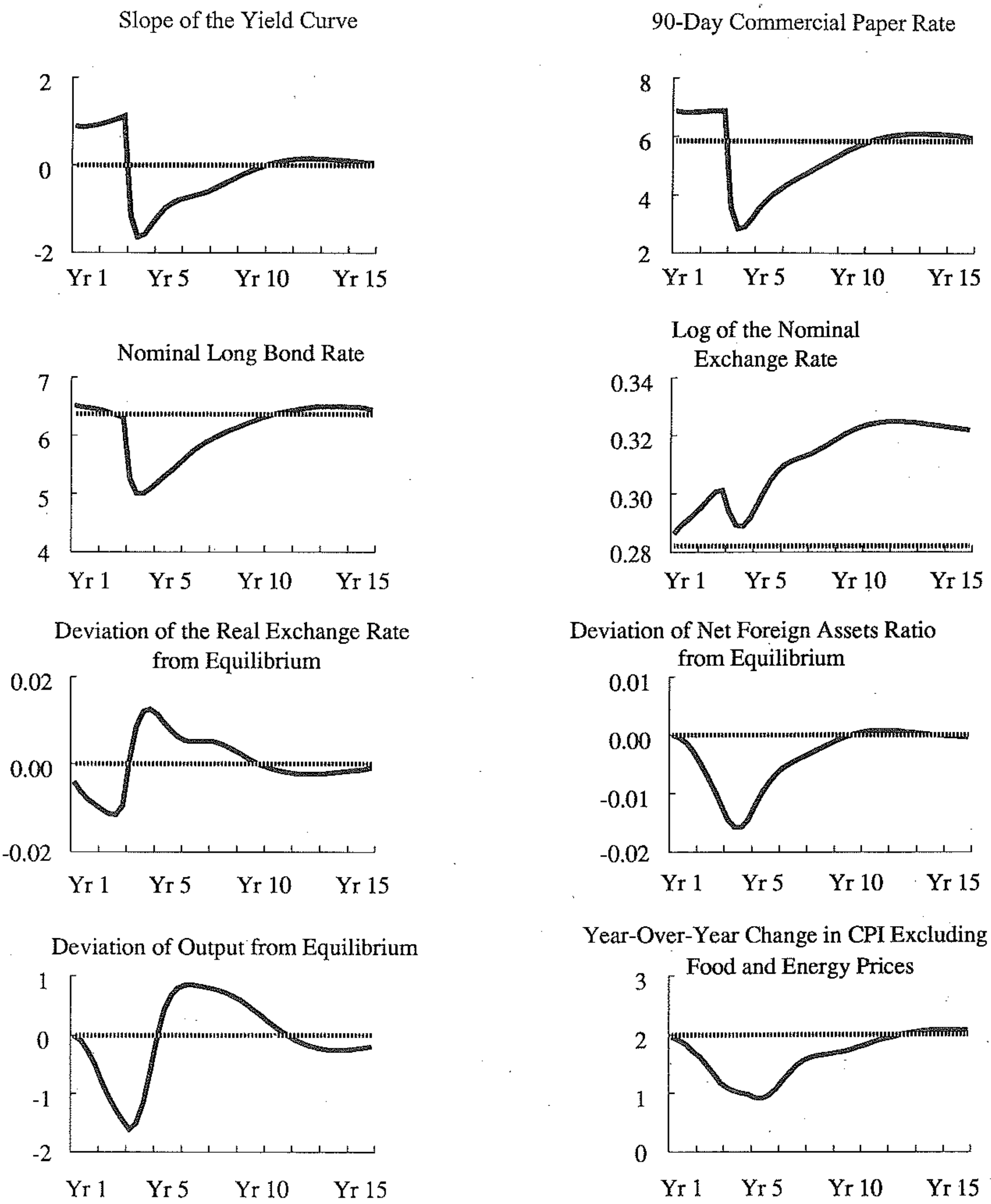
Scenario 2: An interest rate decrease under inflation targeting, from initial conditions of excess supply

	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption	Cost of capital/ Accelerator	Exchange rate	Residual
Real GDP: fourth year after shock*	**- 0.52**	**- 0.00**	**0.11**	**- 0.35**	**- 0.02**	**- 0.71**	**0.45**
of which:							
Private consumption	0.24	0.03	0.48	- 0.46	0.02	- 0.01	0.18
Government expenditure	- 0.05	- 0.00	0.01	- 0.03	- 0.01	- 0.06	0.04
Private investment	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00	0.00
Exports	- 0.32	- 0.01	- 0.13	- 0.00	- 0.01	- 0.33	0.16
Imports	0.38	0.02	0.25	- 0.14	0.02	0.31	- 0.07
Real GDP: fifth year after shock*	**- 0.99**	**- 0.03**	**- 0.07**	**- 0.54**	**- 0.18**	**- 0.59**	**0.42**
of which:							
Private consumption	- 0.27	- 0.02	0.20	- 0.71	- 0.01	- 0.02	0.29
Government expenditure	- 0.08	- 0.00	- 0.01	- 0.04	- 0.02	- 0.05	0.03
Private investment	- 0.28	- 0.00	- 0.00	- 0.00	- 0.28	- 0.00	0.00
Exports	- 0.34	- 0.01	- 0.13	0.00	0.01	- 0.34	0.13
Imports	0.02	- 0.00	0.13	- 0.22	- 0.10	0.18	0.03
Real GDP: steady state*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**- 0.00**
of which:							
Private consumption	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Scenario 3

An interest rate increase under inflation targeting, from the steady state



Note: The solid line is the shock, and the dashed line the control.

Table I.3

Interest rates, exchange rates and asset prices

Scenario 3: An interest rate increase under inflation targeting, from the steady state						
Deviations from baseline	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Policy-controlled interest rate (%)	1.00	1.03	- 2.72	- 1.96	- 1.29	0.00
2. Market-determined interest rates (%)						
Intermediate target	0.89	1.03	- 1.43	- 0.94	- 0.68	- 0.00
Long-term interest rate	0.11	0.00	- 1.28	- 1.02	- 0.61	0.00
3. Other interest rates (%)						
4. Real interest rate						
Real short-term interest rate (%)	1.10	1.61	- 1.52	- 0.80	- 0.67	0.00
5. Exchange rates						
Nominal effective exchange rate	0.78	1.68	0.86	2.02	2.98	3.90
Real effective exchange rate	0.70	1.08	- 0.85	- 0.87	- 0.52	0.00
6. Asset prices						
7. Money and credit						

Table II.3

Real economic activity, price developments, fiscal developments and foreign sector

Scenario 3: An interest rate increase under inflation targeting, from the steady state						
Deviations from baseline (all in % change except where otherwise stated)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Real GDP and its components						
Real GDP	- 0.22	- 1.15	- 1.28	0.40	0.81	0.00
Private consumption	- 0.17	- 0.97	- 1.50	- 0.38	0.28	0.00
Government expenditure	- 0.09	- 0.45	- 0.49	0.19	0.33	0.00
Private investment	- 0.11	- 0.81	- 1.16	- 0.08	1.80	0.00
Exports	- 0.13	- 0.75	- 0.68	0.73	0.77	0.00
Imports	0.05	- 0.01	- 0.69	- 0.89	- 0.05	0.00
2. Unemployment rate (%)	0.10	0.46	0.75	0.32	- 0.25	0.00
3. Real disposable income						
4. Inflation and wages (%)						
GDP deflator	- 0.08	- 0.52	- 1.14	- 1.18	- 0.60	0.00
Consumer prices (excl. food & energy) ...	- 0.15	- 0.60	- 0.98	- 1.04	- 0.61	0.00
Wages/earnings	- 0.04	- 0.27	- 0.78	- 1.27	- 1.22	0.00
Unit labour costs	0.07	0.29	- 0.96	- 2.47	- 1.00	0.00
Import prices	- 0.57	- 0.86	0.22	- 0.89	- 0.88	0.00
5. Government accounts (% of nominal GDP)						
Primary expenditures	0.03	0.14	0.16	- 0.04	- 0.09	0.00
Interest payments	0.06	0.05	- 0.55	- 0.46	- 0.29	0.00
Revenues	0.02	0.13	0.21	0.11	0.03	0.00
Government budget balance	0.09	0.12	- 0.59	- 0.62	- 0.40	0.00
Public sector debt	0.20	1.02	1.30	0.34	- 0.06	0.00
6. Current account (% of nominal GDP)	- 0.03	- 0.26	- 0.13	0.54	0.41	0.00
Trade balance	- 0.15	- 0.64	- 0.11	1.09	0.45	0.00
Net interest payments abroad	- 0.01	- 0.06	- 0.05	0.07	0.15	0.00

Table III.3

Contributions to GDP changes by channel of transmission and by variable

Scenario 3: An interest rate increase under inflation targeting, from the steady state

	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption	Cost of capital/ acceler-ator	Exchange rate	Residual
Real GDP: first year after shock*	**- 0.22**	**- 0.00**	**- 0.01**	**- 0.08**	**- 0.02**	**- 0.11**	**- 0.01**
of which:							
Private consumption	- 0.11	- 0.00	- 0.01	- 0.11	- 0.00	0.02	- 0.01
Government expenditure	- 0.02	- 0.00	- 0.00	- 0.01	- 0.00	- 0.01	- 0.00
Private investment	- 0.02	0.00	0.00	0.00	- 0.02	0.00	- 0.00
Exports	- 0.05	- 0.00	- 0.00	0.00	- 0.00	- 0.05	0.00
Imports	0.02	- 0.00	- 0.00	- 0.03	- 0.01	0.06	- 0.00
Real GDP: second year after shock*	**- 1.15**	**- 0.02**	**- 0.11**	**- 0.39**	**- 0.11**	**- 0.50**	**- 0.02**
of which:							
Private consumption	- 0.67	- 0.02	- 0.16	- 0.52	- 0.03	0.08	- 0.02
Government expenditure	- 0.09	- 0.00	- 0.01	- 0.03	- 0.01	- 0.04	- 0.00
Private investment	- 0.11	0.00	0.00	0.00	- 0.11	0.00	0.00
Exports	- 0.28	0.00	0.00	0.00	- 0.00	- 0.28	- 0.00
Imports	- 0.00	- 0.01	- 0.05	- 0.16	- 0.04	0.26	- 0.00
Real GDP: third year after shock*	**- 1.28**	**- 0.03**	**- 0.29**	**- 0.40**	**- 0.15**	**- 0.31**	**- 0.09**
of which:							
Private consumption	- 1.04	- 0.05	- 0.48	- 0.53	- 0.05	0.08	0.00
Government expenditure	- 0.10	- 0.00	- 0.02	- 0.03	- 0.01	- 0.02	- 0.01
Private investment	- 0.16	- 0.00	- 0.00	- 0.00	- 0.16	- 0.00	0.00
Exports	- 0.26	0.00	0.03	0.00	- 0.00	- 0.25	- 0.04
Imports	- 0.28	- 0.02	- 0.18	- 0.16	- 0.07	0.11	0.05

Table III.3 (cont.)

Contributions to GDP changes by channel of transmission and by variable

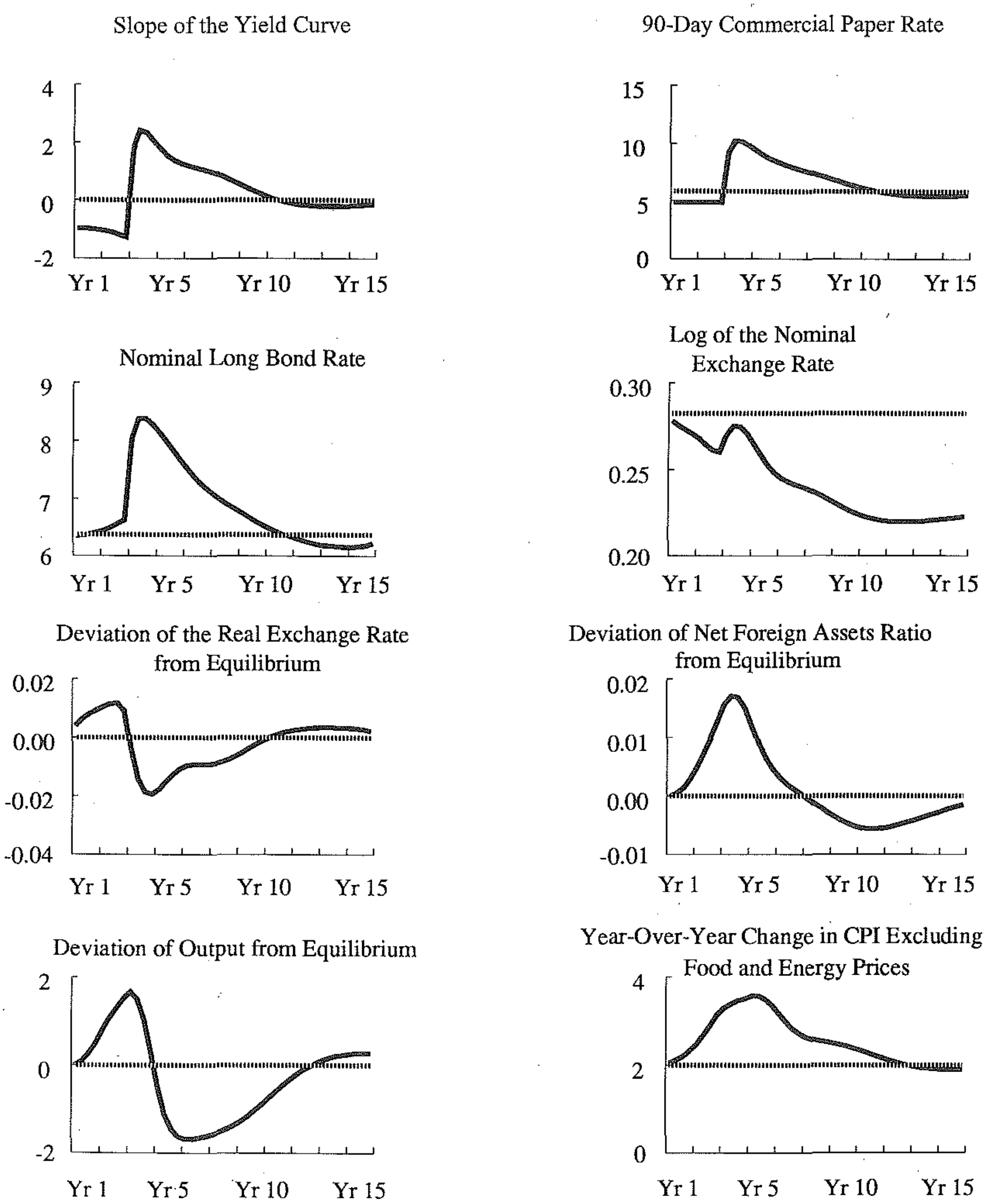
Scenario 3: An interest rate increase under inflation targeting, from the steady state

	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption	Cost of capital/ Accelerator	Exchange rate	Residual
Real GDP: fourth year after shock*	**0.40**	**- 0.00**	**- 0.11**	**0.31**	**- 0.01**	**0.59**	**- 0.38**
of which:							
Private consumption	- 0.26	- 0.04	- 0.48	0.42	- 0.03	- 0.03	- 0.09
Government expenditure	0.04	- 0.00	- 0.01	0.03	0.00	0.05	- 0.03
Private investment	- 0.01	0.00	0.00	0.00	- 0.01	0.00	- 0.00
Exports	0.28	0.01	0.13	0.00	0.01	0.29	- 0.16
Imports	- 0.36	- 0.02	- 0.25	0.13	- 0.02	- 0.29	0.09
Real GDP: fifth year after shock*	**0.81**	**0.02**	**0.06**	**0.49**	**0.13**	**0.46**	**- 0.35**
of which:							
Private consumption	0.19	0.01	- 0.24	0.65	- 0.01	- 0.04	- 0.17
Government expenditure	0.07	0.00	0.00	0.04	0.01	0.04	- 0.03
Private investment	0.24	0.00	0.00	0.00	0.24	0.00	0.00
Exports	0.29	0.01	0.14	- 0.00	- 0.02	0.29	- 0.13
Imports	- 0.02	- 0.00	- 0.15	0.20	0.09	- 0.17	0.01
Real GDP: steady state*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**- 0.00**
of which:							
Private consumption	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Scenario 4

An interest rate decrease under inflation targeting, from the steady state



Note: The solid line is the shock, and the dashed line the control.

Table I.4

Interest rates, exchange rates and asset prices

Scenario 4: An interest rate decrease under inflation targeting, from the steady state						
Deviations from baseline	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Policy-controlled interest rate (%)	- 0.99	- 1.00	4.05	3.03	2.06	0.00
2. Market-determined interest rates (%)						
Intermediate target	- 0.99	- 1.16	2.15	1.49	1.09	0.00
Long-term interest rate	0.00	0.16	1.90	1.55	0.96	0.00
3. Other interest rates (%)						
4. Real interest rate						
Real short-term interest rate (%)	- 1.12	- 1.78	2.27	1.32	1.10	0.00
5. Exchange rate						
Nominal effective exchange rate	- 0.80	- 1.86	- 0.96	- 2.58	- 3.90	- 5.60
Real effective exchange rate	- 0.70	- 1.07	1.43	1.42	0.94	0.00
6. Asset prices						
7. Money and credit						

Table II.4

Real economic activity, price developments, fiscal developments and foreign sector

Scenario 4: An interest rate decrease under inflation targeting, from the steady state						
Deviations from baseline (all in % change except where otherwise stated)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Real GDP and its components						
Real GDP	0.22	1.20	1.17	- 1.14	- 1.68	0.00
Private consumption	0.18	1.07	1.55	- 0.15	- 1.10	0.00
Government expenditure	0.09	0.47	0.45	- 0.47	- 0.66	0.00
Private investment	0.10	0.70	0.87	- 0.56	- 2.85	0.00
Exports	0.13	0.76	0.57	- 1.26	- 1.29	0.00
Imports	- 0.04	0.04	0.81	0.94	- 0.22	0.00
2. Unemployment rate (%)	- 0.10	- 0.47	- 0.70	- 0.02	0.77	0.00
3. Real disposable income						
4. Inflation and wages (%)						
GDP deflator	0.10	0.72	1.64	1.69	0.91	0.00
Consumer prices (excl. food & energy) ...	0.17	0.80	1.41	1.50	0.92	0.00
Wages/earnings	0.06	0.39	1.20	1.92	1.74	0.00
Unit labour costs	- 0.06	- 0.20	1.48	3.53	1.38	0.00
Import prices	0.60	1.07	- 0.15	1.32	1.30	0.00
5. Government accounts (% of nominal GDP)						
Primary expenditures	- 0.03	- 0.14	- 0.14	0.13	0.20	0.00
Interest payments	- 0.01	0.02	0.78	0.71	0.48	0.00
Revenues	- 0.02	- 0.13	- 0.21	- 0.05	0.05	0.00
Government budget balance	- 0.04	- 0.06	0.84	0.92	0.61	0.00
Public sector debt	- 0.18	- 1.04	- 1.26	0.04	0.59	0.00
6. Current account (% of nominal GDP)	0.03	0.24	0.05	- 0.79	- 0.62	0.00
Trade balance	0.15	0.61	- 0.03	- 1.41	- 0.55	0.00
Net interest payments abroad	0.01	0.05	0.02	- 0.15	- 0.28	0.00

Table III.4

Contributions to GDP changes by channel of transmission and by variable

Scenario 4: An interest rate decrease under inflation targeting, from the steady state

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital/ accelerator**	**Exchange rate**	**Residual**
Real GDP: first year after shock*	**0.22**	**0.00**	**0.01**	**0.09**	**0.01**	**0.11**	**0.01**
of which:							
Private consumption	0.13	0.00	0.01	0.12	0.00	- 0.02	0.01
Government expenditure	0.02	0.00	0.00	0.01	0.00	0.01	0.00
Private investment	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Exports	0.05	0.00	0.00	0.00	0.00	0.05	- 0.00
Imports	- 0.02	0.00	0.00	0.04	0.01	- 0.06	0.00
Real GDP: second year after shock*	**1.20**	**0.01**	**0.12**	**0.45**	**0.09**	**0.50**	**0.02**
of which:							
Private consumption	0.74	0.02	0.17	0.59	0.02	- 0.09	0.02
Government expenditure	0.09	0.00	0.01	0.04	0.01	0.04	0.00
Private investment	0.10	- 0.00	- 0.00	- 0.00	0.10	- 0.00	0.00
Exports	0.29	0.00	- 0.00	- 0.00	0.00	0.29	0.00
Imports	0.02	0.01	0.05	0.18	0.03	- 0.27	0.01
Real GDP: third year after shock*	**1.17**	**0.02**	**0.30**	**0.42**	**0.11**	**0.20**	**0.11**
of which:							
Private consumption	1.07	0.04	0.52	0.56	0.04	- 0.09	0.00
Government expenditure	0.09	0.00	0.02	0.03	0.01	0.02	0.01
Private investment	0.12	- 0.00	- 0.00	- 0.00	0.12	- 0.00	0.00
Exports	0.22	- 0.00	- 0.04	0.00	0.00	0.21	0.05
Imports	0.33	0.02	0.20	0.17	0.05	- 0.06	- 0.05

Table III.4 (cont.)

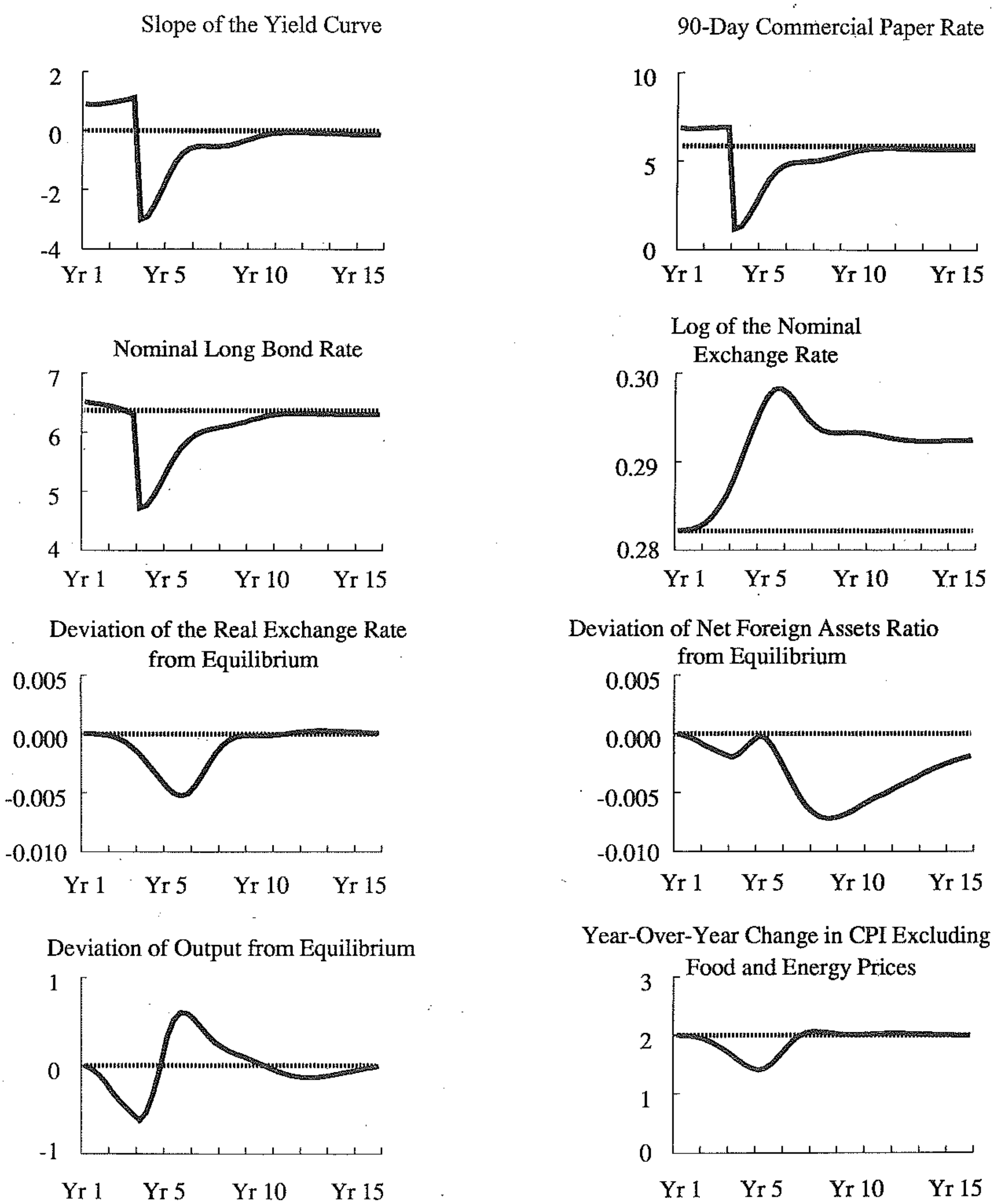
Contributions to GDP changes by channel of transmission and by variable

Scenario 4: An interest rate decrease under inflation targeting, from the steady state							
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital/ Acceler-ator**	**Exchange rate**	**Residual**
Real GDP: fourth year after shock*	**- 1.14**	**- 0.02**	**0.01**	**- 0.55**	**- 0.08**	**- 0.97**	**0.47**
of which:							
Private consumption	- 0.11	0.01	0.43	- 0.73	- 0.00	0.05	0.14
Government expenditure	- 0.09	- 0.00	0.00	- 0.04	- 0.01	- 0.08	0.04
Private investment	- 0.08	0.00	0.00	0.00	- 0.08	0.00	- 0.00
Exports	- 0.48	- 0.01	- 0.16	- 0.00	- 0.01	- 0.48	0.19
Imports	0.38	0.01	0.26	- 0.23	- 0.01	0.45	- 0.10
Real GDP: fifth year after shock*	**- 1.68**	**- 0.05**	**- 0.19**	**- 0.75**	**- 0.28**	**- 0.78**	**0.36**
of which:							
Private consumption	- 0.76	- 0.06	0.09	- 0.99	- 0.04	0.04	0.19
Government expenditure	- 0.13	- 0.00	- 0.02	- 0.06	- 0.02	- 0.06	0.03
Private investment	- 0.39	0.00	0.00	0.00	- 0.39	0.00	0.00
Exports	- 0.49	- 0.01	- 0.15	0.00	0.01	- 0.48	0.14
Imports	- 0.09	- 0.02	0.11	- 0.31	- 0.15	0.28	- 0.00
Real GDP: steady state*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**- 0.00**
of which:							
Private consumption	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Scenario 5

An interest rate increase under exchange rate targeting, from the steady state



Note: The solid line is the shock, and the dashed line the control.

Table I.5

Interest rates, exchange rates and asset prices

Scenario 5: An interest rate increase under exchange rate targeting, from the steady state						
Deviations from baseline	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Policy-controlled interest rate (%)	1.00	1.03	- 4.10	- 1.73	- 0.89	0.00
2. Market-determined interest rates (%)						
Intermediate target	0.89	1.03	- 2.61	- 1.01	- 0.55	- 0.00
Long-term interest rate	0.11	0.00	- 1.49	- 0.73	- 0.35	0.00
3. Other interest rates (%)						
4. Real interest rate						
Real short-term interest rate (%)	1.01	1.20	- 3.59	- 1.30	- 0.80	0.00
5. Exchange rates						
Nominal effective exchange rate	0.02	0.23	0.87	1.53	1.42	1.00
Real effective exchange rate	0.00	0.06	0.28	0.50	0.31	0.00
6. Asset prices						
7. Money and credit						

Table II.5

Real economic activity, price developments, fiscal developments and foreign sector

Scenario 5: An interest rate increase under exchange rate targeting, from the steady state						
Deviations from baseline (all in % change except where otherwise stated)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Steady state**
1. Real GDP and its components						
Real GDP	- 0.08	- 0.44	- 0.40	0.49	0.39	0.00
Private consumption	- 0.15	- 0.77	- 0.54	1.37	1.18	0.00
Government expenditure	- 0.03	- 0.17	- 0.15	0.20	0.15	0.00
Private investment	- 0.04	- 0.26	- 0.33	0.15	0.88	0.00
Exports	- 0.00	- 0.01	- 0.10	- 0.32	- 0.45	0.00
Imports	- 0.08	- 0.42	- 0.23	0.97	0.98	0.00
2. Unemployment rate (%)	0.04	0.17	0.25	- 0.02	- 0.22	0.00
3. Real disposable income						
4. Inflation and wages (%)						
GDP deflator	- 0.01	- 0.15	- 0.43	- 0.44	- 0.08	0.00
Consumer prices (excl. food & energy) ...	- 0.01	- 0.15	- 0.46	- 0.50	- 0.07	0.00
Wages/earnings	- 0.01	- 0.07	- 0.27	- 0.48	- 0.36	0.00
Unit labour costs	0.04	0.14	- 0.39	- 1.08	- 0.03	0.00
Import prices	- 0.02	- 0.19	- 0.58	- 0.60	0.03	0.00
5. Government accounts (% of nominal GDP)						
Primary expenditures	0.01	0.05	0.05	- 0.06	- 0.05	0.00
Interest payments	0.06	0.02	- 0.69	- 0.37	- 0.20	0.00
Revenues	0.01	0.05	0.05	- 0.05	- 0.10	0.00
Government budget balance	0.07	0.04	- 0.70	- 0.38	- 0.13	0.00
Public sector debt	0.09	0.39	0.12	- 0.61	- 0.70	0.00
6. Current account (% of nominal GDP)	0.02	0.12	0.10	- 0.27	- 0.31	0.00
Trade balance	0.06	0.29	0.05	- 0.99	- 1.08	0.00
Net interest payments abroad	- 0.01	- 0.02	0.05	0.13	0.14	0.00

Table III.5

Contributions to GDP changes by channel of transmission and by variable

Scenario 5: An interest rate increase under exchange rate targeting, from the steady state						
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on con-sumption**	**Cost of capital**	**Residual**
Real GDP: first year after shock*	**- 0.08**	**- 0.00**	**- 0.00**	**- 0.08**	**- 0.00**	**0.01**
of which:						
Private consumption	- 0.11	- 0.00	- 0.00	- 0.11	- 0.00	0.01
Government expenditure	- 0.01	- 0.00	- 0.00	- 0.01	- 0.00	0.00
Private investment	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00	0.01
Exports	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00	0.00
Imports	- 0.03	- 0.00	- 0.00	- 0.03	- 0.00	0.00
Real GDP: second year after shock*	**- 0.44**	**- 0.01**	**- 0.03**	**- 0.44**	**- 0.03**	**0.07**
of which:						
Private consumption	- 0.53	- 0.01	- 0.03	- 0.53	- 0.01	0.05
Government expenditure	- 0.03	- 0.00	- 0.00	- 0.03	- 0.00	0.00
Private investment	- 0.03	- 0.00	- 0.00	- 0.03	- 0.03	0.03
Exports	- 0.01	- 0.00	- 0.00	- 0.01	- 0.00	0.00
Imports	- 0.17	- 0.00	- 0.01	- 0.17	- 0.01	0.02
Real GDP: third year after shock*	**- 0.40**	**- 0.01**	**- 0.03**	**- 0.39**	**- 0.03**	**0.06**
of which:						
Private consumption	- 0.37	- 0.00	- 0.03	- 0.36	0.01	0.01
Government expenditure	- 0.03	- 0.00	- 0.00	- 0.03	- 0.00	0.00
Private investment	- 0.05	- 0.00	- 0.00	- 0.04	- 0.05	0.04
Exports	- 0.04	- 0.00	- 0.00	- 0.04	- 0.01	0.01
Imports	- 0.09	- 0.00	- 0.01	- 0.08	- 0.01	0.01

Table III.5 (cont.)

Contributions to GDP changes by channel of transmission and by variable

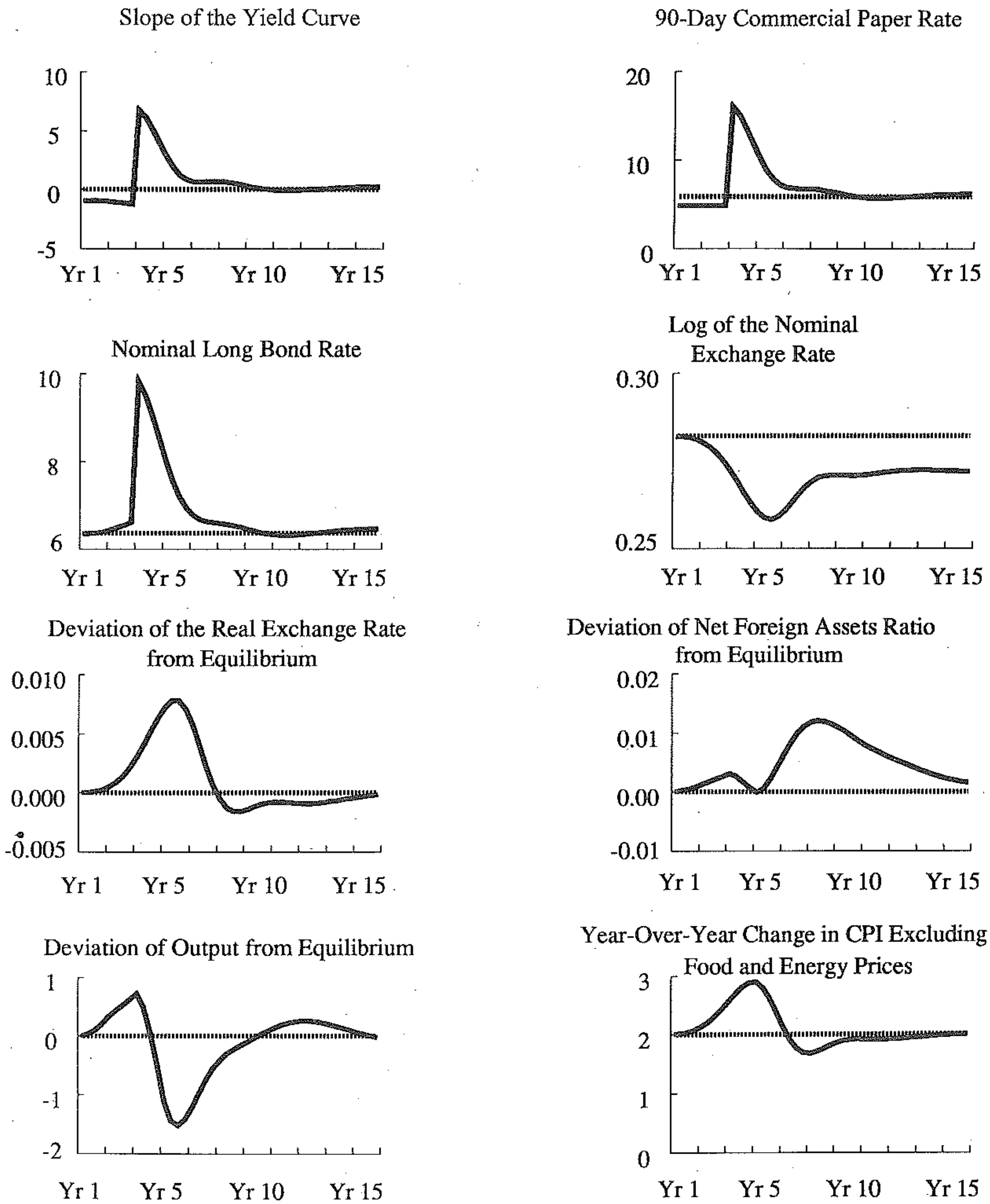
Scenario 5: An interest rate increase under exchange rate targeting, from the steady state

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Residual**
Real GDP: fourth year after shock*	**0.49**	**0.02**	**0.06**	**0.54**	**0.04**	**- 0.16**
of which:						
Private consumption	0.95	0.04	0.09	1.03	0.04	- 0.26
Government expenditure	0.04	0.00	0.00	0.04	0.00	- 0.01
Private investment	0.02	0.00	0.00	0.03	0.02	- 0.04
Exports	- 0.12	- 0.00	- 0.01	- 0.13	- 0.01	0.03
Imports	0.39	0.01	0.03	0.43	0.03	- 0.11
Real GDP: fifth year after shock*	**0.39**	**0.01**	**0.01**	**0.54**	**0.05**	**- 0.21**
of which:						
Private consumption	0.81	0.01	0.02	1.03	- 0.04	- 0.22
Government expenditure	0.03	0.00	0.00	0.04	0.00	- 0.02
Private investment	0.12	0.00	0.01	0.15	0.12	- 0.16
Exports	- 0.17	- 0.00	- 0.01	- 0.19	- 0.00	0.04
Imports	0.40	0.01	0.01	0.49	0.03	- 0.14
Real GDP: steady state*	**- 0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
of which:						
Private consumption	- 0.00	0.00	0.00	0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	- 0.00
Imports	- 0.00	0.00	0.00	0.00	0.00	- 0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Scenario 6

An interest rate decrease under exchange rate targeting, from the steady state



Note: The solid line is the shock, and the dashed line the control.

Table I.6

Interest rates, exchange rates and asset prices

Scenario 6: An interest rate decrease under exchange rate targeting, from the steady state

Deviations from baseline	Year 1	Year 2	Year 3	Year 4	Year 5	Steady state
1. **Policy-controlled interest rate (%)**	- 0.99	- 1.00	8.33	2.69	0.94	0.00
2. **Market-determined interest rates (%)**						
Intermediate target	- 0.99	- 1.16	5.45	1.63	0.63	0.00
Long-term interest rate	0.00	0.16	2.88	1.06	0.30	0.00
3. **Other interest rates (%)**						
4. **Real interest rate**						
Real short-term interest rate (%)	- 1.03	- 1.30	7.41	2.12	1.00	0.00
5. **Exchange rates**						
Nominal effective exchange rate	- 0.05	- 0.44	- 1.45	-2.28	- 1.77	- 1.00
Real effective exchange rate	- 0.01	- 0.13	- 0.47	- 0.75	- 0.31	0.00
6. **Asset prices**						
7. **Money and credit**						

Table II.6

Real economic activity, price developments, fiscal developments and foreign sector

Scenario 6: An interest rate decrease under exchange rate targeting, from the steady state

Deviations from baseline (all in % change except where otherwise stated)	Year 1	Year 2	Year 3	Year 4	Year 5	Steady state
1. **Real GDP and its components**						
Real GDP	0.09	0.49	0.20	- 1.38	- 0.92	0.00
Private consumption	0.17	0.86	0.09	- 3.22	- 2.26	0.00
Government expenditure	0.04	0.19	0.08	- 0.55	- 0.35	0.00
Private investment	0.02	0.13	0.05	- 0.74	- 1.68	0.00
Exports	0.00	0.03	0.18	0.52	0.64	0.00
Imports	0.09	0.44	- 0.10	- 2.13	- 1.71	0.00
2. **Unemployment rate (%)**	- 0.04	- 0.18	- 0.17	0.38	0.67	0.00
3. **Real disposable income**						
4. **Inflation and wages (%)**						
GDP deflator	0.04	0.28	0.70	0.57	- 0.09	0.00
Consumer prices (excl. food & energy) ...	0.04	0.28	0.75	0.67	- 0.13	0.00
Wages/earnings	0.02	0.15	0.48	0.73	0.41	0.00
Unit labour costs	- 0.03	- 0.11	0.77	1.74	- 0.39	0.00
Import prices	0.04	0.35	0.95	0.78	- 0.35	0.00
5. **Government accounts (% of nominal GDP)**						
Primary expenditures	- 0.01	- 0.06	- 0.02	0.16	0.11	0.00
Interest payments	- 0.00	0.05	1.34	0.59	0.23	0.00
Revenues	- 0.01	- 0.05	- 0.02	0.20	0.27	0.00
Government budget balance	- 0.02	0.02	1.34	0.58	0.06	0.00
Public sector debt	- 0.07	- 0.40	0.33	1.69	1.63	0.00
6. **Current account (% of nominal GDP)**	- 0.03	- 0.13	- 0.06	0.59	0.51	0.00
Trade balance	- 0.06	- 0.28	0.27	1.97	1.72	0.00
Net interest payments abroad	0.00	0.01	- 0.14	- 0.27	- 0.25	0.00

Table III.6

Contributions to GDP changes by channel of transmission and by variable

Scenario 6: An interest rate decrease under exchange rate targeting, from the steady state

	Total	Income/ cash flow	Wealth	Direct interest rate effect on con-sumption	Cost of capital	Residual
Real GDP: first year after shock*	**0.09**	**0.00**	**0.00**	**0.09**	**0.00**	**- 0.01**
of which:						
Private consumption	0.12	0.00	0.00	0.12	0.00	- 0.01
Government expenditure	0.01	0.00	0.00	0.01	0.00	- 0.00
Private investment	0.00	- 0.00	0.00	0.00	0.00	- 0.00
Exports	0.00	0.00	0.00	0.00	0.00	- 0.00
Imports	0.04	0.00	0.00	0.04	0.00	- 0.00
Real GDP: second year after shock*	**0.49**	**0.01**	**0.03**	**0.49**	**0.02**	**- 0.06**
of which:						
Private consumption	0.60	0.01	0.04	0.60	0.00	- 0.05
Government expenditure	0.04	0.00	0.00	0.04	0.00	- 0.00
Private investment	0.02	- 0.00	0.00	0.02	0.02	- 0.02
Exports	0.01	0.00	0.00	0.01	0.00	- 0.00
Imports	0.18	0.00	0.01	0.18	0.01	- 0.02
Real GDP: third year after shock*	**0.20**	**- 0.00**	**0.03**	**0.20**	**0.01**	**- 0.04**
of which:						
Private consumption	0.06	- 0.01	0.02	0.06	- 0.00	- 0.01
Government expenditure	0.02	- 0.00	0.00	0.02	0.00	- 0.00
Private investment	0.01	- 0.00	0.00	0.00	0.01	- 0.00
Exports	0.07	0.00	0.00	0.07	0.00	- 0.01
Imports	- 0.04	- 0.00	0.00	- 0.05	- 0.00	0.01

Table III.6 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Scenario 6: An interest rate decrease under exchange rate targeting, from the steady state

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Residual**
Real GDP: fourth year after shock*	**- 1.38**	**- 0.03**	**- 0.14**	**- 1.40**	**- 0.07**	**0.25**
of which:						
Private consumption	- 2.23	- 0.04	- 0.21	- 2.28	0.01	0.30
Government expenditure	- 0.11	- 0.00	- 0.01	- 0.11	- 0.00	0.02
Private investment	- 0.10	- 0.00	- 0.01	- 0.11	- 0.10	0.12
Exports	0.20	0.00	0.01	0.21	0.00	- 0.03
Imports	- 0.87	- 0.01	- 0.08	- 0.90	- 0.03	0.15
Real GDP: fifth year after shock*	**- 0.92**	**- 0.01**	**- 0.04**	**- 1.03**	**- 0.13**	**0.28**
of which:						
Private consumption	- 1.56	- 0.01	- 0.07	- 1.75	0.06	0.20
Government expenditure	- 0.07	- 0.00	- 0.00	- 0.08	- 0.01	0.02
Private investment	- 0.23	- 0.00	- 0.02	- 0.25	- 0.23	0.27
Exports	0.24	0.00	0.02	0.27	- 0.01	- 0.04
Imports	- 0.69	- 0.01	- 0.03	- 0.78	- 0.05	0.17
Real GDP: steady state*	**- 0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
of which:						
Private consumption	- 0.00	0.00	0.00	0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	- 0.00
Imports	- 0.00	0.00	0.00	0.00	0.00	- 0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Monetary policy transmission channels in France: an evaluation using the Bank of France's macroeconometric model[1]

Jean Cordier and Roland Ricart

I. INTRODUCTION

In order to provide an evaluation of monetary policy transmission mechanisms in France, this paper presents the results of two pertinent monetary policy simulation exercises using the integrated version of the Bank of France's real and financial models: the effects of a hypothetical temporary 1 point increase in official rates are analysed, firstly, with all nominal exchange rates left unchanged and, secondly, with the exchange rates of the currencies of the European exchange rate mechanism (ERM) allowed to fluctuate vis-à-vis third currencies.

After detailing the nature of the evaluation exercise carried out (Section II), the paper summarises the main features of the model used (Section III). Against this background, the paper goes on to discuss the results of the two simulations, addressing first the transmission process in the financial sphere (Section IV) and then the effects on activity and prices (Section V).

II. THE NATURE OF THE EXERCISE

The usual method of evaluating national monetary policy transmission mechanisms is to run simulations using a macroeconomic model considered to be representative of the economy under consideration.

On the basis of a baseline simulation covering the period from 1994 to 2002,[2] numerous monetary policy experiments, aimed inter alia at improving analytical knowledge of the reactions of the economy, were conceivable. For the sake of conciseness, only those which appeared to be pertinent to the current French monetary policy context were chosen for the purposes of this paper. In the case of France, a deliberate monetary policy action is understood today essentially as an element in internationally concerted action, either at the global level or at European Union (EU) level. Hence this paper refers to the results of the two overlapping experiments described below.

1. **The simpler exercise tests the results of a joint 1 point increase in official rates in France and abroad, without any movement in exchange rates.** This simulation is designed to assess the impact of the interest rate change on the French economy with the exclusion of the exchange rate channel. In a way, it measures France's contribution to a global monetary policy measure: using solely a national model excludes the influence of interest rate movements abroad on the other economies. Hence this exercise is akin to an analysis of the effects of an isolated interest rate change in France aimed at stabilising the current exchange rate: in this case, too, there would be no

1 This paper forms part of the project being conducted under the aegis of the BIS on the evaluation of national monetary policy transmission channels. A working party has been set up to compare the results obtained with the models used by the national central banks (see SEMEF notes 94-43 of 23rd June 1994, 94-64 of 31st August 1994 and 94-67 of 20th September 1994).
The authors wish to thank Pascal Jacquinot for his help in the projection of the central account and Laurent Baudry and Véronique Brunhes-Lesage for their assistance.

2 See Table 1 for the international values underlying the baseline.

imported effects; on the other hand, the rate change would be isolated and create a differential between French franc and foreign rates, although the effects of the differential itself would be minor.

With this specification, the simulation produces fairly limited effects, thus confirming the commonly accepted view that the cost of stabilising the franc in terms of activity would be low. However, it is prudent to consider that the interest rate sensitivity of the French economy may have increased from the mid-1980s onwards and could therefore be provisionally underestimated by the econometric model. Moreover, the magnitude of the interest rate shocks to which the economy may be exposed in practice may be appreciably greater than the conventional hypothesis used in this simulation.

Table 1

Baseline values of selected exogenous variables

	1993	1994	1995	1996	1997	1998	1999	2000
1. Foreign interest rates (%)								
United States	3.24	4.04	4.74	5.00	5.00	5.00	5.00	5.00
Germany	6.64	5.14	4.64	5.00	5.00	5.00	5.00	5.00
2. Oil prices and other commodity prices								
Barrel of Brent ($)	-20.95	5.43	6.25	1.50	1.50	1.50	1.50	1.50
Food commodities ($)	5.18	0.00	0.00	2.50	2.50	2.50	2.50	2.50
3. Foreign prices								
Consumption prices*	2.85	3.05	2.85	2.40	2.40	2.40	2.40	2.40
4. Foreign output								
Real GDP*	0.32	1.79	2.93	3.10	3.10	3.10	3.10	3.10
5. World trade								
Manufactured goods imports*	- 0.54	5.02	6.41	6.50	6.50	6.50	6.50	6.50
Prices of manufactured goods imports*	1.94	1.42	1.88	1.60	1.60	1.60	1.60	1.60
6. Other important exogenous variables								
Real public investment	1.43	1.51	0.80	2.50	2.50	2.50	2.50	2.50
Public employment	- 0.28	- 0.23	0.36	0.50	0.50	0.50	0.50	0.50
Tax and social contribution rates	held constant							

* Of nine major foreign trading partners of France: average figures weighted by structure of French exports.

2. The more complex exercise, which encompasses the preceding one, assesses the effects of a 1 point rise in official rates in the ERM countries. A joint change of intervention rates in the ERM countries leads to a rise in the exchange rate vis-à-vis third countries, which needs to be made endogenous. Hence the exchange rate channel is included, on terms close to reality. Here again, however, the use of a national model excludes the influence of the other economies: the impact on the French economy of the recessionary effects of the rise in interest and exchange rates on France's partner countries is not taken into account. All that is measured, therefore, is the French contribution to the exchange rate channel operating in the ERM countries. It should be mentioned that the number of countries assumed to be participating in the ERM is of importance. The larger the group (the preparatory work included up to twelve countries), the more the impact of the exchange rate channel diminishes, and we come closer to a model of a closed economy, where the effects of the increase in interest rates on the effective exchange rate of the French franc are minimal and the direct effect of interest rates on demand predominates. Conversely, if the number of ERM participants is reduced, the exchange rate channel in France is in principle stronger. This reasoning cannot be pushed to its limit by assuming an isolated movement of the French franc, as such a simulation would pose insuperable problems. In practice, it bears no relation to the current ERM management style. Technically, it is very difficult to forecast the magnitude of an isolated movement in the French franc as a result of an isolated movement in domestic interest rates within the ERM framework.

In these circumstances, we finally adopted as our central hypothesis a simultaneous increase in rates in six ERM countries: France, Germany, the Netherlands, Belgium, Luxembourg and Denmark.

Making the exchange rate endogenous heightens appreciably the effects of the interest rate increase. Despite its limitations, this simulation confirms the importance of the exchange rate channel in France, although its magnitude is not exceptional. It coincides with the results obtained using multinational models, in which the exchange rate channel plays an important part in the bloc formed by the ERM countries as a whole.[3] This should naturally lead to the exchange rate in the ERM countries being an indicator or even a common objective of their monetary policy.

In calibrating the simulations, a 1 point rise in official rates for a period of two years only was assumed. The temporary shock is the cumulative effect of two permanent, more or less symmetrical shocks occurring at an interval of two years. The idea of a temporary shock was preferred because, in certain theoretical or empirical models, a permanent rise in rates causes the economy to diverge: the initial rise in real interest rates leads to a slowdown in activity and in inflation, which reinforces the rise in real interest rates, and so on. This movement can only be interrupted by a voluntary return of real interest rates to their equilibrium value, in line with the medium-term inflation objective set by the authorities.

Furthermore, given the characteristics of our model, a reduction in rates of the same magnitude may be considered as having symmetrical effects.

Finally, the results of the simulations could in principle be sensitive to the starting conditions, especially because the financial part of our model relates in particular to asset stock variables. In practice, however, one has to move some distance away from the starting date chosen for the reference simulation (first quarter of 1994) for there to be any appreciable changes, since stock variables alter only slowly over time.

III. MAIN FEATURES OF THE MODEL USED

1. A real and financial model

The model used is the linked version of the Bank of France's real model and its financial model (MEFISTO), for which bibliographical references are given at the end of the paper. With a view to a modular set-up, these two quarterly models exist side by side; they can be used either separately, for short and medium-term forecasting, or in linked mode for simulation exercises.

Linked in this way, the model used is structured around 88 behavioural equations estimated econometrically. The accounting or institutional relationships relate chiefly to income distribution and financial operations (covered in flow and stock terms). Accounting modules ensure coherence between flows and stocks and also enable the main results to be transformed into data conforming to different institutional headings (balance of payments, monetary statistics, external monetary position, etc.).

The main exogenous variables relate to the international environment (prices, activity, world demand for manufactured goods) and budgetary policy (government expenditure in real terms, tax and social contribution rates). Monetary policy and financial asset prices can, as the case requires,

3 This point has been mentioned previously in Cordier (1993).

be considered to be exogenous or made endogenous to varying degrees. Thus for the simulations in this exercise the exchange rate and the interest rates included in the model remain endogenous, while the official interest rate is made exogenous.

2. The main blocks

The endogenous variables are determined in the main blocks, which are presented separately below, although they are largely interdependent. The diagram on the following page summarises the main interrelationships.

The interest rate block (1) models three principal interest rates. The money market rate is determined, when it is endogenous, by a reaction function integrating the inflation differential between France and Germany, the German short-term rate, exchange reserves and the differential between US and German short-term rates. The money market rate is then used together with the inflation rate to determine the bond yield, which may be affected secondarily by the net demand for bonds relative to short-term investments. Finally, the block contains a representative lending rate, which is dependent on the money market rate and a risk premium which increases in line with corporate indebtedness and decreases in line with the level of activity.

Asset prices (in particular equity and property prices) are not modelled.

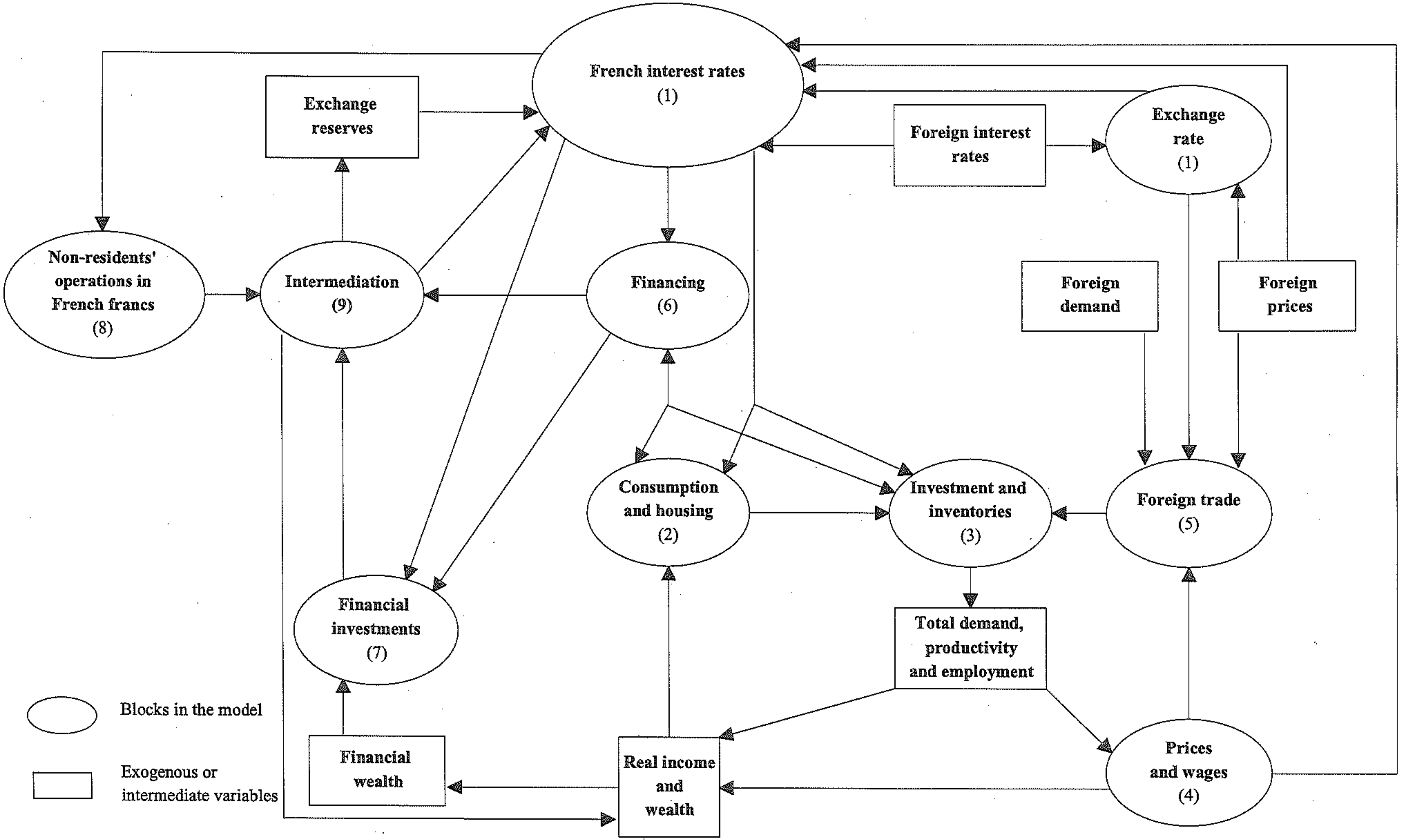
The exchange rate is generally held to be exogenous to the model, since, if the simulations require it to be endogenous, it can be incorporated from the results of additional simulations made with an international model. However, for the purposes of the present exercise, the exchange rate of the ERM currencies is aligned with the US dollar/Deutsche Mark rate, where the relationship is considered to satisfy the uncovered long-term real interest rate parity condition, with adaptive expectations.

The household demand block (2) includes a consumption function which takes account of current income and inflation but also of unsecured short-term personal loans, which supplement income and depend on credit market conditions. In addition, housing investment is included because it partly substitutes for consumption. Housing investment depends on household income, the cost of capital as measured by real long-term interest rates, and the influence of inflation expectations on the demand for housing credit. The determination of household income is an important input to this block; it depends on primary income, tax and welfare policy and income from capital.

Firms' demand for factors of production (3) is based on a clay-clay production function. Investment depends over the long term on a unit accelerator, with account also being taken of pressures on productive capacity and of hours of utilisation of equipment. The pace of investment is influenced by lending rates, changes in which can speed up or slow down investment in equipment. Employment is derived from the level of activity, with account being taken of the parameters of technical advances in the production function. Changes in inventories are a function of current cyclical changes, expectations concerning inflation and activity, and corporate cash positions.

The prices and wages block (4) determines the structure of domestic prices and the inflation rate. The price component of value added and the average per capita wage rate are the main variables incorporated in the model. The rate of increase in the price component of value added is fully indexed to that in unit labour costs and also includes the effects of capacity utilisation rates and of import prices on operating margins, as well as the temporary effects on the latter of changes in the price of imported energy. The rate of increase in average per capita wages is fully indexed to that in consumption prices and productivity and is influenced by the level of (Phillips term) and changes in (hysteresis term) the adult male unemployment rate. This equation is stabilised by the inclusion of a shift in the constant, which captures the change in the pace of inflation in France in the mid-1980s.

Main blocks of the Bank of France's model



The foreign trade block (5) models foreign trade prices and volumes on the basis of relative prices in national currency and levels of activity in France and abroad. Export and import prices are determined via specific marginal behaviour, influenced for more than half by domestic prices. Export and import volumes of manufactured goods follow the Marshall-Lerner conditions.

The financing block (6) explicitly models resident non-financial agents' demand for funds: demand for credit and supply of short-term securities, bonds and shares. This demand for funds depends on the volume of agents' spending, the structure of their financial wealth and the interest rate structure. In particular, the level of firms' indebtedness depends on real interest rates and on their self-financing capacity. Firms' indebtedness in turn has an adverse impact on lending rates and through the latter on their investment. Households' indebtedness depends on their spending, the level of interest rates and expectations concerning inflation and activity. Their indebtedness in turn influences their spending. In addition, the general government sector issues short-term securities and bonds, or sells shares in state-owned firms.

The block of non-financial agents' investments (7) models their portfolio selection between the various types of investment available. Total financial assets of households and firms are determined in accounting terms as the sum of net financial wealth and financing; in principle they correspond to the difference between the sum of total wealth and financing and the stock of physical assets. For households and firms, the breakdown of investments into nine French franc denominated assets and one foreign currency asset is the result of portfolio selection behaviour conditioned by the relative risk of the investments, the interest rate structure and agents' real financial wealth. Additional determinants in the model are institutional and activity variables. Thus the monetary base is not only the result of a demand for money but the resultant of all financing and investment behaviour, in accordance with a traditional French approach giving preference to the analysis of the process of money creation.

The block of non-residents' financial behaviour (8) enables non-residents' demand for French francs together with its breakdown between various French franc assets to be determined. Overall demand is modelled as the share of French franc assets in a measure of global financial wealth. It depends on transaction and long-term investment motives and also on short-term speculation motives, which are influenced by movements in exchange and interest rates. From non-residents' French franc position and their overall position vis-à-vis residents (the opposite of the cumulative current transactions balance) we derive non-residents' net supply of foreign currency to residents (the counterpart of residents' net foreign currency position). This supply of foreign currency is one of the essential determinants of the exchange market.

The intermediation block (9) specifies the role of the financial markets and financial intermediaries in balancing financial stocks. Credit institutions form the counterpart on the credit market, the money market and the bond market, to which they also contribute through their issuing activity. The imbalances which may arise on these markets may thus retroact in part on the lending rate and the bond yield. Non-residents, whose presence on the equity market is considered to be rationed, form the final counterpart of that market. Finally, the Bank of France ensures the equilibrium of French franc operations between banks (resident and non-resident) and that of spot foreign currency operations on the exchange market. The imbalances which may arise on that market will entail a change in domestic interest rates via the central bank's reaction function. Hence this block, which "finishes off" the model as a whole, retroacts on the interest rate block.

3. Scope and limitations of the tool

A model of this kind can be used to analyse the standard monetary policy transmission channels, viz. substitution effects, income effects and wealth effects plus, in an open economy, external effects, which are channelled in particular via the exchange rate. These standard effects are sometimes masked by direct interventions by the authorities outside market mechanisms (administrative rationing, subsidies and tax treatment), as was the case in France up to the mid-1980s.

In addition, they could usefully be supplemented by a fuller and more realistic treatment of market mechanisms, in particular the role of financial operators (the effect of expectations, the process of endogenous rationing by the financial markets). Using the MEFISTO module of the Bank of France's model, it is already possible to analyse fairly closely the process of transmission within the financial sphere itself.

However, comprehensive coverage of the subject does not necessarily entail increasing the degree of analysis. As is known, it may on the contrary be useful to attempt the broadest possible synthesis in order to retain only the essential part. It is therefore tempting to impose a priori certain major theoretical assessments. It should be pointed out in this connection that this is not the approach adopted in this model: only theoretical behaviour that has been the subject of empirical estimation has been included, and no long-term constraint has been imposed a priori without having been statistically tested. Virtually all the econometric relationships have been estimated in the form of error correction models, with their long term validated by cointegration analyses. Our results, therefore, are in no way prescriptive but simply provide a kind of inventory.

Moreover, it is well-known that the results obtained using econometric models are representative of historical average behaviour which may not be capable of reproduction ad infinitum. Although that may reduce (but does not eliminate) the predictive power of these tools, it detracts very little from their explanatory power. They offer an explicit interpretation in cases where, as in other areas, simple common sense comes up against its limits. The difficulty stems rather from the fact that an economy may be exposed to "extraordinary" shocks which cause an appreciable change in its structural parameters without there being sufficient temporal remove to be able to understand them and estimate their impact.

Thus in the case of France, agents were confronted during the 1980s with a marked change in the techniques of monetary control by the authorities. Nonetheless, it is still a matter of debate as to how far the behaviour of private sector agents has undergone structural change as a result. In fact, the structural parameters of the models have remained relatively stable. The change in question can be viewed rather as a change in the way the monetary authorities use the transmission channels. Up to the mid-1980s monetary policy was conducted predominantly through quantitative controls and regulation of financing and investment and through adjustments to the nominal exchange rate. Since then the liberalisation of financial markets and the maintenance of a stable nominal exchange rate have come to the fore. In this connection one may speak of a regime shift, as manifested, for example, in the adjustment of the French real interest rate to the world real interest rate. Nonetheless, the analyst may predict that a different way of managing the exchange rate channel does not signify that it has disappeared. The main problem for modellers of the French economy is rather that of analysing the direct impact of interest rates: residents have had to adapt to a more active regulation of the financial markets by means of interest rates and thus are probably more sensitive today to changes in interest rates and asset prices.

For modellers of the French economy, therefore, the challenge is to evaluate this new sensitivity, given that the standard macroeconomic models of the French economy only allot a significant role to two types of transmission mechanism: the exchange rate channel and that of income effects. Other mechanisms, such as substitution effects and above all wealth effects and endogenous rationing effects, are more controversial and are still proving difficult to verify empirically. In the Bank of France's models we have naturally tried to take account of these developments.[4] Thus substitution effects have been enhanced appreciably. On the other hand, we remain sceptical as regards the extent of wealth effects on demand. Finally, while we readily admit that there may be endogenous rationing effects, in particular for credit to households, they are still difficult to distinguish from more traditional substitution effects.

4 See in this connection Boutillier and Cordier (1994).

IV. THE TRANSMISSION PROCESS IN THE FINANCIAL SPHERE

We may now turn to an analysis of the two simulation exercises undertaken. To begin with, we evaluate the process of transmission of the monetary shock across the financial sphere. To this end, we look first at the impact of the rise in official rates on the interest and exchange rate structure (Section 1), and then we evaluate the impact on the financing and investment aggregates (Section 2) before addressing the consequences of these changes for income from capital (Section 3). The subsequent section looks at the effects on activity and prices.

The results of the two exercises are presented simultaneously: paragraph 1 in each case shows the effects of the scenario in which the exchange rate is exogenous, and paragraph 2 refers to the more complete scenario in which the exchange rate remains endogenous.

The tables containing the main results commented on here are given in Tables I.1 and I.2.

1. Interest rates and the exchange rate

The increase in official rates leads essentially to a moderate rise in bond yields and bank lending rates.

The rise in long rates occurs only very slowly, reaching 0.25 points in the first year and 0.32 points in the second. This result, which is usual in this kind of technical simulation, is due to the "arbitrary" nature of the increase in official rates, which is not based in this case on a pick-up in inflation; the outcome would be different if the economy were subject to an inflationary shock, which would be taken into account both in the central bank's reaction function and in the bond yield equation.

Lending rates respond more rapidly, but again only partially, to the increase in short-term rates, rising by 0.4 points. The reason is that the macroeconomic environment is not altered to an extent that allows the banks fully to pass the movement in short-term rates through to lending rates, which are therefore smoothed.

The effect on domestic interest rates is comparable when the exchange rate is made endogenous.

On the other hand, the increase in interest rates in the ERM countries leads to an appreciation of the ERM currencies of 1.3% after one year and 2.2% in the second year. This appreciation fades only gradually thereafter, despite the return of official rates to their starting level. The adjustment lags are fairly long because they cumulate the adjustment of long-term rates to the official rates and the adjustment of the exchange rate to long-term rates. In effective exchange rate terms, the appreciation of the French franc amounts to 0.8% in the first year and 1.4% in the second, before falling to 0.9% in the third year and being cancelled out beyond the year 2000.

2. Financing and investment

The interest rate changes and their impact on business and household activity and income (see Section V below) lead to a decline in the demand for financing. Households and firms trim their demand for credit, which falls by 1 point in the first year and is 1.4 points down in the second. This financial deflation disappears after the fourth year. In the first year non-financial agents (actually companies) also reduce the supply of bonds (to a lesser extent), but this subsequently recovers as a result of the increase in the government deficit.

At the same time, there is a contraction in households' and, especially, firms' investment portfolios. However, the decline in investment is smaller than that in financing owing to two factors (discussed in Section V) which support private sector agents' financial saving: on the one hand, the relative resilience of firms' and households' income largely preserves their saving; on the other hand, the significant reduction in their investment spending has a favourable effect on their financial saving.

In addition, some portfolio reallocations occur. M_1 is rapidly affected by the contraction in firms' cash positions, which are subsequently rebuilt in part. Moreover, the change in the interest rate structure makes financial assets bearing interest, particularly at money market rates, relatively more attractive, which moderates the impact on M_3. The return of interest rates to their initial level in the third year tends to cancel out these effects.

When the exchange rate is endogenous, the effects are comparable in nature but more pronounced in magnitude and more persistent. This is linked to the lasting impact of the exchange rate appreciation on the price level. There is a lasting reduction in the monetary aggregates.

3. Income from capital

The interest rate movements produced by this simulation alter income from capital to the detriment of the general government sector. There is a lasting increase in the interest burden: it is 0.2% of GDP higher after two years and less than 0.1% higher thereafter, as the return of official rates to their initial level limits the "snowball" effect.

In this simulation households see an improvement in their net income from capital for two years, be it only because they are net creditors. They benefit in particular from the rise in rates fully passed through to investments bearing market rates of interest. Moreover, they lower their interest payments by reducing their recourse to credit.

Firms' income is altered fairly little overall. While there is an increase in the cost of their debt, which is very large in stock terms, this is largely offset by the reduction in the debt. In addition, their financial investments earn appreciably better interest and decline by less than their financing.

Financial institutions suffer in the first year under the increase in official rates, but the decline in credit is very soon accompanied by an appreciable improvement in their position on the money and bond markets, which they balance. They absorb the major part of the additional government paper and collect the increase in the public interest burden.

If the exchange rate is made endogenous, households benefit slightly less, as they accumulate less financial wealth under this scenario, as reflected in the flow of net interest payments they receive. On the other hand, firms, which reduce their investment spending more significantly, realise larger financial margins, and this has a positive impact on their net financial asset position and their net income from capital.

As the counterpart to this, general government is penalised somewhat more. Moreover, the more marked decline in the activity of financial intermediaries in this scenario reduces their gains from the increase in interest rates.

V. EFFECTS ON ACTIVITY AND PRICES

This section details the effects of the aforementioned changes in interest rates, exchange rates, financing volumes and income from capital on total demand (Section 1), activity (Section 2), prices (Section 3) and the external position (Section 4). The main results are given in Table II.

The respective contributions of the different transmission channels are analysed together with the impact on activity (Section 2). They are detailed in Table III.

As in the preceding section, the results of the two simulations are presented simultaneously: paragraph 1 in each case shows the effects of the scenario in which the **exchange rate**

is exogenous, and paragraph 2 refers to the more complete scenario in which the **exchange rate remains endogenous**.

1. Total demand

When the exchange rate is exogenous, any effect of a global increase in rates on exports is excluded a priori since this scenario ignores the impact on demand and activity abroad. The recessionary effects are therefore systematically underestimated.

The total impact of the developments described in Section IV on domestic demand is, moreover, modest and transitory, amounting to –0.13% in the second year and virtually zero at the end of the third.

However, this overall result conceals a more marked modification in the structure of domestic demand.

Firstly, business investment is affected by the rise in lending rates. This is a transitory effect and does not correspond to a classic capital/labour substitution effect, which has not regularly been in evidence in France since the second oil shock. The desired level of capital is not put in doubt ex ante, but the speed with which it is put in place is slowed by the increase in interest rates. Through this mechanism, investment is slowed, being reduced by 1.33% in the second year. It subsequently recovers to a little above its reference level owing to the catching-up in the desired level of capital.

Secondly, households' residential investment is definitely lowered through a classic substitution effect. The rise in real long-term rates reduces the desired stock of housing and depresses households' investment flows, which are 1.1% lower in the first year, 2.1% lower in the second and still 1.6% lower in the third.

Finally, consumption is stimulated in the usual way by the income effect. This positive impact is partly offset by the smaller contribution of unsecured short-term personal loans, the outstanding stock of which is reduced by the rise in interest rates. At the end of the second year the slowdown in activity and wages depresses households' income and consumption at the same time as the interest rate rise is cancelled out. Moreover, the decline in housing investment has in itself a negative effect on the propensity to save and thereby sustains consumption. Overall, however, consumption is increased by only 0.1% in relation to the reference level.

Thus households utilise income (boosted by income from capital) differently. They reduce their housing capital formation. In the first two years they increase their consumption and their financial saving, which rises by 0.2% of disposable income.

The endogenous exchange rate scenario ignores the effects of the interest rate rise and of the loss of competitiveness in France's ERM partner countries.

On the other hand, it includes the effects of the loss of competitiveness of the French economy caused by the appreciation of the exchange rate. In particular, this lowers total exports by 0.3% in the second and third years.

Taking the multiplier effects caused by the reduction in exports into account, the impact on domestic demand is –0.4 in the second year, falling to –0.3 in the third. This decline is due essentially to the additional decrease in investment in response to the shrinking of export markets. Moreover, the favourable income effects on consumption caused by the increase in interest rates are now offset by effects due to the more marked decline in employment and wages. Subsequently consumption is buoyed only by disinflation, which allows households to reduce saving designed to restore the real value of cash holdings.

2. Activity

Taking into account the reduction in imports caused by the decline in domestic demand, and in particular of investment, the impact on GDP is lessened appreciably, amounting to –0.07% in the first year and –0.13% in the second year when the exchange rate is exogenous.

When the exchange rate is endogenous the difference in total demand is approximately twice as great as in the first scenario, reaching -0.5% in the second and third years.

Taking into account the adverse competitiveness effects on imports, the impact on GDP is three times more pronounced than in the scenario without exchange rate changes, viz. –0.18% in the first year and –0.36% during the second. It is essentially transitory, falling back to –0.20% in the third year and disappearing thereafter.

In analysing the relative contributions of the different transmission channels to GDP growth (see Table III), it should be recalled that they measure all effects ex post, given the configuration of the model.

We shall focus on the second year, when the impact is greatest, and on the third, when it is still significant.

Thus it can be seen that the exchange rate channel accounts for just over half (–0.21% out of –0.36%) in the second year. The proportion in the third year (–0.14% out of –0.20%) is greater still. The short-term responsiveness of investment relays the recessionary impact on exports very strongly.

The direct effect of interest rates on domestic demand thus accounts for less than half. The recessionary effect is produced largely by investment (–0.17% out of –0.36% in the second year), as corporate investment and inventories react rapidly to the increase in rates. However, the difference in investment and inventories is offset to a fairly large extent in terms of GDP by the accompanying decline in imports. Housing investment is affected more slowly but more permanently.

Consumption plays a modest role. On the one hand, the income effect is positive, even if it accounts for barely +0.1 points of GDP. On the other hand, the direct effect of interest rates on consumer credit is small. Finally, there is no evidence of a wealth effect.

3. Pressures, prices, wages

Here the effects are very small and difficult to measure. However, they can be analysed as follows. The slight decline in activity has an equal impact (–0.1%) on productivity, then on employment, then on wages. In the short term the fall in productivity sustains prices. In the longer term the fall in wages brings about a fall in unit labour costs. This is not fully reflected in prices as the reduction in investment limits the fall in productive capacity utilisation rates.

When the exchange rate is endogenous, the more adverse scenario has a greater downward impact on price and wage formation. In particular, the fall in import prices (of up to -0.7% in the second and third years) affects the price/wage linkage. The domestic wage and price level is revised downwards by 0.3 to 0.4 points after three to four years. The trend is slightly more pronounced for wages, which follow consumption prices, than for value added prices, and this has a beneficial effect on corporate margins.

4. Balance of payments and foreign exchange market

In this area the effects are a little more marked.

First of all, the decline in domestic demand has an effect (very significant in the short term) on imports, which are particularly sensitive to investment. Thus the trade balance improves by some Fr.fr. 10 billion in the second year. This result depends very strongly on the limitations of this scenario, which does not take account of the recessionary impact of the increase in interest rates on activity abroad, which would reduce French exports. It is reversed when rates are lowered, which leads to a pick-up in investment and thus in imports.

Moreover, the increased government deficit is ultimately lower than the increase in financial saving of the domestic private sector. The counterpart to this in the short term is a reduction in the net asset position of the rest of the world vis-à-vis residents.

The increase in interest rates, in the limited framework of this scenario, raises the net demand for French francs on the foreign exchange market in the short term.

With endogenous exchange rates, the terms-of-trade gain and the sensitivity of imports to the slowdown in investment initially bring about a more marked improvement in the trade balance in value terms. Subsequently the adverse effects of the loss of competitiveness are felt. Finally, over the long term, the gradual fall in costs and prices and the decline in the nominal exchange rate reduce and eventually eliminate the loss of competitiveness caused by the initial increase in the nominal exchange rate.

Nonetheless, the position of the rest of the world vis-à-vis residents experiences a lasting improvement in the long term, from the fourth year onwards.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in the policy-controlled interest rate with fixed nominal exchange rates							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rate (%)							
Representative long-term interest rate	0.25	0.32	0.09	0.02	0.01	0.00	0.00
3. Other interest rates (%)							
Bank lending rate	0.41	0.42	0.00	0.00	0.00	0.00	0.00
Deposit rate	regulated interest rate held constant						
4. Real interest rates (%)							
Real short-term interest rate	0.98	0.99	0.03	0.02	0.00	- 0.01	- 0.01
Real long-term interest rate	0.23	0.32	0.12	0.04	0.01	0.00	0.00
5. Exchange rates							
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	0.00	- 0.01	- 0.01	0.00	0.00	- 0.01	0.00
Important bilateral exchange rates							
US dollar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deutsche Mark	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Asset prices and wealth							
7. Net interest and dividend payments							
Household sector	4.88	5.13	0.23	0.05	- 0.01	- 0.05	- 0.05
Non-financial enterprises	0.19	- 0.03	- 0.05	0.28	0.31	0.29	0.30
Abroad	- 1.35	- 3.83	- 3.20	- 0.83	- 0.18	0.24	0.59
8. Money and credit							
Monetary aggregates							
M_1	- 1.04	- 0.47	0.15	- 0.05	0.17	0.05	- 0.11
M_2	- 0.61	- 0.37	- 0.04	- 0.11	0.04	- 0.01	- 0.10
M_3	- 0.55	- 0.39	- 0.13	- 0.15	0.01	0.00	- 0.06
Total domestic credit (public and private)	- 0.79	- 0.98	- 0.23	- 0.02	0.04	0.05	0.04
Domestic bank credit	- 0.98	- 1.39	- 0.46	- 0.10	- 0.04	- 0.08	- 0.11

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in the policy-controlled interest rate with endogenous nominal exchange rates (fixed in the ERM: 6 countries)

Deviations from baseline*	1994	1995	1996	1997	1998	1999	2000
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rate (%)							
Representative long-term interest rate	0.24	0.29	0.05	- 0.02	- 0.02	0.00	0.01
3. Other interest rates (%)							
Bank lending rate	0.43	0.45	0.02	0.00	- 0.01	- 0.01	- 0.01
Deposit rate	regulated interest rate held constant						
4. Real interest rates (%)							
Real short-term interest rate	1.05	1.10	0.10	0.06	0.01	- 0.03	- 0.05
Real long-term interest rate	0.29	0.39	0.15	0.05	- 0.01	- 0.03	- 0.03
5. Exchange rates							
Nominal effective exchange rate	0.79	1.37	0.90	0.50	0.27	0.15	0.10
Real effective exchange rate	0.43	0.64	0.27	0.05	- 0.06	- 0.09	- 0.08
Important bilateral exchange rates							
US dollar	- 1.31	- 2.23	- 1.48	- 0.83	- 0.44	- 0.26	- 0.17
Deutsche Mark	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Asset prices and wealth							
7. Net interest and dividend payments							
Household sector	4.25	4.36	0.05	- 0.06	- 0.04	- 0.02	0.00
Non-financial enterprises	0.00	- 0.47	- 0.62	- 0.21	- 0.01	0.05	0.08
Abroad	5.19	3.65	- 3.54	- 0.99	0.39	0.82	1.01
8. Money and credit							
Monetary aggregates							
M_1	- 1.22	- 0.73	0.17	- 0.22	- 0.40	- 0.31	- 0.26
M_2	- 0.75	- 0.63	- 0.17	- 0.34	- 0.38	- 0.30	- 0.25
M_3	- 0.69	- 0.64	- 0.24	- 0.32	- 0.36	- 0.28	- 0.23
Total domestic credit (public and private)	- 0.88	- 1.25	- 0.55	- 0.24	- 0.09	- 0.04	- 0.02
Domestic bank credit	- 1.16	- 1.90	- 1.07	- 0.50	- 0.20	- 0.17	- 0.21

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table III

Contributions to GDP changes by channel of transmission and by variable

?olicy experiment: Temporary increase in the policy-controlled interest rate with endogenous nominal exchange rates (fixed in the ERM: 6 countries)

	Total	**Income/ cash flow**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy**
ٰeal GDP: first year after shock*	**- 0.18**	**0.10**	**0.00**	**- 0.13**	**- 0.09**	**- 0.06**
f which:						
rivate consumption	0.04	0.08	0.00	0.01	0.00	- 0.05
iovernment expenditure	0.00	- 0.00	0.00	0.00	0.00	0.00
rivate investment:						
Residential private investment	*- 0.07*	*0.02*	*- 0.00*	*- 0.08*	*- 0.00*	*- 0.01*
Non-residential private investment	*- 0.19*	*0.05*	*- 0.00*	*- 0.17*	*- 0.05*	*- 0.02*
Inventory formation	*- 0.04*	*0.06*	*0.02*	*- 0.05*	*- 0.00*	*- 0.05*
xports	- 0.05	0.00	0.00	- 0.01	- 0.04	- 0.00
nports	0.12	- 0.10	- 0.01	0.16	0.00	0.06
.eal GDP: second year after shock*	**- 0.36**	**0.07**	**- 0.01**	**- 0.17**	**- 0.21**	**0.06**
f which:						
rivate consumption	0.01	0.10	- 0.00	0.00	- 0.01	0.08
overnment expenditure	- 0.00	0.00	0.00	0.00	- 0.00	- 0.00
:ivate investment:						
Residential private investment	*- 0.13*	*0.01*	*- 0.00*	*- 0.13*	*0.00*	*- 0.01*
Non-residential private investment	*- 0.28*	*0.03*	*- 0.01*	*- 0.17*	*- 0.11*	*- 0.02*
Inventory formation	*- 0.08*	*- 0.02*	*- 0.00*	*- 0.03*	- 0.04	*0.02*
xports	- 0.08	- 0.00	- 0.00	- 0.01	- 0.07	- 0.00
ıports	0.20	- 0.05	0.00	0.17	0.03	0.04
eal GDP: third year after shock*	**- 0.20**	**- 0.00**	**- 0.00**	**- 0.05**	**- 0.14**	**- 0.01**
'which:						
ivate consumption	- 0.03	0.03	- 0.00	- 0.01	- 0.03	- 0.02
overnment expenditure	- 0.00	0.00	0.00	- 0.00	- 0.00	- 0.00
ivate investment:						
Residential private investment	*- 0.09*	*- 0.00*	*- 0.00*	*- 0.08*	*0.00*	*- 0.01*
Non-residential private investment	*- 0.06*	*- 0.02*	*0.00*	*0.03*	*- 0.06*	*- 0.01*
Inventory formation	*0.01*	*- 0.05*	*- 0.01*	*0.05*	*- 0.02*	*0.04*
:ports	- 0.04	- 0.00	- 0.00	0.00	- 0.04	0.00
ıports	0.01	- 0.04	0.01	- 0.03	0.01	- 0.02

Table III (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in the policy-controlled interest rate and endogenous nominal exchange rates (fixed in ERM: 6 countries)

	Total	**Income/ cash flow**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy**
Real GDP: fourth year after shock*	**- 0.01**	**0.01**	**0.01**	**- 0.02**	**- 0.01**	**0.03**
of which:						
Private consumption	0.03	0.01	0.00	- 0.01	- 0.02	0.04
Government expenditure	- 0.00	0.00	0.00	- 0.00	- 0.00	- 0.00
Private investment:						
Residential private investment	*- 0.05*	*- 0.00*	*0.00*	*- 0.05*	*0.01*	*- 0.00*
Non-residential private investment	*0.10*	*- 0.01*	*0.01*	*0.06*	*0.03*	*0.01*
Inventory formation	*0.09*	*0.01*	*0.00*	*0.04*	*0.04*	*0.00*
Exports	0.00	- 0.00	0.00	0.00	- 0.00	0.00
Imports	- 0.16	0.00	- 0.01	- 0.06	- 0.06	- 0.03
Real GDP: fifth year after shock*	**0.07**	**- 0.01**	**0.00**	**- 0.02**	**0.04**	**0.06**
of which:						
Private consumption	0.05	- 0.00	0.00	- 0.00	- 0.00	0.06
Government expenditure	- 0.01	0.00	0.00	- 0.00	- 0.01	- 0.00
Private investment:						
Residential private investment	*- 0.02*	*- 0.01*	*0.00*	*- 0.03*	*0.01*	*0.03*
Non-residential private investment	*0.13*	*- 0.02*	*0.00*	*0.04*	*0.06*	*0.04*
Inventory formation	*0.04*	*- 0.00*	*0.00*	*0.00*	*0.03*	*0.01*
Exports	0.02	- 0.00	0.00	0.00	0.02	0.00
Imports	- 0.14	0.01	- 0.00	- 0.03	- 0.06	- 0.05
Real GDP: final (seventh) year after shock*	**0.05**	**- 0.01**	**- 0.00**	**- 0.01**	**0.04**	**0.03**
of which:						
Private consumption	0.04	- 0.01	0.00	- 0.00	0.01	0.04
Government expenditure	- 0.01	0.00	0.00	- 0.00	- 0.01	- 0.01
Private investment:						
Residential private investment	*- 0.01*	*- 0.00*	*- 0.00*	*- 0.01*	*0.00*	*0.00*
Non-residential private investment	*0.04*	*- 0.00*	*- 0.00*	*0.02*	*0.02*	*0.01*
Inventory formation	*- 0.02*	*0.00*	*- 0.00*	*- 0.00*	*- 0.01*	*- 0.01*
Exports	0.02	- 0.00	- 0.00	0.00	0.01	- 0.00
Imports	- 0.01	0.01	0.00	- 0.01	- 0.01	- 0.02

* Due to rounding errors, the contributions of variables may not add to the total effect.

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The transmission of monetary policy in the econometric model of the Deutsche Bundesbank for the German economy

Wilfried Jahnke and Hans-Eggert Reimers

I. INTRODUCTION

For many years the Deutsche Bundesbank has used an econometric model of the German economy to forecast macroeconomic developments and to simulate economic policy decisions. This model is a quarterly model with approximately 330 equations. Following German unification it was supplemented temporarily by a sub-model of the real economy in eastern Germany.[1] Households, enterprises, the government sector and foreign countries are used in the model as agents for supply and demand on the labour and goods markets. Numerous constraints and considerable time-lags in adjustment on these markets result in prices and wages reacting only very slowly and sluggishly. This causes market disequilibria which are reflected on the labour market in underemployment and on the goods market in an under-utilisation or an overstretching of production capacities. For financial markets it is assumed in the model that an equilibrium of supply and demand is achieved more quickly than on the goods and labour markets by changes in interest rates, bond yields and exchange rates. In addition to the sectors already mentioned, banks and the central bank as the monetary policy institution play a special role on the financial markets.

The modelling of the transmission process of monetary policy in Germany is described in Section II of the paper. The interest and liquidity policy instruments which the Bundesbank has at its disposal and how it uses them to influence interest rate movements on the money market are described below in Section II.1. Section II.2 then deals with the effects of monetary policy on the financial structure, i.e. on money stocks and portfolio demand on financial markets in a system of sectoral accounting identities. From this, the influence of monetary policy measures on movements in interest and exchange rates follows in Section II.3. In Section II.4 the question is examined of how monetary policy measures in the model are transmitted from the financial markets to the goods and labour markets, i.e. to developments in the real economy. Section III of the paper deals with the design and the results of different monetary policy simulation experiments which have been carried out with the model. The quantitative scale of these effects is established in Section III.1. The relative importance of different transmission channels, i.e. their contribution to the total effects, is assessed empirically in Section III.2.

II. MODELLING THE TRANSMISSION OF MONETARY POLICY IN GERMANY

1. Monetary policy instruments and the money market

In order to be able to satisfy non-banks' cash requirements and to cover their own maintenance of reserves, banks require central bank money[2] which is made available to them by the

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1 The model is fully documented in Deutsche Bundesbank (1994b).

2 Only the Bundesbank has the right to issue banknotes denominated in Deutsche Mark which are the sole legal tender in Germany.

Bundesbank essentially through open market operations, rediscount credits and foreign exchange transactions. If currency in circulation is represented by BGU, minimum reserves on domestic liabilities by MIRI[3], cash holdings of banks by KABK, the surplus of central bank money (excess reserves) by ZBGD, open market operations by AUSG[4], granted refinancing facilities by REFL, the net external position by WAE, all other items[5] by SOPB and the overall provision of central bank money by ZEBA, then the supply of and the demand for base money is expressed in the Bundesbank's econometric model of the German economy by the following extended central bank balance sheet identity:

$$\underbrace{AUSG + REFL + WAE + SOPB}_{\text{Supply of central bank money}} = ZEBA = \underbrace{BGU + MIRI + KABK + ZBGD}_{\text{Demand for central bank money}}$$

If the supply of central bank money is insufficient to cover the contemporaneous demand from currency in circulation and the maintenance of reserves, a shortage of central bank money will result. In this case the variable ZBGD becomes negative. In order to compensate for such fractional amounts the Bundesbank grants the banks short-term lombard credit. The surplus (or shortage) of central bank money serves in the model as an indicator of the availability of funds in the money market. If there is an ample supply of liquidity unused refinancing facilities occur which exercise a restraining influence on interest rate movements in the money market. With a tight supply of liquidity, the banks are dependent, however, - at least temporarily - on taking up lombard loans. A squeeze of this kind in the money market is reflected in a rise in interest rates. In the model, however, the way in which central bank money is supplied or demanded has no effects by itself. What is crucial, rather, is the overall supply of central bank money. If, for example, the net external position increases - as in autumn 1992 and in summer 1993 - as a result of exchange market interventions, this increase can be offset by a corresponding reduction in open market operations. Viewed in the longer term, however, marked shifts in the structure of central bank money supply have taken place. The contribution of refinancing facilities to central bank money supply decreased whereas the share of open market operations, on the other hand, increased strongly.[6]

On what conditions, i.e. primarily at what interest rates and for what periods the Bundesbank makes central bank money available, is of crucial importance for interest rates on the market for central bank money (money market). The most expensive form of refinancing is the lombard credit which is granted only very temporarily, i.e. only for a few days. The most favourable form is the discount credit, with maturities of up to a maximum of three months. Ranking between these is the interest rate for securities repurchase agreements which are contracted for periods of two or four weeks. In the case of a pressurised money market with tight liquidity supply it is close to the lombard rate, whereas in the case of a relaxed money market with ample supply of liquidity it is close to the discount rate. If the Bundesbank buys short-term foreign exchange assets, the banks forgo the yields which such assets return. The three-month Euro-dollar rate is used as a basis for this in the model.

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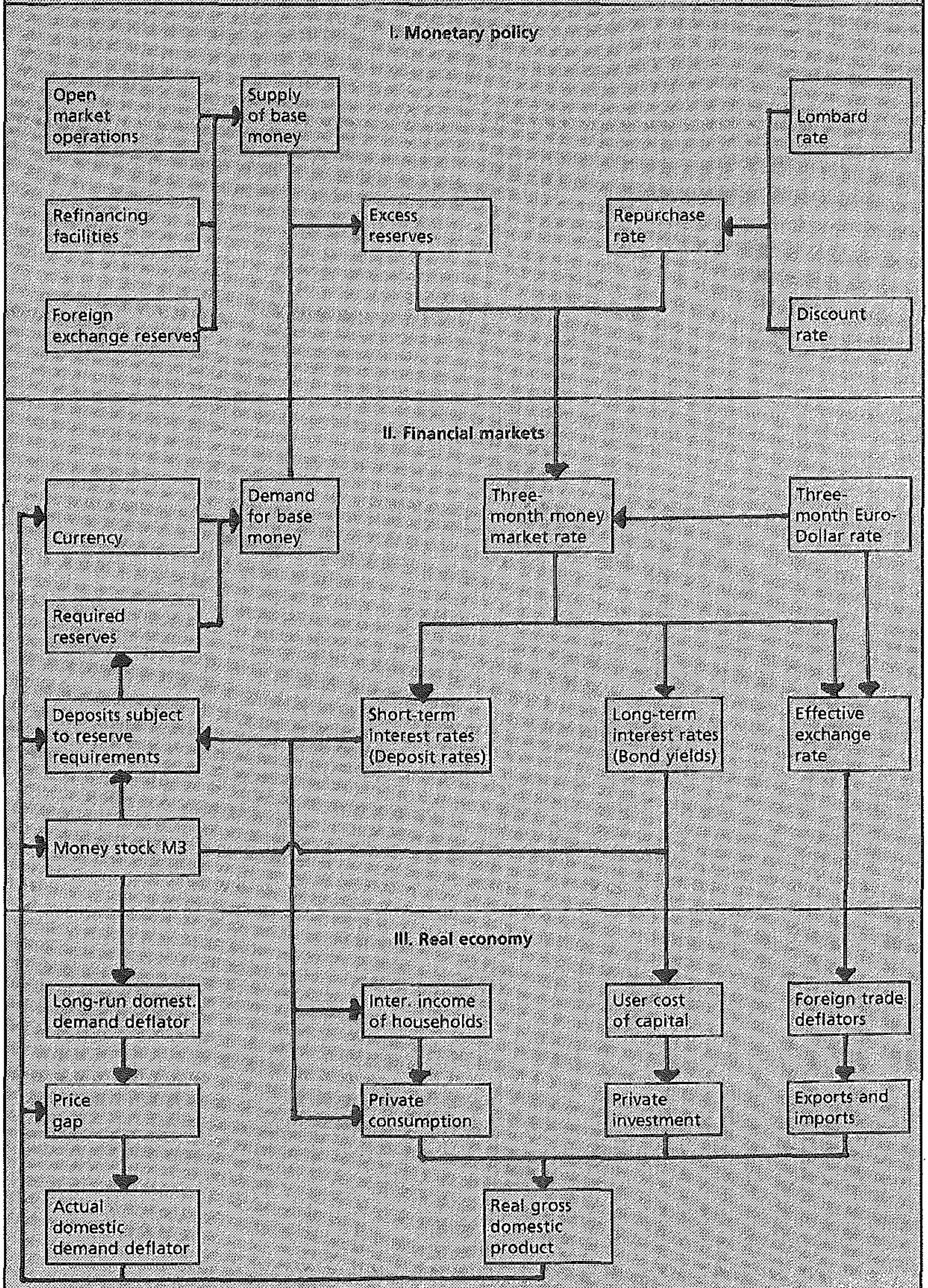
3 The minimum reserve ratios were lowered considerably as of 1st March 1993 and 1st March 1994 and are now only 2% for time and savings deposits and 5% for sight deposits. The non-interest-bearing minimum reserve holdings of the banks are principally for the purpose of stabilising the short-term requirement for central bank money and to prevent too large fluctuations in the interest rate for day-to-day money.

4 These are securities repurchase agreements, foreign exchange swap and repurchase agreements, as well as Treasury bill sales which are occasionally used for managing the money market.

5 These are balances of and credits to the public sector which in connection with the Treaty on European Monetary Union are practically no longer of significance since 1st January 1994, as well as other assets and liabilities of the Bundesbank (e. g. buildings, furniture and equipment, provisions, reserves and capital).

6 The monetary policy instruments of the Bundesbank are described in detail in Deutsche Bundesbank (1994a).

Chart 1: Transmission process of monetary policy in a simplified flow diagram of the econometric model of the German economy



Deutsche Bundesbank

Interest rate movements in the money market are represented in the model by the interest rate for three-month funds.[7] In the long run this rate of interest is determined by interest rate and liquidity policy measures of the Bundesbank. Of primary significance in this context are the interest rate for securities repurchase agreements as the most important refinancing rate and the relationship between the surplus or shortage of central bank money and the overall supply of central bank money as an indicator of the availability of funds in the money market. Changes in interest rates on foreign money markets, in particular on the Euro-dollar market, as well as price expectations are also reflected temporarily in interest rate movements in the money market. Adjustment to long-run values is performed in the model by an error correction process. If the rate for three-month funds is expressed as RGD, the securities repurchase rate as RPEN, the three-month Euro-dollar money market rate as RGDE, the price deflator of final demand as PEV and the change from the previous quarter as Δ_1, the following equation is estimated in the model (t-values below the coefficients):

$$\Delta_1 RGD = \underset{(1.82)}{0.12} + \underset{(14.22)}{0.85}\,\Delta_1 RPEN + \underset{(4.91)}{0.16}\,\Delta_1 RGDE + \underset{(2.58)}{5.84}\,\Delta_1 \ln(PEV)$$
$$+ \underset{(2.94)}{0.27}\,(RPEN_{-1} - RGD_{-1}) - \underset{(2.19)}{2.53}\,\frac{ZBGD_{-1}}{ZEBA_{-1}}$$

$$\overline{R}^2 = 0.81 \qquad DW = 2.12$$

This equation has been estimated from the first quarter of 1975 to the first quarter of 1994.

2. Money and portfolio demand in a system of sectoral financial balances

A marked substitution exists between the market for central bank money and the markets for other financial assets. In this context, the so-called universal banks which carry out practically every type of banking business, including securities transactions, play a dominating role in Germany. Financial transactions outside the banking system, on the other hand, are of lesser significance - at least up till now.[8] Monetary policy measures are therefore transmitted primarily to the operations of banks which take in short, medium and long-term deposits, issue savings bonds and bank bonds, grant short, medium and long-term credits, including lending against securities and acquiring foreign assets and liabilities. Changes in the scope and conditions of refinancing facilities at the Bundesbank cause the banks for their part to adjust their conditions in business with non-banks, as well as to reshuffle deposits and credits. In the model a distinction is made in the case of non-banks between households and enterprises[9], the government sector and foreign countries.

The portfolio decisions of households and enterprises are of particular significance for developments in financial markets. In the model their overall gross financial assets are composed of

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7 In reality the Bundesbank principally influences the day-to-day money market rate which evens out supply and demand on the market for central bank money. There is, however, an extremely close substitution between day-to-day money and three-month funds.

8 In the model other financial institutions such as building and loan associations, insurance enterprises, investment funds, etc. are not included in the banking sector but in the enterprises sector.

9 For statistical reasons it has not been possible to separate the financial activities of households from those of enterprises.

liquid assets M3P, longer-term assets POGK, the capital of banks KARK and other items SOPP. These are balanced with short and long-term borrowing from the banks KREP, as well as net financial assets of households NGVH and enterprises NGVU:

$$M3P + POGK + KARK + SOPP = KREP + NGVH + NGVU$$

The above equation is the accounting identity of private domestic non-banks. Net financial assets of all households derive from their net incomes in the income cycle (cumulative private savings), whereas net financial liabilities of enterprises derive from their net expenditure in the investment process (financing deficits). The capital of banks, as well as the other items, are treated in the model as exogenous variables and borrowing is determined by the development of gross national product. The demand from households and enterprises for liquid assets is derived in the model from a money demand equation. The demand for longer-term assets is then given by the accounting identity.

The demand for money is based on a long-run link between the stock of money on one side and real gross domestic product BIPR as well as the average rate of interest RFPG for longer-term assets as opportunity costs on the other side. It is assumed in this context that the nominal demand for money is homogeneous in relation to prices[10] which are represented by the price deflator of domestic demand PINV (elasticity of 1). The following equation has been derived from the estimation which was performed logarithmically:

$$\ln M3P = -7.67 + 1.59 \ln BIPR + 1.00 \ln PINV - 1.60 RPFG + M3PEC$$

Seasonal fluctuations have been taken into account as well as the jump in the data series in connection with German unification[11] in 1990. Under these assumptions the long-run money demand function in Germany proved to be remarkably stable even following unification.[12] Insofar as financial innovations resulting from the liberalisation and globalisation of financial markets and the accompanying changes in the structure of private portfolios have been of significance at all in Germany, they have not permanently impaired the stability of the money demand function.[13] The adjustment of the short-run demand for liquid assets to its long-run values is performed using an error correction mechanism in which deviations M3PEC (M3 private error correction) of the estimated money stock from the actual money stock are eliminated over the long run.[14]

The money stock in the hands of households and enterprises is made up of currency in circulation, sight deposits, time deposits for up to four years[15] and savings deposits at three months notice. This refers to those liquid assets which are subject to minimum reserve requirements and thus generate a corresponding demand for central bank money. In the model the overall money stock is allocated to the various liquid assets using a system of dynamic portfolio demand equations which meet the usual homogeneity and adding-up restrictions.[16] The share which an asset has in the overall

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10 This has also been confirmed empirically.

11 The jump in the money stock which is neutral in terms of its impact on the price level was set at 9%.

12 Cf. O. Issing and K.-H. Tödter (1994) and S. Gerlach (1994).

13 The long-run income elasticity in relation to nominal gross domestic product can be calculated as a (weighted) average of the elasticities for real GDP and for price movements.

14 R.F. Engle and C.W.J. Granger (1987).

15 At the end of 1993, however, more than three quarters were accounted for by maturities of up to three months.

16 Cf. in this context K.-H. Tödter and M.C. Wewel (1991).

money stock is explained in each case in terms of its "own" interest rate, the average interest rate of the entire portfolio and nominal gross domestic product as a transactions variable. It is assumed in this context that interest is not paid on currency in circulation and on sight deposits.[17] A rise in its "own" interest rate leads to an increase in the assets concerned, whereas an increase in the average rate of interest leads to a shift to other assets.

A similar system of portfolio demand equations is estimated for the allocation of the longer-term financial assets of households and enterprises. The longer-term assets are made up of savings deposits at over three months' notice, savings bonds, bank bonds, government bonds and other claims on the public sector, assets held in the Euro-DM market and other foreign assets. With regard to the interest paid on these external assets the fact is taken into account that interest paid in foreign currency has to be converted using the appropriate exchange rates into amounts in Deutsche Mark. The average rate of interest paid on longer-term assets, which is regarded as the opportunity cost of the demand for money, consequently also depends on exchange rate movements. Changes in each individual interest rate lead in the model to a reallocation of the entire portfolio, these adjustments requiring considerable time.

In addition to households and enterprises, some demand for financial assets also comes from the public sector. Sight deposits SINS and short-term time deposits TKMS are held, for instance, for transaction purposes.[18] Some funds are also invested for a longer term in time deposits TELS, however. The public sector usually runs a deficit in its revenue and expenditure transactions which it finances mainly by borrowing from banks - including the acquisition of government bonds by the banks - KRES. In part, funds are also procured, however, by direct borrowing from households and enterprises VSTP, as well as by borrowing abroad NAVS.[19] If the other items are combined into an exogenous variable SOPS and the net financial asset position of the public authorities is expressed as NGVS, the following accounting identity applies to the government sector in the model:

$$\mathrm{SINS} + \mathrm{TKMS} + \mathrm{TELS} + \mathrm{SOPS} = \mathrm{KRES} + \mathrm{VSTP} + \mathrm{NAVS} + \mathrm{NGVS}$$

In contrast to households and enterprises, the public sector does not orientate itself in its investment and borrowing decisions on an optimisation which is derived from differentials in interest rates and yields. The financial assets of the public sector are, rather, determined by the movement of their revenues, whereas borrowing from the banks depends on the borrowing requirement, i.e. the budget balance. Borrowing abroad is then derived as a "residual".

In the model foreign transactions are captured only very broadly as an aggregate. The movement in the current account produces changes in the net external asset position of the German economy vis-à-vis foreign countries or, alternatively, the net debtor position of foreign countries vis-à-vis the German economy NGVA. This is reflected in the model in the capital and foreign exchange accounts, i.e. in changes in the net foreign position of the Bundesbank WAE, the banks NAVK, the public sector NAVS, the households and enterprises SAVP, as well as the Euro-DM assets EUME. With the inclusion of various exogenous items which, in part, cannot be identified statistically[20], SOPA, the accounting identity of foreign countries is derived:

17 The premiums (bonuses) which are often paid as part of the interest on savings deposits are not shown in the statistics, as a result of which the disclosed interest paid on these assets is too low.

18 For reasons of simplification it is assumed that the public sector holds neither cash nor savings deposits. At the end of 1993 savings deposits (including savings bonds) amounted to only DM 7.8 billion. These amounts are reflected in the other items.

19 Lending by public authorities to foreign countries, e.g. developing countries, is also partly reflected in the variable NAVS, however.

20 The other items which are not recorded in another balance cancel each other out overall.

$$NGVA + NAVS + SAVP + EUME + NAVK + WAE - SOPA = 0$$

The model thus contains a complete and interdependent system of the financial structure, consisting of behavioural equations and accounting identities of the financial transactions between the banking system, i.e. the Bundesbank and the private banks, on the one hand, and the non-banks, i.e. households and enterprises, the government sector and foreign countries, on the other. This system ensures that the accounting restrictions of the individual sectors (budget constraints) are observed.

3. Influences of monetary policy on interest rates and exchange rates

Changes in individual items in the consolidated balance sheet of the banking system and in the portfolio structures of the various non-banks, respectively, such as, for instance, an increase in net external assets caused by inflows of foreign exchange, cannot by themselves be regarded as the cause of a change in other balance sheet items. Substitution between the various liquid and longer-term financial assets, as well as domestic and foreign financial assets of the sectors is generated, rather, by shifts in the pattern of interest rates and the yield structure and by exchange rate movements. In addition, the fact that assets which are more liquid are also used for transaction purposes, whereas longer-term assets are used for investment purposes also plays a part. Monetary policy measures result in a change of interest rates on the money market. As a result the cost of funds to the banks increases or decreases. The banks, for their part, react by adjusting their conditions in deposit and lending transactions and by appropriate reshuffling of their asset and liability structure, the corollary of which is to be found in changes of the non-banks' portfolio structure. The banks pass on changes in their cost of funds to differing extents and with differing speed in their lending and deposit rates. Shorter-term interest rates are adjusted more quickly and strongly than interest rates for longer-term assets. The movement of the banks' deposit and lending rates are determined in the model largely by changes in money market rates. The question of whether the relevant deposits are subject to minimum reserve requirements or are minimum reserve-free is taken into account in the term structure equations. The cost burden of deposits for which the banks have to maintain interest-free minimum reserves is passed on - at least partially - to the customers and results in a certain reduction in deposit rates.

The banks do not conduct only direct lending and deposit business with customers, however, but also figure in Germany to a considerable extent as purchasers, sellers and issuers on the securities markets. Reallocations of banks' portfolios in this area consequently directly affect the yield pattern for fixed-interest securities. The level of and changes in the capital market yields do not, nevertheless, depend solely on movements in money market rates and thus on the monetary policy of the Bundesbank. In addition to interest rate movements in the foreign capital markets, disequilibria in the domestic credit and capital markets also play a certain part. These imbalances are described in the model by a simple "credit quota", i.e. the ratio of the banks' lending to domestic non-banks and their borrowing from domestic non-banks. The higher lending is in relation to borrowing, the tenser are the credit and capital markets and the higher interest rates will be.

Changes in inflationary expectations which are reflected endogenously in nominal interest rates are also of significance. Inflationary expectations are described in the model by the so-called price gap. This is the relationship of the long-run level of prices to the current price level, the long-run level of prices depending, in turn, on the development of the money stock M3 and the growth of potential output. The more strongly the money stock rises in relation to potential production, the more strongly the level of prices will rise in the long run. This is expressed in a growing price gap and increasing inflationary expectations which result in rising nominal rates of interest.[21] Monetary policy thus influences the long-run level of prices in two ways: firstly, by the

21 Cf. also page 389.

movement of short-term interest rates and, secondly, - in the opposite direction - by the development of the money stock.

If the credit quota is designated as KREC, the long-term level of prices as PSM3, the average yield from foreign government bonds as RGBF and the current deflator of domestic demand as PINV, the following dynamic term structure equation for the yield on government bonds outstanding RFUO is produced in the model, for example:

$$\mathrm{RFUO} = \underset{(1.96)}{0.63} + \underset{(2.24)}{0.06}\left(1+\ln \mathrm{KREC}\right)\ \mathrm{RGD} + \underset{(1.61)}{2.57}\sum_{i=1}^{4} 0.25\ \ln\frac{\mathrm{PSM3}_{-i}}{\mathrm{PINV}_{-i}}$$

$$+\underset{(1.71)}{0.07}\ \mathrm{RGBF} + \underset{(8.14)}{1.03}\ \mathrm{RFUO}_{-1} - \underset{(2.47)}{0.26}\ \mathrm{RFUO}_{-2}$$

$$\overline{R}^2 = 0.91 \qquad \mathrm{DW} = 1.81$$

The coefficients of the lagged endogenous variables point to the fact that adjustment to changes in the determinants requires considerable time. Similar term structure equations are estimated for the other interest rates in the model.

A further important area of business for German banks consists in short and long-term capital transactions with other countries. With increasing domestic interest rates and unchanged interest rates abroad, the acquisition of financial assets in other countries becomes less attractive and corresponding capital imports ensue. In contrast, assets denominated in Deutsche Mark gain in this case in terms of attractiveness. This tends to result in an appreciation of the Deutsche Mark. In the model the overall external value of the Deutsche Mark against 18 currencies is disaggregated into the external value against those currencies participating in the exchange rate mechanism of the European Monetary System, into the external value against the US dollar and into the external value against the other currencies.[22] These exchange rates are explained endogenously in the model.

Imperfect substitution exists in the model between the various financial assets denominated in Deutsche Mark and in a foreign currency. The returns on financial assets in a foreign currency result from the yield of these assets and anticipated movements in the exchange rate. A capital import follows if the interest paid on external assets minus the anticipated change in the exchange rate[23] is below the yield of comparable domestic financial assets. This applies to the entire maturity spectrum of domestic and external assets at home and abroad. In the model a comparison of money market investments with a three-month maturity is used. If the external value of the Deutsche Mark against the US dollar is expressed as AUUS and the interest rate for three-month deposits in Germany is designated as RGD and in the Euro-dollar market as RGDE, the following applies to uncovered interest rate parity:

$$\left(\mathrm{RGDE} - \mathrm{RGD}\right) - \left(\ln \mathrm{AUUS}^{e} - \ln \mathrm{AUUS}\right) = 0$$

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22 These include the currencies of some EC countries, such as the pound sterling and the Italian lira, which do not participate in the exchange rate mechanism of the EMS. The fluctuation margin of EMS currencies was widened to ± 15% in August 1993. In the meantime, however, virtually all the EMS currencies have returned to the earlier fluctuation margin of ± 2.25% without the necessity of a formal decision having to be made.

23 In many cases a risk premium must additionally be taken into account.

In the long run the anticipated dollar exchange rate is determined by price movements at home and abroad, i.e. by purchasing power parity. If the deflator of total expenditure in the domestic market is designated as PEV and in the USA as PEVU, this produces:[24]

$$\ln AUUS - \ln AUUS_{-1} = \ln PEVU - \ln PEV$$

If the change from the corresponding quarter of the previous year is designated as Δ_4, the following estimated equation for the movement of the dollar exchange rate may be derived from this taking into account time-lags:

$$\Delta_4 \ln AUUS = \underset{(1.68)}{0.006}\,\Delta_4(RGD - RGDE) + (1 - 1.18 + 0.38)\,\Delta_4 \ln \frac{PEVU}{PEV}$$

$$+ \underset{(11.28)}{1.18}\,\Delta_4 \ln AUUS_{-1} - \underset{(3.60)}{0.38}\,\Delta_4 \ln AUUS_{-2}$$

$$\overline{R}^2 = 0.76 \qquad DW = 2.11$$

On the condition that the interest rate differential does not change in the long run, the movement of the external value of the Deutsche Mark against the US dollar thus follows purchasing power parity. In the shorter term, however, considerable deviations from purchasing power parity may occur. An increase in interest rates in the money market induced by monetary policy action results in an appreciation of the Deutsche Mark. If interest rates in the Euro-dollar market increase to the same extent, the exchange rate of the Deutsche Mark against the US dollar remains unchanged. Similar exchange rate equations have been estimated for the external value of the Deutsche Mark against the EMS currencies and the other currencies.

A change in short-term interest rates on the money market caused by monetary policy action thus leads in the model to changes in the banks' lending and deposit rates, in yields on the securities markets and in exchange rates. The concomitant change in the interest rate level and in the interest rate structure will trigger numerous shifts in the financial portfolio structure of households and enterprises which affect virtually all the financial markets. This reallocation of financial assets has an impact on the various money stock aggregates.

4. Monetary policy and the real economy

Changes in bank interest rates, capital market yields and exchange rates in the financial markets induced by monetary policy measures in turn influence activities on the goods and labour markets. If, for example, the interest paid on financial assets rises in comparison with returns on fixed capital, goods prices and wage rates, a series of substitution, income and exchange rate effects are generated in the model.

In the market for consumer goods a rise in short-term interest rates for savings and time deposits causes households to save more and to reduce their expenditure on consumption. Long-term interest rates, on the other hand, are of more importance for the investment decisions of enterprises. An upturn in capital market yields raises the user cost of capital. On the market for capital goods this results in less being invested, i.e machines ultimately being replaced by labour. An appreciation of the

24 Cf. also in this context Deutsche Bundesbank (1993).

Deutsche Mark reduces the cost of imports and increases the cost of exports. On the market for internationally traded goods domestic products are replaced by foreign products. Exports fall and imports rise.

The substitution effects are, to a considerable extent, masked by income effects, some of which operate in the opposite direction. Households, which are predominantly in a net creditor position, generally achieve net interest earnings which rise with an increase in the level of interest rates and thus increase their disposable income. This, by itself, results in private consumption expenditure being extended. In contrast to this the net debtors in the financial markets, i.e. primarily private enterprises and the public sector, are adversely affected when there is an increase in interest rates. Higher interest costs have a negative impact on the profit performance and cash-flow of enterprises and thus form an additional barrier to capital spending. An interest-rate-induced deterioration of the budget situation also has some influence on the expenditure behaviour of the government.[25]

In addition to substitution, exchange rate and income effects, a direct influence of the growth in the money stock on movements in prices, based on the quantity equation, is also incorporated in the model.[26] If both the goods market and the money market are in equilibrium, the level of prices is determined by the money stock, as well as by potential output and the trend in the income velocity which is derived from a long-run money demand function. Assuming price homogeneity in relation to the deflator of domestic demand PINV, a link is established by this money demand function between the money stock M3 and potential output BIPQ:[27]

$$\ln M3 = -7.52 + 1.56 \ln BIPQ + 1.00 \ln PINV$$

For the long-term price level PSM3 this then produces:

$$PSM3 = \frac{M3}{BIPQ^{1.56}}\, e^{7.52}$$

This is the price level which arises in the long run with currently held money balances if gross domestic product corresponds to potential output and the income velocity corresponds to its trend value. A growth in the money stock which exceeds the growth of potential output and the slowdown in the trend of velocity leads in the long run to an inflationary bloating of incomes, turnover and monetary demand. In the shorter and medium term, however, price movements are also influenced strongly by other factors, in particular by wage costs and import prices, with the result that the current level of prices deviates considerably from the price level to be expected in the long run. These factors can exercise a permanent influence on price movements, however, only if they are accommodated by a corresponding expansion of the money stock. The so-called price gap, i.e. the relationship between the long-run price level and the current deflator of domestic demand which then arises represents an indicator of inflationary expectations. If the price level which is to be anticipated

25 Wealth effects which are based on a revaluation of assets in the context of changes in bond prices, share prices and exchange rates (asset prices) do not, however, lead directly to a change in spending in the model.

26 Cf. also Deutsche Bundesbank (1992), O. Issing (1992) and K.-H. Tödter and H.-E. Reimers (1994).

27 When estimating this function both the statistical jump in the series caused by German unification and seasonal fluctuations are taken into account. Although the equation does not contain an interest rate variable and the money stock, the income variable, as well as the price variable are defined somewhat differently than in the money demand equation for households and enterprises, practically the same income elasticity is produced at 1.56, (cf. page 385).

in the long run is significantly above the actual level of prices a marked acceleration of inflationary pressure is to be expected.

Taking account of developments in wage costs per man-hour LA and import prices PIM, the actual movement of the private consumption deflator PCP adjusts itself in the model to the long-run price level in a dynamic error correction process:

$$\Delta_4 \ln PCP = \underset{(2.08)}{0.07}\,\Delta_4 \ln LA + \underset{(2.20)}{0.05}\,\Delta_4 \ln PIM + \underset{(2.15)}{0.05}\,\sum_{i=1}^{4} 0.25 \ln \frac{PSM3_{-i}}{PINV_{-i}}$$

$$+\underset{(4.94)}{0.62}\,\Delta_4 \ln PCP_{-1} + \underset{(0.28)}{0.04}\,\Delta_4 \ln PCP_{-2} + \underset{(1.33)}{0.14}\,\Delta_4 \ln PCP_{-3}$$

$\overline{R}^2 = 0.98 \qquad DW = 1.95$

Similar adjustment equations are estimated in the model for the other price deflators. It follows from these estimates that considerable time-lags are to be expected in the adjustment of price movements to monetary growth. In the meantime price movements depend, to a considerable extent, on other influences, in particular, for example, on wage rises and movements in import prices.

The decline in demand on numerous goods markets caused by an increase in interest rates leads to a cut-back in production and a corresponding fall in employment. This results in reduced income payments which in turn trigger changes in the net asset position of the various sectors. The degree of utilisation of production capacities decreases and unemployment rises. The effects on private consumption, private investment, government expenditure and foreign trade are reflected in changes in real gross domestic product. In addition, these changes on the goods and labour markets trigger certain adjustments in the case of goods prices and wage rates. The processes in the real economy then in turn have certain repercussions on financial markets. Thus the demand for money, for example, depends crucially on the development of real gross domestic product and the level of prices. Movements in interest and exchange rates are influenced by changes in domestic goods prices and inflationary expectations. Time-lags of greater or lesser duration occur at each stage of this lengthy and interdependent transmission process. The mutual dependencies, which have effects which are partly positive and partly negative, are the reason why knowledge of individual interest elasticities, such as that for private consumption, private investment or the demand for money, for example, are by no means sufficient for being able to assess the impact of monetary policy measures. Monetary policy is able to exert only an indirect influence on developments in the financial markets, i.e. financial assets, interest rates and exchange rates, and on trends in the real economy, i.e. production, employment, prices and wages. The final result always presents itself as the resultant of numerous forces which are influenced by the wage bargainers with wage rate policy, by the government with fiscal policy and by developments in other countries.

III. DESIGN AND RESULTS OF MONETARY POLICY SIMULATION EXPERIMENTS

1. Effects of a temporary increase in interest rates

The transmission processes which are specified in the econometric model of the Bundesbank for the German economy between a change in monetary policy instruments, on the one hand, and the money market, the other financial markets, as well as the goods and labour markets, on the other hand, contain numerous mutual dependencies. With the model it is possible to investigate the effects which are generated by a certain change of monetary policy in controlled simulation experiments. In these the effects of monetary policy are separated under "laboratory conditions" from the influences of other exogenous factors such as fiscal policy, wage rate policy or developments in foreign trade and payments.

First of all, in order to identify the specific effects of monetary policy measures, a so-called reference scenario or baseline with an unchanged monetary policy stance for the ten year period from 1994 to 2003 has been calculated using the model. The results of this baseline then serve as a basis of comparison for a policy scenario in which the interest rates of the Bundesbank, i.e. the lombard rate, the discount rate and the securities repurchase rate, were raised for two years by 100 basis points.[28] This is a notional simulation experiment as both the size and the duration of such an interest rate rise do not correspond to reality. Nevertheless, it is possible to draw conclusions on the short-run and long-run effects of an increase in interest rates from such a standardised change in monetary policy instruments. The differences between the baseline, on the one hand, and the policy simulation, on the other, may then be attributed solely to the increase in interest rates, whereas the influence of all other exogenous variables is, so to speak, filtered out. Further, the question arises of what effects changes in interest rate have if exchange rates remain unchanged. On the condition of exogenously fixed exchange rates a temporary change in interest rates, in turn, is simulated in a second experiment.

A two-year increase in Bundesbank interest rates by 100 basis points is transmitted quickly and almost completely to interest rates in the money market. The rate for three-month funds rises temporarily by around 0.9% p.a., and the rate for time deposits with a maturity of up to three months increases by 0.83 percentage points. The interest rate for current account credits is, admittedly, raised by the banks initially only by 55 basis points. In the second year, however, the increase in interest rates is also fully passed on to the customers. The increase is much less in the case of yields for fixed-interest securities which move up by merely a good 0.2 percentage points reflecting the limited influence of monetary policy on the movement of long-term interest rates. This is because capital market yields also depend on the level of interest rates abroad and on expected price rises. The various different effects on the short-term and long-term interest rates result in a shift in the yield curve: a normal yield curve becomes flatter and an inverse yield curve becomes more marked.

An increase in the level of interest rates in Germany with unchanged interest rates abroad and on the international capital markets implies that financial assets in the form of Deutsche Mark securities return a higher yield than previously. As a result, the demand for Deutsche Mark increases and an appreciaton of the Deutsche Mark ensues. Overall, the external value of the Deutsche Mark in the second year is 1.3% above its value in the baseline solution. The real effective external value appreciates initially by 1.2%. But after four years it has fallen back on the level of the baseline solution with the result that this real variable does not undergo a permanent revaluation. The cost of capital is defined for three types of investment: investment in machinery and equipment, industrial buildings and housing construction. This rises with increased interest rates. The increase in capital costs for investments in residential construction, amounting to 2.2%, is especially marked. Capital costs for investment in machinery and equipment move up only half as strongly. Positive effects are to be noted for both categories after five years have elapsed. Only capital costs for industrial buildings regress back to the baseline.

The changes in market interest rates generated by the two-year increase in Bundesbank interest rates, in the interest rate structure and in exchange rates cause private investors to reallocate considerably their portfolios. This involves substantial shifts from liquid assets to longer-term assets. As the opportunity cost of holding cash has increased, the levels of cash and sight deposits, in

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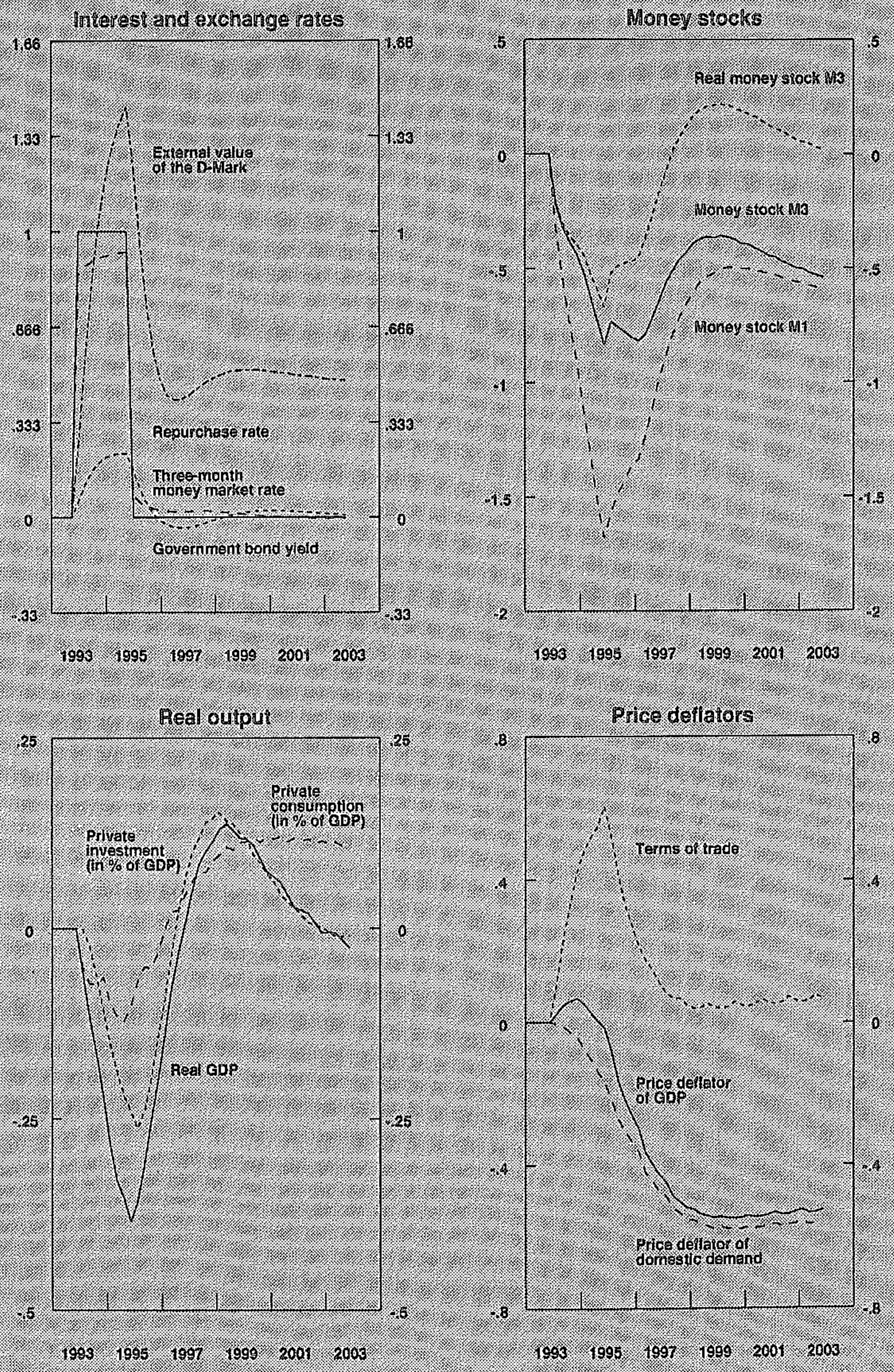
28 In the simulation experiments the model version dated 2nd August 1994 was used, the coefficients of which were estimated up to the first quarter of 1994. The results of the temporary increase in central bank interest rates with endogenous exchange rates are shown in Tables I.1 and II.1.

Chart 2: Effects of a temporary increase in Bundesbank interest rates in the econometric model of the German economy

Deviation from baseline in % or in % p.a.



Deutsche Bundesbank

particular, are reduced. In the second year the money stock M_1 is approximately 1.7% below its comparative value in the reference scenario. The diminuation of the money stock M_3 amounts to 0.8%. After five years have elapsed its decline has halved to 0.4%. At the same time, switching in the case of credits is to be noted. Whereas the loans and advances of banks to enterprises and households regress permanently by 0.6%, those to the public sector rise initially by 0.3% and subsequently by more than 1.5%.

The reduced currency in circulation and, to a certain extent, also the minimum reserves, which are to be held on sight and savings deposits, are the principal factors which cause the requirement for central bank money to fall. It is assumed in the simulation that the Bundesbank adapts to the reduced demand for central bank money by contracting fewer securities repurchase agreements. This means that the Bundesbank accommodates its own increase in interest rates monetarily.

The temporary increase in domestic interest costs and the appreciation of the Deutsche Mark against foreign currencies generate effects on developments in the real economy which are initially clearly restrictive. Real consumption expenditure of households and corporate investments are noticeably below the baseline. In addition, the increase in the cost of German products abroad which is caused by the appreciation of the D-Mark results in a marked slowdown in real exports of goods and services. In the second year following the increase in interest rates real gross domestic product is 0.37% below the baseline. The increased interest receipts of households which, admittedly, initially increase private savings and thus their net financial assets, nevertheless subsequently have a restraining effect on the decline in consumption expenditure. Following this, the initial setback in economic activity quickly recedes and reverses after seven years to a slight increase of 0.1%.

In the initial phase of the transmission process of a raising in policy-controlled interest rates which, according to the simulations, lasts about two years, reduced production results in no significant wage and price increases. The enterprises are burdened with higher interest costs. Productivity declines as a result of falling capacity utilisation and individual wage and salary earners are made redundant. The unemployment rate increases by 0.24 percentage points. The goods and labour markets react only very slowly and sluggishly to shifts in demand and the market imbalances which they cause. Because of this, an easing of prices and costs - which is further increased by the appreciation of the Deutsche Mark and the accompanying reduction in the cost of imports - sets in only after a certain time. After two years, however, the deflator of private consumption is 0.14% below the baseline and the hourly rates of pay have likewise fallen by approximately 0.14%. The GDP deflator falls somewhat less because the terms of trade improve significantly in connection with the appreciation of the Deutsche Mark. The slackening in costs and prices which set in are passed on all the more easily, the less liquidity is available. The reduced growth in the money stock caused by the interest rate increase results in the long run in an equally large fall in the level of prices.[29]

In the second phase of the transmission process marked successes of the temporary increase in interest rates are observed in terms of price movements. The prices for private consumption and the GDP deflator remain more than 0.5% below their baseline. The tendency to persistence of prices results in the increase of real rates of interest being greater in the medium term than that of the nominal ones. The appreciation of real incomes which accompanies price reductions compensates almost fully for the negative effects on real domestic product which are caused by the increase in interest rates. Real disposable income raises above the baseline and real gross domestic product too slightly exceeds its value in the reference scenario.

The price and output effects which are generated by an increase in interest rates significantly alter the flows of expenditure and income between the sectors and thus financial balances and net financial assets. Because households' interest income rises, while their consumption expenditure simultaneously falls, an increase in private savings occurs. After five years households' net financial assets are significantly above their level in the baseline. In contrast, with an increase in

29 Viewed in real terms the money stock falls back to its level in the baseline.

interest rates the public authorities are burdened with additional interest payments. Simultaneously, the nominal reduction of incomes and turnover leads to reduced tax and social contribution revenues. As a result budget deficits increase and the net level of debt increases. The effects of an increase in interest rates on the current account and thus on the net external position are characterised by effects operating in the opposite direction. On the one hand, the appreciation of the Deutsche Mark makes the competitive situation of the German economy worse in relation to foreign countries and real exports fall significantly. This is, however, virtually offset by the sharp decline in import prices caused by the appreciation and the accompanying improvement in the terms of trade, with the result that the current account changes only slightly overall.

In summarising it may thus be stated that in the long run the macroeconomic supply curve progresses vertically, i.e. output does not change, whereas the price level clearly falls. Ultimately, there is no trade-off between growth and employment, on the one hand, and price stability, on the other. As considerable time-lags are effective in the case of monetary policy measures, these effects set in only in the medium and longer term, however. The shortage of liquidity caused by interest rate increases is transferred to reduced demand for money and leads in the long run to a fall in prices. The results of a temporary change in interest rates are confirmed by a permanent change in interest rates which may be interpreted as a series of several temporary changes.[30]

As a result of an exogenisation of exchange rates, the direction of the effects of a temporary increase in policy-controlled interest rates changes only in the case of a very few variables in the first two years.[31] Subsequently, only a few minor changes of direction are to be noted. But the scale of the variable adjustments is markedly smaller. The central bank rates which are increased temporarily lead to increased money and capital market rates. There is an upturn in capital costs and real rates of interest which depend on these. The shifts in income lead to a switching from liquid assets to monetary capital components. The scale of money stock adjustments is, however, somewhat smaller than in the first simulation experiment. By filtering out exchange rate adjustments the cost of German export goods in other countries rises imperceptibly and no fall in import prices is noted. Exports decline just as little with the result that small-scale losses occur in the domestic product. After two years they amount to approximately 0.1% in comparison with the baseline. The slight import price adjustments result in a stronger curbing of import demand in relation to gross domestic product than in the first experiment. The price successes are accordingly less than with the reference experiment. This underlines the great significance of exchange rate adjustments for a non-inflationary monetary policy.

2. Relative importance of different transmission channels

Whereas, in the previous section, the different quantitative effects were described between interest rates, on the one hand, and financial and real variables, on the other, this section will examine the relative importance of single channels in the transmission process. In this complex process various channels are identified on the basis of the influences of differing interest rate variables on aspects of the goods markets. An exact separation of individual channels is not possible, however. Identification succeeds all the more easily depending on how direct the relationship between interest rates and output and prices on the goods market is.

The influence of domestic interest rates on the exchange rates which determine import and export prices, as well as import and export demand, is designated as the exchange rate channel. This channel thus contains real and nominal aspects of the goods market. The investment decisions of the private sector are covered in the capital cost channel. They depend on an average interest rate and

30 For the effects of a permanent interest rate reduction cf. H. Herrmann and W. Jahnke (1994).

31 The effects of a temporary increase in interest rates with exogenous exchange rates are contained in Tables I.2 and II.2, respectively.

on a risk premium which is partially determined by the yield on bonds outstanding. These variables are used as a reference point, although the long-term interest rate is also influenced by the price gap which has been changed by interest rate increases.

The income and cash flow channel contains the interest income of households from net financial assets and government interest payments which influence government expenditure and revenue. In addition, the interest income of the Bundesbank is taken into account in the appropriate profit equation. As a result of a change in interest rates households' net financial assets undergo a revaluation to which households adapt with altered consumption. Instead of estimating this influence of assets on consumption directly, the consumption equation in the Bundesbank's model for the German economy contains a real interest rate which partially captures these effects. In this context, the real interest rate variable also reflects substitutions between current and future consumption. These are, however, also reflected in the fluctuations of savings and thus of assets. The direct interest rate effect in the consumption equation is used as a reference point for the wealth channel.

The effect of the price gap on price movements (price gap channel) is characterised as an additional transmission path for monetary policy. Price effects arise as a result of changes in the stock of money which are not absorbed in the real economy and which are accompanied by a widening of the price gap. The demand for money depends in the short and long run firstly on a transaction variable and, secondly, on an interest rate variable. Five different channels of the transmission process are thus identified: income and cash flow, direct interest rate effect on consumption, cost of capital, exchange rate, price gap.

The relative importance of the various transmission channels is analysed empirically using a method developed by Siviero.[32] The equations contain individual channels which are modified for the simulations. In the equations the coefficients of the variables concerned are provided with so-called flags. These flags assume the value zero if the full interest rate effect is identified. In this case the interest rate variable is fixed in the respective equations at its baseline values so that specific reactions are filtered out. The differences between the overall effects and the partial effects for individual variables are designated as the contribution of the respective channel to the overall effect. In the simulations only one channel at a time is set to zero. It is, admittedly, a disadvantage in this approach that in interdependent models the sum of the partial effects does not necessarily result in the overall effect. If the channels were successively eliminated, however, the magnitude of the effects would depend on the sequence of elimination. This is because different models are simulated in each case. These limitations should be borne in mind when interpreting the results. Strictly speaking, it is possible to state only the relative significance of a single effect in comparison with the overall effect and the direction in which the respective channel operates.

In assessing the relative importance of individual transmission channels of a temporary increase in interest rates the relationships which have been described previously provide evidence of the direction of the isolated channels.[33] The income channel exerts a positive contribution, whereas the exchange rate and the direct interest rate on consumption channels contribute negatively to the overall effect. Not only the capital cost channel, but also the income and price gap channels play a minor role for developments in gross domestic product in the short-run. The exchange rate channel, on the other hand, is of particular significance which points to a high level of price competition on foreign markets. The direct interest rate on consumption channel subsequently gains in importance, describing in particular the fall in private consumption and imports. The slowdown in private consumption and in exports reduces the sales potential of enterprises. As a result of this they make a marked reduction in their investment in machinery and equipment. The capital cost channel hits construction expenditure harder, however, which thus proves to be more sensitive to capital costs than the other investments.

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32 E. Mauskopf and S. Siviero (1994).

33 The results are shown in Table III.

In the long run no effects on gross domestic product are observed with a temporary increase in interest rates. There are no effects even in the individual channels of transmission. The composition of gross domestic product, on the other hand, changes. Whereas private consumption and investment increase, government expenditure and exports fall. There are, accordingly, more significant contributions to be noted in the case of the individual channels for the components. The increase in consumption and the accompanying rise in capital spending are explained by the direct effect on consumption and the exchange rate channel.

The income, direct interest rate on consumption and exchange rate channels are of roughly equal importance for the fall in government expenditure. The decline in exports is induced predominantly via the exchange rate channel. It is worth noting that the discrepancy is in some cases higher than the values of individual channels. This shows again the high interdependence of the model where the separation of a channel generates an alternative model. The effects in these different models do not sum up to the effects in the full model.

IV. SUMMARY

In the macroeconometric model of the Deutsche Bundesbank for the German economy the transmission process of monetary policy is empirically described. It contains the important monetary policy instruments of the Bundesbank and includes money as well as portfolio demand relationships. The influences of monetary policy on interest rates and exchange rates are presented which affect real activity and prices.

The simulation experiment of a temporary increase in interest rates shows in the beginning a decrease of real output. In the medium term real activity recovers and returns to its baseline. In the long run a temporary restrictive monetary policy results in a lower price level. These results are supported considerably by flexible exchange rates, as the price level effects are lower assuming exogenous exchange rates. Despite the drawbacks in the identification of individual channels it is shown that the exchange rate channel is relatively important to explain the real activity development whereas the cost-of-capital channel is important for investment decisions.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Money market rate for three-month funds	0.88	0.92	0.05	0.02	0.02	0.02	0.01
Yield on government bonds	0.13	0.22	0.08	- 0.03	- 0.03	0.00	0.02
3. Other interest rates (%)							
Bank lending rate	0.55	0.88	0.38	0.07	0.02	0.02	0.02
Deposit rate	0.76	0.83	0.05	- 0.00	0.01	0.02	0.01
4. Real interest rates							
Real short-term interest rate (%)	0.77	0.86	0.12	0.10	0.12	0.11	0.08
Real long-term interest rate (%).............	0.10	0.18	0.12	0.06	0.07	0.07	0.08
User cost of capital							
Machinery and equipment	0.61	1.14	0.73	0.32	0.30	0.35	0.29
Business construction	1.10	1.91	0.99	0.10	- 0.03	0.04	- 0.03
Residential construction	1.28	2.21	1.39	0.75	0.71	0.67	0.42
5. Exchange rates							
Nominal effective exchange rate	0.67	1.33	0.87	0.43	0.45	0.50	0.51
EMS exchange rate	0.31	0.70	0.63	0.46	0.45	0.48	0.50
US dollar exchange rate	1.35	2.70	1.70	0.58	0.47	0.53	0.54
Other currencies	0.73	1.37	0.81	0.37	0.45	0.51	0.52
Real effective exchange rate	0.64	1.15	0.57	0.05	- 0.00	0.01	0.01
6. Money and credit							
Monetary aggregates							
M_1	- 0.91	- 1.68	- 1.36	- 0.99	- 0.65	- 0.52	- 0.50
M_3	- 0.44	- 0.83	- 0.80	- 0.64	- 0.43	- 0.37	- 0.39
Domestic credit							
Private	- 0.11	- 0.39	- 0.58	- 0.59	- 0.54	- 0.53	- 0.56
Public	0.05	0.31	0.75	1.14	1.14	1.52	1.60

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in interest rates (exchange rates exogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Money market rate for three-month funds	0.89	0.93	0.06	0.04	0.02	0.01	0.01
Yield on government bonds	0.13	0.22	0.09	0.00	0.01	0.02	0.02
3. Other interest rates (%)							
Bank lending rate	0.56	0.89	0.40	0.10	0.04	0.02	0.02
Deposit rate	0.76	0.84	0.07	0.01	0.01	0.01	0.01
4. Real interest rates							
Real short-term interest rate (%)	0.77	0.85	0.10	0.07	0.07	0.05	0.03
Real long-term interest rate (%)	0.09	0.16	0.08	0.04	0.05	0.05	0.04
User cost of capital							
Machinery and equipment	0.58	0.98	0.56	0.30	0.33	0.32	0.25
Business construction	1.06	1.66	0.70	0.11	0.12	0.13	0.07
Residential construction	1.26	2.07	1.13	0.54	0.53	0.44	0.26
5. Exchange rates							
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMS exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
US dollar exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other currencies	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	0.00	- 0.03	- 0.10	- 0.17	- 0.21	- 0.21	- 0.19
6. Money and credit							
Monetary aggregates							
M_1	- 0.88	- 1.44	- 0.84	- 0.50	- 0.30	- 0.19	- 0.13
M_3	- 0.41	- 0.58	- 0.26	- 0.15	- 0.08	- 0.04	- 0.03
Domestic credit							
Private	- 0.06	- 0.17	- 0.24	- 0.24	- 0.22	- 0.20	- 0.18
Public	0.03	0.17	0.38	0.55	0.64	0.69	0.70

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.15	- 0.37	- 0.30	- 0.07	0.09	0.14	0.11
Private consumption	- 0.14	- 0.26	- 0.13	0.02	0.13	0.20	0.24
Government expenditure	0.01	0.09	0.16	0.11	0.01	- 0.06	- 0.13
Private investment	- 0.43	- 1.21	- 0.80	0.30	0.63	0.53	0.35
Residential	- 0.27	- 0.95	- 0.87	0.08	0.57	0.60	0.46
Non-residential	- 0.67	- 1.56	- 0.71	0.55	0.69	0.46	0.25
Inventories (in bill. DM)	1.24	0.85	- 2.37	- 2.52	0.08	1.45	1.36
Exports	- 0.29	- 0.65	- 0.44	- 0.11	- 0.07	- 0.11	- 0.16
Imports	- 0.24	- 0.68	- 0.50	0.06	0.21	0.16	0.11
2. Unemployment rate (%)	0.08	0.24	0.23	0.08	0.02	0.02	0.02
3. Real disposable income	0.05	0.14	0.22	0.33	0.40	0.43	0.41
4. Inflation and wages							
GDP deflator	0.03	- 0.02	- 0.20	- 0.37	- 0.48	- 0.52	- 0.53
Consumer prices	- 0.03	- 0.14	- 0.31	- 0.45	- 0.55	- 0.61	- 0.62
Wages per hour	- 0.03	- 0.14	- 0.28	- 0.35	- 0.37	- 0.40	- 0.45
Unit labour cost	0.05	- 0.02	- 0.22	- 0.36	- 0.48	- 0.55	- 0.57
Import prices	- 0.30	- 0.71	- 0.65	- 0.42	- 0.38	- 0.39	- 0.40
5. Government accounts (% of nominal baseline GDP)							
Revenues	- 0.17	- 0.54	- 0.70	- 0.58	- 0.51	- 0.55	- 0.63
Primary expenditures	0.03	0.03	- 0.11	- 0.32	- 0.46	- 0.55	- 0.64
Interest payments	0.06	0.24	0.28	0.19	0.18	0.19	0.21
Financial deficit	- 0.27	- 0.82	- 0.87	- 0.45	- 0.23	- 0.19	- 0.20
Public sector debt	- 0.12	- 0.72	- 1.59	- 2.14	- 2.36	- 2.49	- 2.61
6. Current account (% of nominal baseline GDP)	0.15	0.31	0.14	- 0.27	- 0.47	- 0.46	- 0.40
Trade balance	0.03	0.14	0.14	- 0.17	- 0.39	- 0.44	- 0.44

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in interest rates (exchange rates exogenous)

Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.06	- 0.13	- 0.07	0.04	0.11	0.13	0.12
Private consumption	- 0.14	- 0.19	- 0.06	0.02	0.06	0.11	0.14
Government expenditure	- 0.00	0.01	0.04	0.04	0.01	- 0.02	- 0.06
Private investment	- 0.26	- 0.63	- 0.32	0.26	0.38	0.32	0.24
Residential	- 0.18	- 0.57	- 0.42	0.18	0.38	0.37	0.31
Non-residential	- 0.37	- 0.72	- 0.19	0.36	0.38	0.28	0.18
Inventories (in bill. DM)	0.59	0.21	- 1.23	- 0.97	0.21	0.71	0.65
Exports	- 0.04	- 0.07	- 0.02	0.06	0.09	0.09	0.07
Imports	- 0.17	- 0.37	- 0.21	0.06	0.13	0.12	0.10
2. Unemployment rate (%)	0.04	0.09	0.07	0.02	0.00	- 0.00	- 0.02
3. Real disposable income	0.06	0.23	0.32	0.29	0.25	0.25	0.25
4. Inflation and wages							
GDP deflator	- 0.00	- 0.04	- 0.13	- 0.22	- 0.27	- 0.27	- 0.25
Consumer prices	- 0.01	- 0.06	- 0.15	- 0.23	- 0.28	- 0.29	- 0.27
Wages per hour	- 0.01	- 0.05	- 0.10	- 0.12	- 0.14	- 0.16	- 0.18
Unit labour cost	0.01	- 0.02	- 0.10	- 0.18	- 0.24	- 0.28	- 0.27
Import prices	0.00	0.00	- 0.01	- 0.01	- 0.01	- 0.01	- 0.01
5. Government accounts (% of nominal baseline GDP)							
Revenues	- 0.10	- 0.17	- 0.17	- 0.17	- 0.17	- 0.19	- 0.19
Primary expenditures	0.01	0.00	- 0.06	- 0.14	- 0.20	- 0.24	- 0.28
Interest payments	0.06	0.24	0.26	0.14	0.11	0.11	0.11
Financial deficit	- 0.17	- 0.42	- 0.36	- 0.16	- 0.09	- 0.05	- 0.03
Public sector debt	- 0.08	- 0.40	- 0.80	- 1.00	- 1.08	- 1.11	- 1.11
6. Current account (% of nominal baseline GDP)	0.22	0.46	0.23	- 0.12	- 0.21	- 0.19	- 0.16
Trade balance	0.14	0.31	0.17	- 0.09	- 0.16	- 0.15	- 0.16

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table III

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)							
	Total	**Income/ cash flow**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Price gap**	**Discrepancy[2]**
Real GDP: first year after shock[1]	**- 0.15**	**0.02**	**- 0.06**	**0.01**	**- 0.09**	**0.01**	**- 0.04**
of which:							
Private consumption	- 0.08	0.03	- 0.11	0.00	- 0.01	0.00	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.04	0.01	- 0.01	- 0.01	- 0.01	0.00	- 0.02
Residential private investment	*- 0.03*	*0.01*	*- 0.01*	*- 0.01*	*- 0.01*	*0.00*	*- 0.01*
Non-residential private investment	*- 0.06*	*0.00*	*- 0.03*	*0.00*	*- 0.03*	*0.00*	*0.00*
Inventories	*0.05*	*0.00*	*0.02*	*0.00*	*0.03*	*0.00*	*0.00*
Exports	- 0.11	0.00	0.00	0.03	- 0.09	0.01	- 0.06
Imports	- 0.08	0.01	- 0.06	0.00	- 0.02	0.00	- 0.01
Real GDP: second year after shock[1]	**- 0.37**	**0.05**	**- 0.14**	**- 0.01**	**- 0.24**	**0.02**	**-0.05**
of which:							
Private consumption	- 0.14	0.08	- 0.21	0.00	- 0.04	0.01	0.02
Government expenditure	0.02	0.00	0.01	0.00	0.02	0.01	- 0.02
Private investment	- 0.21	0.02	- 0.07	- 0.06	- 0.09	0.01	- 0.02
Residential private investment	*- 0.11*	*0.01*	*- 0.02*	*- 0.05*	*- 0.04*	*0.01*	*- 0.02*
Non-residential private investment	*- 0.13*	*0.02*	*- 0.05*	*- 0.02*	*- 0.07*	*0.01*	*- 0.02*
Inventories	*0.03*	*- 0.01*	*0.01*	*0.00*	*0.02*	*0.00*	*0.01*
Exports	- 0.26	0.00	0.00	0.05	- 0.23	0.00	- 0.08
Imports	- 0.21	0.05	- 0.12	0.00	-0.09	0.01	- 0.06
Real GDP: third year after shock[1]	**- 0.30**	**0.08**	**- 0.13**	**- 0.01**	**- 0.22**	**0.04**	**- 0.06**
of which:							
Private consumption	- 0.07	0.11	- 0.17	0.01	- 0.04	0.02	0.00
Government expenditure	0.03	- 0.01	0.01	- 0.01	0.02	0.01	0.01
Private investment	- 0.24	0.04	- 0.07	- 0.06	- 0.13	0.03	- 0.05
Residential private investment	*- 0.09*	*0.01*	*- 0.02*	*- 0.03*	*- 0.04*	*0.01*	*- 0.02*
Non-residential private investment	*- 0.06*	*0.02*	*- 0.02*	*- 0.01*	*- 0.04*	*0.01*	*- 0.02*
Inventories	*- 0.08*	*0.01*	*- 0.02*	*0.00*	*- 0.04*	*0.00*	*- 0.03*
Exports	- 0.18	0.00	0.00	0.03	- 0.16	0.00	- 0.05
Imports	- 0.15	0.06	- 0.10	- 0.01	- 0.08	0.02	- 0.04

Table III (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (exchange rates endogenous)

	Total	**Income/ cash flow**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Price gap**	**Discrepancy[2]**
Real GDP: fourth year after shock[1]	**- 0.07**	**0.06**	**- 0.10**	**0.00**	**- 0.08**	**0.04**	**0.01**
of which:							
Private consumption	0.01	0.10	- 0.12	0.00	0.00	0.02	0.01
Government expenditure	0.02	- 0.01	0.00	0.00	0.01	0.01	0.01
Private investment	- 0.03	0.03	- 0.04	0.01	- 0.04	0.02	- 0.01
Residential private investment	*0.01*	*0.01*	*0.00*	*0.01*	*0.00*	*0.01*	*- 0.02*
Non-residential private investment	*0.05*	*0.01*	*0.00*	*0.01*	*0.02*	*0.01*	*0.00*
Inventories	*- 0.09*	*0.01*	*-0.03*	*-0.01*	*-0.06*	*0.00*	*0.00*
Exports	- 0.05	- 0.01	0.00	0.00	- 0.05	0.00	0.01
Imports	0.02	0.05	- 0.05	0.01	0.01	0.01	- 0.01
Real GDP: fifth year after shock[1]	**0.09**	**0.04**	**- 0.05**	**0.01**	**0.03**	**0.04**	**0.02**
of which:							
Private consumption	0.07	0.07	- 0.06	0.01	0.05	0.03	- 0.03
Government expenditure	0.00	- 0.01	- 0.01	0.00	0.00	0.02	0.00
Private investment	0.12	0.00	0.00	0.03	0.06	0.01	0.02
Residential private investment	*0.06*	*0.00*	*0.01*	*0.03*	*0.03*	*0.01*	*- 0.02*
Non-residential private investment	*0.07*	*0.00*	*0.01*	*0.01*	*0.05*	*0.01*	*- 0.01*
Inventories	*0.00*	*0.00*	*- 0.01*	*0.00*	*- 0.01*	*0.00*	*0.02*
Exports	- 0.03	0.00	0.00	- 0.01	- 0.03	0.00	0.01
Imports	0.06	0.02	- 0.03	0.01	0.04	0.01	0.01
Real GDP: final year (2003) after shock[1]	**- 0.01**	**0.01**	**0.01**	**- 0.01**	**- 0.01**	**0.00**	**0.00**
of which:							
Private consumption	0.13	0.01	0.05	- 0.01	0.05	0.02	0.01
Government expenditure	- 0.07	- 0.03	- 0.03	0.00	- 0.03	- 0.01	0.03
Private investment	0.02	- 0.02	0.02	0.01	0.01	- 0.01	0.01
Residential private investment	*0.02*	*- 0.01*	*0.01*	*- 0.01*	*0.01*	*0.00*	*0.02*
Non-residential private investment	*0.00*	*- 0.01*	*0.00*	*0.00*	*0.00*	*- 0.01*	*0.02*
Inventories	*- 0.01*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*- 0.02*
Exports	- 0.10	0.01	- 0.04	- 0.01	- 0.06	- 0.02	0.02
Imports	0.00	0.00	0.00	0.00	0.00	- 0.01	0.01

[1] Percentage deviations from baseline. Due to rounding errors, the contribution of variables may not add to the total effect. [2] Due to interaction between the different channels.

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Monetary policy and the transmission channels in the Bank of Italy's quarterly econometric model

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I. INTRODUCTION

The effects of monetary policy on the economy and the channels through which changes in the policy variables are transmitted to the rest of the economic system are as old an issue as macroeconomics itself.

To the extent that the central banks' view of the economy and of the actual working of monetary policy is embodied in their econometric models, a comparison across models of the simulated response to a standardised policy intervention should shed some light on the issue at hand. In particular, it should allow to gauge both the effectiveness and the transmission channels of monetary policy in the single countries, and the differences thereof.

This paper, as a part of the BIS project, presents the effects of monetary policy on the Italian economy, as well as the relevance of the different transmission channels, as they result from appropriate simulations of the Bank of Italy Quarterly Econometric Model (BIQM).

The paper is organised as follows. Section II provides an overview of the model used. Section III focuses on the monetary and financial block of the model, describing the main channels of monetary policy in relation to the financial structure of the economy. Section IV briefly presents the design of the simulations. Section V analyses the main results, relating them to the features of the financial structure previously described. Section VI quantifies a decomposition of the overall results into the channels of transmission. The last section concludes.

II. AN OVERVIEW OF THE MODEL

In the BIQM, rather traditionally, a number of adjustment processes govern the short-run dynamics of an economy whose long-run behaviour is consistent with a neo-classical model with exogenous growth. In the absence of shocks, when all adjustment processes have taken place and expectations are fulfilled - that is, in the long-run - the model describes a full employment economy,[1] in which all real variables grow at the same rate, equal to the sum of the rates of growth of population and productivity. Output, employment and the capital stock are consistent with an aggregate production function; all relative prices are constant. Inflation is constant as well, and equals the exogenous rate of growth of foreign prices, assuming no changes in the nominal exchange rate. Money is neutral (but not super-neutral). Moreover, the model is dynamically stable: exogenously setting the rates of growth of population, productivity and foreign prices, fixing arbitrarily a level for the nominal exchange rate and a level for both domestic and foreign nominal interest rates - smaller than the rate of growth of nominal GDP - and letting money supply to adjust, a simulation of the model run for an extended period converges to a steady-state growth path. On the latter, however, the government debt and foreign debt to GDP ratios are not likely to be realistic numbers, as they depend

1 By full employment it is meant a level of production and employment consistent with a constant rate of growth of prices.

on the arbitrary choices of the nominal exchange and interest rates. To guarantee that government debt and foreign debt to GDP ratios are at desired levels, control techniques need to be employed.

The theoretical structure underlying the steady-state is also a traditional one. The supply sector can be thought of as being composed by producers who operate in a monopolistically competitive market for their output, and are price-takers in the market for the production factors, each producer being endowed with the same (Cobb-Douglas) constant returns to scale technology. These assumptions imply that each firm knows the minimum average cost of its competitors and justify the hypothesis that the price of output is set as a mark-up on that cost, at a level that keeps potential entrants out of the market. Along a steady-state growth path, firms decide, in each period, the cost minimising factor mix. The level of domestic activity is then set to generate, given factor demands, a non-accelerating-inflation rate of unemployment. Life-cycle consumers choose the desired addition to the real stock of total wealth. The latter must be consistent with the demand for new capital by the firms, the demand for net (real) foreign assets by both firms and consumers, the (real) addition to the stock of government debt. Given the latter, relative prices (real interest rate, real exchange rate, real wage rate) are determined so as to achieve the required consistency. As consumers do not anticipate, in the computation of their life-time resources, the need for the government to satisfy a long-run solvency condition, the stock of government debt is perceived to be part of total wealth, and the Ricardian equivalence does not hold.

The intrinsic dynamics of the long-run equilibrium, deriving from wealth and capital accumulation, combines in the model with the dynamics coming from the short-run adjustment processes. The most important ones reflect the putty-clay nature of capital, the stickiness of prices and wages, the possibility that expectations differ from realised values, and the corresponding revision of both plans and expectations. As to expectations, the BIQM makes use, to a large extent, of survey data on actual expectations. This allows the estimation of the model to be carried out without any need for arbitrary assumptions on the expectation formation mechanism - as it would be the case with any regressive or extrapolative scheme or, for that matter, with rational expectations. In simulation and forecasting, however, the model can be solved either by using the estimated equations explaining the "observed" expectations or by imposing some simpler filtering of past observations. It is also possible to solve the model assuming, locally, rational expectations (or, more accurately, model consistent expectations). As will be explained below, this is so, in particular, for the exchange rate, where an uncovered interest parity condition (UIP) is assumed. In the case of exchange rates, unfortunately, the work needed in order to use the actual data on expectations is not completed, and it is not yet possible to contrast the results presented in the paper with those that would be obtained with an estimated expectation formation mechanism.

III. THE MONETARY BLOCK OF BIQM AND THE FINANCIAL STRUCTURE

The basic structure of the monetary and financial block of the BIQM is similar to the one described in Banca d'Italia (1986) and summarised in Galli, Terlizzese and Visco (1989a, 1989b). The block generates, for given financial balance of the private sector - determined, as explained above, by consumption and investment choices - the gross flows of assets and liabilities and their allocation.

The flow of credit to the private sector plays a central role. The demand for domestic credit by the private sector is influenced by its borrowing requirement, the borrowing costs, the return on financial assets and the cost of foreign funds. The demand for credit is modelled as a portfolio balance scheme according to which firms finance the shortage of funds by recourse to credit or by the sales of assets. Funds loaned to the private sector combine with credit flows to the public sector to determine, along with the balance of payment, the overall expansion of gross financial wealth. The allocation of the latter is modelled along the lines of portfolio models as well; however, monetary assets are prior claims relative to other financial decisions and are determined in relation to transaction variables (consumption; GDP). Interest rates influence directly portfolio choices, for a given level of financial wealth; they also indirectly influence overall credit flows and financial assets expansion through their effects on real spending decisions.

With respect to the basic structure described above, the BIQM also embodies the reforms that have taken place since 1986 in both the conduct of monetary policy and the functioning of credit and financial markets.[2]

The model includes a money market section; through open market operations the central bank controls the overnight rate, which, in the BIQM, is assumed to be the instrument of monetary policy. The overnight rate influences, in turn, the conditions in the interbank market. The three-month interbank rate determines Treasury bill yields according to their different maturities; it also influences the corresponding Euro-lira yield through a simple arbitrage equation; together with foreign interest rates, the euro-rate sets the exchange rate through an uncovered interest rate relation.

Along the lines suggested in Modigliani-Shiller (1973) and following the methodology in the MPS econometric model, the block contains term structure equations linking the return on fixed income long-term Treasury bonds[3] to the three-month Treasury bill rate. The theoretical foundation of the yield curve equation is the preferred habitat theory, according to which longer-term interest rates are set in relation to both future expectations of real interest and inflation rates, with volatility on financial markets and relative asset supplies influencing the term premium.

Commercial banks face a downward sloping demand for loans and set the loan rate so as to maximise profits. The rate on commercial loans is determined in relation to a weighted average of the yields on Treasury bills and Treasury bonds; the spread between the loan rate and the rates on Treasury securities depends negatively on the degree of liquidity of banks' balance sheets, calculated by appropriately weighting their components - the weights gradually declining from 1 for excess reserves to small values for long-term assets. It is this "liquidity" variable that allows credit conditions to influence the monetary mechanism and determines interactions between the financial and real blocks of the BIQM.

Deposit rates are set by banks as a mark-down on the average return of their assets, to preserve adequate profit margins. Due to reserve obligations remunerated at below market interest rates, increases in market interest rates tend to have a positive effect on the spread between the rate on bonds and that on deposits.

1. The channels of transmission

The monetary policy transmission mechanism in the BIQM is based on stock-flow interactions in response to changes in relative prices of goods and financial assets, to achieve desired

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2 Monetary policy now operates through market oriented procedures; the Bank of Italy sets official interest rates and establishes a penalty rate on refinancing which, in normal circumstances, is a ceiling for interbank interest rates. On the Government securities market, a fundamental step was the abolition of the floor price for Treasury bill auctions in 1988 and 1989. In 1988 the reform of the secondary market for longer-term Treasury securities increased their liquidity. Further steps in this direction enhanced the integration among financial markets, creating closer links among interest rates. Through the term structure of interest rates, monetary impulses have become more rapid in influencing decisions by operators. With regard to external flows, up to 1986 they reflected tight controls on capital movements. In 1988, long-term capital movements were liberalised; two years later impediments to monetary transactions were lifted: there is now full international integration of monetary and financial markets.

3 It should be noted that this rate is not a constant maturity rate but it is constructed as a weighted average of one to ten years maturity Treasury bonds quoted in the stock market. Its average maturity therefore changes over time; it declines from five to two years during the 1970s, it fluctuates around two years during the 1980s and increases sharply to five years more recently. It has not been possible to use a longer-term fixed maturity rate, as it is only since the opening of the screen-based secondary market in 1988 that data on constant maturity medium-term bonds are available.

stock positions. A rise in financial rates alters the desired balance between real and financial assets of the economic agents; the rise, in addition, modifies the flow of payments among the different sectors of the economy.

For the sake of the exposition, the effects of a change in the stance of monetary policy might be divided in two steps: (1) the effects on market interest rates and on exchange rates; (2) the effects of the latter on the components of aggregate demand, on inflation and on employment. The changes in these macroeconomic variables, in turn, feed back into the financial system, affecting the quantities, such as money and credit. As pointed out above, changes in the composition of balance sheets may exert second round effects on interest rates, thus setting the stage for interactions between the real and financial blocks of the model.

If securities and loans were perfect substitutes, then the bond rate and the loan rate would move by the same amount; the first step in the transmission of monetary policy could then be gauged indifferently by looking at either rate. If, on the contrary, loans and bonds were imperfect substitutes, it would be necessary, in order to analyse the effects of monetary policy, to make explicit reference to the overall cost of financing.

The latter is the case in the BIQM. As mentioned above, the determination of the loan - Treasury bond spread depends on a "liquidity" variable. The statistical significance of this variable in the loan rate equation suggests imperfect substitutability of securities and loans in banks' portfolios, the condition for a "credit channel" to be active.[4] The reallocation of banks' assets in favour of loans that took place at the end of the 1980s has reinforced this channel in the Italian case. As stressed in Buttiglione and Ferri (1993), the considerable amount of securities held by banks in the past, acting as "secondary" liquidity, cushioned the price of loans from restrictive policies, thus limiting the effectiveness of central bank actions. At present, with a more balanced composition of banks' assets, the ability of the central bank to influence the loan rate is enhanced. However, the issue is still unresolved of whether the banking system's setting of the loan rates reinforces or cushions the monetary impulses. This issue will be touched upon later (Section V.1).

The mechanisms through which interest rates affect aggregate demand - the second step in the transmission mechanism - can be, somewhat arbitrarily, grouped into transmission channels. Remembering that, apart from administrative constraints on the supply of funds, in the model there is no direct effect of quantities of money and credit on spending and inflation, four main transmission channels can be distinguished: cost of capital, wealth, income and exchange rate channels.

Underlying the working of all these channels is the slow adjustment of prices, whereby a rise in the nominal interest rate results, for an extended period of time, in a rise of the real rate.

The increase in real interest rates has a negative effect on the accumulation of capital. In the tradition of Jorgenson and Bishoff, in the BIQM the higher interest rate raises the real cost of capital, reducing the optimal capital-output ratio and thus investment. A similar mechanism, although somewhat simplified, operates for investment in housing and in structures, and for inventories accumulation. Durable consumption too is negatively influenced by higher interest rates that increase the rental cost of durable goods.

An increase in interest rates has negative wealth effects since it reduces the discounted present value of the expected future income streams and therefore consumption expenditure. It also induces substitution of future for present consumption. Indeed, the BIQM does not make a clear distinction between wealth and substitution effects, as it lacks a satisfactory endogenisation of the asset prices. This in turn is the consequence of a relatively thin stock market, which makes data on

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4 In this paper, by credit channel it is meant the mechanism that operates through the setting of loan rates, as in Bernanke and Blinder (1988). The effects of monetary policy due to endogenous rationing by banks or to credit ceilings are not taken into account. It is worth noticing, however, that the latter were an important instrument of monetary policy until the mid-1980s and are accordingly considered in the estimation of the model.

stock prices highly volatile and scarcely representative of the impact of changes in interest rates on the value of wealth.

A rise in interest rate increases disposable income of those spending units with a positive financial balance; the effects are stronger the higher the share of short-term and floating rate securities in assets portfolios. The cash-flow channel is therefore strictly linked to the financial structure of the economy. It might also be influenced by differences in the propensity to spend of the different sectors. A change in interest payments among sectors will have effects on expenditure if net debtors and net asset holders have different propensity to spend. An extreme example of this is when the higher interest payments to the private sector (with a propensity to spend less than one) is compensated by a cut in the purchase of goods by the public sector (with, by definition, a unitary propensity to spend; see Section V.2).

In most models of exchange rate determination, a rise in domestic interest rates appreciates the currency. A stronger currency has widespread effects on the economy both on the real and on the financial sides. For given domestic demand, it causes a drop in net exports. Taking into account multiplier effects on imports and non-price competitiveness on exports, the initial negative effect would be partially offset. The rise in the exchange rate affects final demand prices directly, via a fall in import prices. Indirectly, lower inflationary pressures come from the loss of competitiveness, following the exchange rate appreciation. Also, the contraction of aggregate demand lowers the mark-up charged by firms.

The effects on quantities and prices feed back into the financial block, influencing financial aggregates, such as money and credit, and modifying the balance sheets of the different sectors. In turn, the composition of the balance sheets is an important determinant of the effectiveness of monetary policy. It is thus important to highlight some of the features of the Italian financial structure, even if not all of them are presently reflected in the BIQM.

2. Some features of the Italian financial structure

The monetary policy transmission mechanism is influenced by the dimension and composition of total wealth. Several indicators, such as the financial interrelations ratio (FIR, calculated as the ratio of total financial wealth to real wealth), show that the financial deepening of the Italian economy, though greatly increased since the beginning of the 1980s, is still low when compared with the other major industrial countries: in Italy the FIR was 0.9 in 1992, with ratios well above 1 in Germany, France and Japan and close to 2 in the United States and the United Kingdom (see Fazio, 1994).

With reference to financial wealth only, the effects of monetary policy on the economy are influenced by the net position of the spending units; by the maturity distribution of assets and liabilities; by their composition between floating and fixed instruments. Table 1 gives a broad picture of these features. It shows, for selected years, total financial assets of the private sector and their counterparts. The ratio of financial assets to GDP has risen from 100% in 1980 to 164% in 1993; the corresponding ratio for net financial assets has increased, over the same period, from 41% to 90%. An important development has been the growth of medium and long-term securities (in particular, government bonds), which increased from 8% of total assets in 1980 to 33% in 1993; over the same period, the share of liquid instruments on total financial assets has fallen from 92% to 62%.

Table 1

Financial assets of the non-state sector[1] and counterparts

(stocks in trillions of Italian lire)

	Financial assets								
	1980			1985			1993		
	Stocks	% share	% GDP	Stocks	% share	% GDP	Stocks	% share	% GDP
Liquid assets	356.3	91.7	91.9	719.6	76.6	88.8	1,589.2	62.1	101.9
of which: M_2	*290.1*	*74.7*	*74.8*	*529.6*	*56.3*	*65.3*	*986.3*	*38.5*	*63.2*
Medium and long-term securities	31.2	8.0	8.0	211.8	22.5	26.1	834.4	32.6	53.6
Domestic financial assets	387.5	99.7	100.0	931.4	99.1	114.9	2,423.6	94.7	155.3
Foreign financial assets[2]	0.9	0.3	0.2	8.3	0.9	1.0	136.0	5.3	8.7
Total financial assets	388.5	100.0	100.2	939.7	100.0	115.9	2,559.7	100.0	164.1
	Counterparts								
	1980			**1985**			**1993**		
	Stocks	**% share**	**% GDP**	**Stocks**	**% share**	**% GDP**	**Stocks**	**% share**	**% GDP**
Credit to the non-state sector	227.9	51.7	58.8	461.5	41.2	56.9	1,161.9	39.6	74.5
of which:									
Domestic	*209.9*	*47.7*	*54.1*	*406.1*	*36.3*	*50.1*	*1,037.6*	*35.4*	*66.5*
[from "short-term" banks]	*129.9*	*29.5*	*33.5*	*251.5*	*22.5*	*31.0*	*638.3*	*21.8*	*40.9*
Net position	160.6	-	41.4	478.2	-	59.0	1,397.8	-	89.6
Credit to the state sector	212.6	48.3	54.8	657.4	58.8	81.1	1,769.2	60.4	113.4
of which: Domestic	*207.5*	*47.1*	*53.5*	*635.6*	*56.8*	*78.4*	*1,526.5*	*52.1*	*97.8*
Total credit	440.5	100.0	113.6	1,118.9	100.0	138.0	2,931.1	100.0	187.9
of which: Domestic	*417.4*	*94.8*	*107.7*	*1,041.7*	*93.1*	*128.5*	*2,564.1*	*87.5*	*164.3*

[1] The non-state sector includes: households, firms, insurance companies and local government. [2] Estimates.

However, the reallocation of financial wealth in favour of longer-term securities has only partly reduced the actual degree of liquidity of financial portfolios; indeed, a significant part of the increase in medium and long-term securities was due to floating rate securities. The main counterpart to these developments has been the growth of credit to the state sector, which increased from 55% of GDP in 1980 to 113% in 1993; over the same period, its share in total debt increased from 48% to 60%.

A more in-depth picture of the financial structure in Italy is offered by the financial accounts of households and firms taken separately (Table 2).

Table 2

Indicators of financial structure in Italy

	Domestic financial assets		Domestic financial liabilities		Net financial assets	
	Total	*of which: Short-term*	Total	*of which: Short-term*	Total	*of which: Short-term*
	Households (stocks as a percentage of disposable income)					
1989	155.10	*98.99*	12.55	*2.90*	142.55	*96.09*
1990	158.92	*100.86*	13.26	*2.86*	145.66	*98.00*
1991	162.42	*100.48*	13.85	*2.85*	148.58	*97.63*
1992	166.98	*103.88*	14.33	*3.01*	152.65	*100.88*
1993	185.09	*107.78*	15.16	*2.95*	169.93	*104.83*
	Firms (stocks as a percentage of value added)					
1989	55.41	*20.52*	78.88	*38.42*	- 23.47	*- 17.90*
1990	58.65	*19.49*	84.50	*42.04*	- 25.85	*- 22.55*
1991	61.07	*19.02*	87.57	*43.07*	- 26.50	*- 24.04*
1992	59.27	*18.64*	92.82	*46.10*	- 33.55	*- 27.47*
1993	62.11	*18.77*	94.51	*44.51*	- 32.39	*- 25.74*

Coherently with the data presented above, Italian households show a high net financial position, which amounted to 170% of disposable income in 1993 (143% in 1989). As gross financial assets in 1993 were equal to 185% of disposable income (155% at the end of the 1980s), domestic debt of households amounted to only 15% of disposable income. A relevant share of the positive financial position of households is short-term.

Firms have a negative net financial position, equal to 32% of value added in 1993 (an increase of almost ten points since 1989). As stressed in Fazio (1994), this ratio is not grossly at variance with that prevailing in the major countries. Gross debt increased to 95% of value added in 1993, from 79% in 1989; financial assets of firms increased significantly over the period (even though at a lower pace than liabilities): from 55% of value added in 1989 to 62% in 1993.

Since the late 1980s, the increasing net indebtedness of firms, coupled with higher interest rates, has determined larger net interest outlays of firms, which peaked at 8% of value added in 1992 (Table 3); in that year, the financial deficit of firms reached a maximum of almost 9% of value added. On the contrary, net interest accruing to households constitutes a significant and rising portion of their disposable income.

This broad picture of the Italian financial structure suggests that the large net positive financial position of households, along with its significant share of short-term[5] and variable rate instruments, determines strong positive cash-flow effects, which tend to alleviate the restrictive effects

5 It should be recalled, however, that the share of fixed rate medium and long-term Treasury securities has increased in the last years.

of monetary policy imparted to the economy through the other channels. Since Italian firms, on the contrary, have a debtor position which is mostly of short-term maturity, the cash-flow channel reinforces the negative effects on investment operating through the traditional cost of capital channel.

Table 3

Financial balances and income gearing

	1985-87	1988-93	1992	1993
	Firms (percentage of value added)			
Interest outlays (net)	5.90	6.71	7.89	7.33
Financial balance (- deficit; + surplus)	- 2.53	- 5.53	- 8.75	- 2.47
	Households (percentage of disposable income)			
Interest receipts (net)	8.52	10.66	11.79	12.49
Financial balance (- deficit; + surplus)	-	15.37*	11.68	16.20

* 1990-93.

IV. THE SIMULATION DESIGN

The standardised monetary policy intervention that is required by the BIS research project protocol consists of an increase of one hundred basis points of the policy controlled interest rate, sustained for two years. After that, the controlled interest rate goes back to its baseline values. The simulation experiment was carried out under the following three alternative assumptions:

(i) the lira exchange rate is held fixed at its baseline values. Implicitly, this corresponds to a coordinated rise of the interest rates in the major OECD countries;

(ii) the lira exchange rate is endogenised through an UIP, with model consistent expectations;

(iii) the lira exchange rate vis-à-vis the ERM countries is held fixed at the baseline values, whereas it follows a pre-set time path - agreed upon with the BIS - for the other countries. It is worth noting that, to keep a sizable effect on the effective exchange rate, the United Kingdom has been included among the non-ERM countries.

In addition, a few alternative versions of these experiments were performed, to acquire a feeling of the robustness of the results.

No explicit fiscal rule has been assumed in the exercise. Most public expenditures have been kept fixed at baseline values in real terms. However, an exercise has been run wherein the higher flow of interest payments has been compensated by an equivalent variation in an appropriate item of the public sector accounts.

As to the choice of the policy controlled interest rate, the assumed monetary policy instrument is the overnight rate, which moves in line with the officially administered rates. In the exercise, both the overnight rate and the discount rate have been increased by the same amount.

The mechanism through which the exchange rate is endogenised is based on an uncovered interest parity relation, with exogenous risk premium and rational expectations. Following the rise in the interest rate, the exchange rate appreciates by an amount that depends on the cumulated increase in the domestic interest rate and on the chosen terminal condition, and it depreciates afterwards, to guarantee that the arbitrage condition holds in every period. If the temporary increase of the interest rate is assumed to be the consequence of a temporary rise in the level of money supply, then no variable of the BIQM is affected in the long run. It is thus appropriate to choose, as the terminal condition, the level of the exchange rate in the baseline at the end of the simulation period (i.e., the first quarter of the year 2001). It must be acknowledged that the expectation formation mechanism underlying the term structure of interest rates - though in principle akin to the one assumed for the UIP - is modelled as a backward looking filter.

Concerning the exchange rate endogenisation, a specific word of caveat is in order. The limited availability of data relative to the floating of the lira, coupled with the widespread difficulties in obtaining a satisfactory and widely agreed upon explanation of the exchange rate determination - both at the theoretical and at the empirical level - call for extreme caution in interpreting the results of the experiments as representative of the likely response of the exchange rate to the monetary policy shock. It is perhaps better to interpret these experiments as providing the building blocks for a better understanding - as well as for an empirical assessment - of the effects of the monetary policy. Unfortunately, a realistic assembly of those building blocks is not yet available.

The effects of monetary policy on the economy are analysed as deviations from baseline values over a seven-year period spanning from 1994.Q1 to 2000.Q4. The baseline incorporates the projections completed at the Bank of Italy in the month of September 1994, with assumptions regarding international variables (other than interest rates) based on the IMF/OECD forecasts available at that time.

V. THE RESULTS

Table 4 presents the main assumptions concerning the exogenous variables in the baseline. In Tables I and II the effects of the monetary shock are presented, differentiating on the basis of the three assumptions concerning the exchange rate. In Table III the relative importance of the main transmission channels is quantified, together with the contribution of the demand components to the deviations of GDP from the baseline.

1. From policy to market interest rates

The effects of the policy interest rate rise on market rates are not significantly different according to the three alternative assumptions concerning the exchange rate. As a consequence, it is simpler to present first the results regarding what was referred to as the first step of the transmission mechanism - from policy to market interest rates.

Table 4

Baseline values of selected exogenous variables

	1993	1994	1995	1996	1997	1998	1999	2000
1. Foreign interest rates (%)								
Euro-dollar three-month interest rate	3.2	4.1	5.0	5.5	6.0	6.3	6.3	6.3
Euro-Deutsche Mark three-month interest rate	7.3	5.5	5.0	5.5	6.0	6.0	6.0	6.0
2. Oil prices and other commodity prices								
Import of energy deflator, in dollars	- 10.6	- 1.3	3.5	2.1	2.1	2.1	2.0	2.0
Imports of agricultural products deflator, in dollars	- 10.4	11.3	1.6	2.0	2.0	2.0	2.0	2.0
Imports of non-agricultural commodities deflator, in dollars	- 13.7	1.9	1.8	4.0	4.0	4.0	4.0	4.0
3. Foreign prices								
Price of manufactured goods of 14 of Italy's competitors in national currencies; export weighted average	- 0.9	1.6	1.8	1.8	1.8	1.8	2.0	2.0
Price of manufactured goods of 14 of Italy's competitors in national currencies; import weighted average	- 1.1	2.3	2.0	2.0	2.0	2.0	2.0	2.0
4. Foreign output								
GDP of OECD countries	1.3	2.6	2.7	2.9	2.9	3.0	3.0	3.0
5. World trade								
World trade	3.7	6.8	6.3	6.3	6.3	6.3	6.0	6.0

Note: All variables except those in subject 1 are expressed in percentage changes from previous year. All baseline values are based on IMF forecasts, except for GDP of OECD countries, which is based on OECD forecasts.

In the first year following the policy shock, the rise in the three-month Treasury bill rate is less than unity (about 0.8 percentage points); only in the second year the rise is of the same magnitude as the policy rate increase. The surge in the Treasury bond rate is smaller than the one in the shorter maturity bond: 0.6 - 0.7 in the first year; 0.8 - 0.9 in the second. In the third year the Treasury bill rate is still 0.2 percentage points above the baseline values, which are attained in the fourth year; the Treasury bond yield goes back to the baseline at a slightly slower pace.

The limited scope for the policy intervention to influence the steepness of the yield curve reflects the characteristics of the "long-term" Treasury bond, which refers to a composite security with variable maturity (see footnote 3). The maturity has been relatively short over a significant part of the estimation period, so that monetary policy in the past was only able to induce parallel shifts of the yield curve. Although this might be perceived as a signal of strength of monetary policy, it might in fact have been detrimental in those circumstances when the central bank aimed at influencing only the shorter end of the yield curve, to avoid undesirable effects on aggregate demand and employment (for instance, in the presence of pressures on the exchange rate). Recent developments in financial markets have likely changed the relation between short and long-term rates; however, the relatively short period of time and the turbulence on financial markets since the floating of the lira do not allow to pin down the new relation in econometric estimates.

A less controversial picture of the effectiveness of monetary policy emerges with regard to the determination of banks' interest rates. In the simulation exercise, the loan rate increases by about sixty basis points in the first year and ninety in the second, thus showing a response similar to that of the rate on Treasury bonds. A less prompt response would be observed in the first year had the discount rate been left unchanged (only thirty-three basis points). While this result points to the absence of a powerful credit channel - in force when the loan rate rises more than the security rate - it also shows that the monetary policy effectiveness is not cushioned by banks' behaviour. In addition, preliminary estimates provide evidence that the response of banks' interest rates to policy shocks has become stronger and more rapid, due to the reforms of money markets and the changes in the composition of banks' assets (see also Ferri and Buttiglione, 1993).

Following the rise in the policy rate, the deposit rate rises by less than either the security or the loan rate. This result points to two related aspects of the financial structure in Italy: firstly, due partly to the presence of relatively high reserve requirements, banks do not fully translate the rise in Treasury security rates, thus accepting a loss in the volume of their intermediation; secondly, in the short run banks increase interest margins.

2. From market interest rates to the macroeconomy

The impact of the changes in market interest rates on the macroeconomic variables varies according to the different scenarios regarding the response of the exchange rate. The analysis of the results is accordingly organised below. Except when specifically mentioned otherwise, the results are given as percentage deviations from baseline values.

Exchange rates at the baseline

The drop in GDP, in the first year of the experiment, is very small (Table II.1). In the face of a sizable shock (100 basis points), GDP falls by just one tenth of a percentage point. The drop is indeed larger for domestic demand (0.2%). The openness of the Italian economy is thus reflected in a fairly large leakage of the original impulse: in particular, imports fall by almost 0.3%, and net exports, as a percentage of GDP, rise by 0.1%.

The monetary tightening shows up most clearly on investments, that fall by about half a percentage point. Capturing the relative unavailability of long-term credit, the estimated equation makes investment to depend on short to intermediate maturity interest rates, that react more quickly to the policy controlled interest rate. In principle, investment is also affected, in the short run, by a cash-flow variable, which should fall as the financial burden rises. However, due to data problems, the effects of an exchange rate change on the measure of the financial burden used in the BIQM are somewhat unreliable; for this reason, its effects on investment have been sterilised in the experiments with endogenous exchange rate, as well as, for the sake of comparability, in the present experiment. Had the cash-flow been fully endogenous, the fall in investment would have been only slightly higher (0.6%).

Consumption expenditure falls by 0.15%. Disposable income, however, shrinks by a much smaller amount and, moreover, the response of consumption to changes in disposable income is estimated to be rather slow, with very little effect in the first year. The fall in consumption, therefore, is mostly the result of wealth/substitution effects.

Prices are virtually unaffected, as there is no direct link in the BIQM from monetary policy to prices, aside from exchange rate changes. Prices, as explained above, are set to slowly adjust to a mark-up over (minimum) average costs. Given the Cobb-Douglas assumption, the latter can in turn be expressed solely as a function of unit labour costs, where the productivity term is a long distributed lag of past productivities, due to the putty-clay nature of capital. Therefore, even relatively large changes in the current productivity would only marginally affect the unit labour costs relevant for price setting behaviour, that would therefore mainly reflect, in the short run, changes in the nominal wages. On the other hand, employment (and the unemployment rate) changes very little, (both as a consequence of labour hoarding and of the very slow adjustment towards its equilibrium level) so that the change in wages is also small. It is worth noting, mainly for future reference, that the non-malleable nature of capital implies that current changes in the relative factor prices show up with very long delays. Thus, a current rise of the optimal labour-output ratio, due to the increase in the interest rate and in the rental cost of capital, would keep employment higher, *ceteris paribus*, for a very long period of time, resulting in lower productivity and higher unit labour costs.

The change in the public sector borrowing requirement (PSBR) is driven by the increase in the flow of interest payments, as current expenditures are mostly kept at the baseline (in real terms). There is a slight increase in the revenues coming from the withholding tax on interest payments (both on deposits and on government securities). Due to the average maturity of the debt (slightly more than three years), the gross flow of interest payments rises by only one-quarter of the full impact of the interest rate increase.

The trade balance improves, although marginally, mostly as a result of the reduced absorption. The current account, however, worsens as Italy is in a debtor position and the rise in domestic interest rates raises the financial burden of the debt.

In the second year of the experiment, the effects of the policy tightening are compounded with those coming from multiplier/accelerator mechanisms, but the overall picture, the composition of the effects and the mechanisms at work are not significantly different from those identified in the first year. The drop in GDP reaches 0.3%, resulting from a more pronounced fall of the domestic demand components (0.6) and a sizable leakage from net exports, that, as a percentage of GDP, rise by 0.3.

The monetary shock has a very sharp effect on capital accumulation: investments fall by 1.5%, with a drop of 1.9% for the non-residential component. Of the total effect, only 40% is due to the accelerator mechanism. Much of the rest is attributable to the slow unfolding of the change of the relative factor prices. In the simulation in which the increased interest payments are allowed to affect - via cash-flow effects - the investment decisions, the drop in the accumulation is only slightly higher (1.6%).

Private consumption also falls by considerably more than in the first year (0.35%). This reflects the fuller response of both the long-term Treasury bond to the policy controlled interest rate and the lagged effect of the drop in disposable income. The current disposable income, however, is already above its baseline values, reflecting the higher interest payments from the public sector received by the private sector.

The impact on prices is still very small, less than one-tenth of a percentage point, coming from a reduction in wages that, although small, is not yet offset by the reduction in productivity. Indeed, current unit labour costs - as opposed to the labour costs computed with trend productivity - increase.

As to the PSBR, the main effect comes, as in the first year, from the increased flow of interest payments, which rises by about a half of the percentage increase in the short-term Treasury bill rate. The rise in expenditure, as a percentage of GDP, is a consequence of the automatic stabilisers, mainly unemployment benefits, triggered by the drop in the level of activity.

The current account improves, differently from what observed in the first year, as the lower growth of the economy is large enough to bring about an improvement in the trade balance that more than offsets the larger flow of interest payments.

In the third year of the experiment the monetary tightening comes to an end, as nominal interest rates start adjusting back to their baseline levels. The same reversion is observed in the main macroeconomic aggregates. Although GDP is still below the baseline, its rate of growth is higher and the shortfall from the base is reduced to 0.24.

This reflects, essentially, the behaviour of private consumption. The increase of the disposable income, resulting from the higher flow of interest payments, is both larger and in place since a longer period, pushing consumption expenditures upwards. In the same direction operates the reduction of the interest rate, directly affecting consumption via the wealth/substitution channel. As a result, consumption reduces its gap from the base to 0.12%, becoming larger than in the baseline in the following years.

The growth of investment, on the other hand, is still below that of the baseline, as the (delivery and production) lags implied by the putty-clay assumption make the effect of the initial rise in interest rates long lived. However, from the following year even investment starts going back to the baseline values, though with an oscillatory motion.

The latter is indeed common to most variables in the model. It is not easy to identify its causes, given the complex dynamic interactions that take place in the BIQM. One source of oscillatory motion, though, comes from the interaction of the price setting and the wage-setting behaviours.[6] In particular, it can be noted that prices overshoot the baseline values, as the lower productivity and the higher unit labour costs eventually start dominating. Simulating the model for a longer period would show that this tendency is eventually reversed, only to start new oscillations. The latter, however, are dampened, and the model eventually settles down.

Concerning financial aggregates, the rise in the spread between the rate on Treasury bills and that on deposits, along with the fall in demand and prices, determines a reduction of the money stock M_2; the fall is higher than that in prices, thus determining, in the short run, a reduction in real money balances. Total domestic debt is subject to two opposite influences. Credit to the non-state sector is crowded out by both the rise in interest rates and the lower pace of investment; the shortfall reaches half a percentage point in the second year. Credit to the state sector, on the contrary, is positively influenced by the higher interest bill, in the absence of compensating measures on the primary balance (compare this outcome with the results of a "balanced budget" increase of the interest rate presented in the section below). Overall, the latter effects prevail.

Exchange rate at the baseline, contemporaneous rise of foreign interest rates

The exchange rate assumption underlying the experiment discussed above can be rationalised as resulting from a coordinated increase of domestic and foreign interest rates. However, the rise of foreign interest rates would have reduced the comparability with the companion experiment in which the exchange rate is allowed to vary (and no similar increase in foreign interest rates is required). In particular, the different assumption on foreign interest rates would have implied a larger discrepancy when the total effect of monetary policy is decomposed into transmission channels (see Section VI.1 below). For the sake of realism and as a sensitivity exercise, the simulation where both domestic and foreign interest rates are raised has nevertheless been performed. The results are not markedly different from those obtained with the previous exercise. Essentially, the transmission of the monetary impulse would be faster, both when the policy rate is increased and when it is brought back to the baseline values. As a result, the observed response of the macro variables would be initially slightly stronger, and the reversion to the baseline would set in more quickly.

Flexible exchange rate

This experiment, while sharing in broad terms much of the qualitative features of the ones commented above, shows more pronounced deviations from the baseline, due to the non-negligible reaction of the wage-price sector of the economy to the exchange rate changes (an initial appreciation followed by the depreciation needed to meet the terminal condition).

In the first year, GDP falls by 0.32% (Table II.2). The loss of competitiveness following the initial appreciation of the exchange rate reduces exports (- 0.24%) and partly offsets the fall in

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6 A comparable simulation in which both wages and prices are kept at their baseline levels shows a much smaller oscillatory behaviour.

imports due to the lower absorption. As a result, net exports, as a percentage of GDP, are only marginally different from the baseline and, contrary to the first experiment, the foreign leakage of the initial restrictive impulse of monetary policy is almost negligible.

Private investment drops by slightly more than one percentage point. Compared with the first experiment, the larger response is the result of three different effects. It is in part due to the smaller leakage, which in turn triggers a stronger accelerator effect. It is also due to the larger fall in the real interest rate, induced by the contractionary effects on inflation of the exchange rate appreciation. Indeed, it must be noted that the user cost of capital, which is computed using slowly adjusting inflationary expectations and involves the price of the new investment, actually rises above the baseline by an amount slightly smaller than that observed in the first experiment. However, the optimal capital-output ratio, which governs investment decisions, falls by more, reflecting the larger fall of the price of the competing factor, the wage rate. Finally, the investment behaviour is also explained by a larger fall in the cash-flow variable affecting, in the short run, the capital accumulation decisions. In turn, the reduction of the cash-flow follows from the loss of competitiveness, that exerts a downward pressure on mark-up decisions and therefore on profits. It is worth remembering that the cash-flow effect is computed under the simplifying assumption that the service of the financial debt does not change from its baseline values. If this assumption were removed, the cash-flow would change as a result of two effects, partly offsetting: the rise in interest rate would increase the interest payments of firms, thus lowering the cash-flow; the (initial) appreciation of the exchange rate would reduce the Lira value of both the stock and the service of the foreign currency denominated debt (in the following years of the exercise, with the exchange rate depreciating, the two factors would work in the same direction). The net effect of these changes on private investment would be negligible.

The response of private consumption to the policy shock is almost the same as in the first experiment (- 0.13%). It results, however, from two factors working in opposite directions. On the one hand, the larger increase in the real interest rate exerts a stronger negative effect on consumption expenditures; on the other hand, the larger drop in the price level boosts the real value of the disposable income - via capital gains on the nominally fixed components of financial wealth - and pushes consumption up.

The price response to the monetary tightening and to the induced appreciation of the exchange rate is the consequence of a direct impact on final prices of the import prices, of the (above mentioned) downward pressure of the exchange rate appreciation on the mark-up decisions, and of the price-wage spiral. It is worth mentioning that the BIQM takes into account the pricing-to-market behaviour of foreign competitors faced with a lira appreciation or depreciation. In particular, the estimated equation attributes to the foreign currency price of Italian imports a short-run elasticity with respect to the effective lira exchange rate of about - 0.5 (the long-run elasticity is zero, that is, the pass through is complete).[7] In this setting, the initial appreciation of the effective exchange rate (1.7%) yields a slightly smaller fall in the price of imports (1.4%), a reduction in the unit margins of the domestic producers (0.4%), and a drop of consumer prices by 0.48%. The wage rate falls by 0.36%, as the lower inflation gets reflected in the wage earners' claims. As in the first experiment, the changes in the PSBR are mostly driven by the change in interest payments. Indeed, the larger fall in the nominal level of activity produces a reduction both of the revenues and of the (endogenous part of the) expenditures. In percentage deviation from the baseline, both revenues and expenditures fall by about 0.3% - they both rise, however, as a percentage of nominal GDP, the former as a consequence of disproportionate increase of the withholding tax on interest payments, the latter reflecting the automatic stabiliser nature of most expenditures. The percentage change of the flow of interest payments is essentially the same as that observed in the first experiment.

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7 Moreover, the competitiveness measure affecting the pricing decisions of the domestic producers takes into account the foreign competitors' reaction mentioned above. The estimated effect is however asymmetric, with fiercer foreign competitiveness on the domestic market being more effective in keeping low the unit margins of domestic producers than laxer foreign competitiveness would be in making room for domestic unit margins increases.

In the second year of the experiment, the drop of GDP is quite sizable (0.53%). Even greater is the contraction of the domestic demand (0.72%), as net exports, as a percentage of GDP, rise by 0.2%. This is due, essentially, to a larger fall of the imports, that reflects in a disproportionate way the drop in investment. The latter is particularly acute (2.3%), even larger for the machinery component, where the drop is almost three percentage points. As already argued, investment decisions are affected by the increase of the interest rates in more than one way. Worth noting is the increase of the user cost of capital (4.2%) and the companion reduction of the optimal capital-output ratio (4.6%), which also reflects the reduction of the wage rate.

As in the first year, the fall in private consumption is very similar to that observed in the first experiment, even though it results from more pronounced changes, partly offsetting each other. It needs to be mentioned that the increase in (real) disposable income is particularly large (0.7%), and will determine a more rapid reversion of consumption expenditures to the values of the baseline, and indeed a larger overshooting, in the following years.

Prices keep falling, even though the exchange rate is on a devaluating path. Due to the estimated lags in pricing decisions, the GDP deflator shortfall from the base deepens to 0.64%, and the same is true for consumer prices. Wages fall by more (as they are also affected by the rise in the unemployment rate), notwithstanding the upward pressure arising from the reduction in the productivity of labour. This pressure will, eventually, drive prices above the level of the baseline - a result that in turn will be reversed, on the longer run, with converging oscillatory movements.

From the third year, when the policy controlled interest rate is back to its baseline value and the same can essentially be said for the nominal exchange rate, the differences between the two exercises narrow considerably. In particular, GDP follows a very similar path, returning to the baseline values with very persistent oscillatory movements.

In this exercise the fall in money and credit is more pronounced than the one obtained in the first experiment; this result follows basically from the sharper drop in prices. The money stock declines by 0.6% in the first year, reaching a maximum fall of 1.7% in the second year. The reduction in credit to the private sector is 0.5% in the first year, larger than the one observed in the first experiment, mainly as a result of the lower investment expenditure. This larger reduction brings about, differently from the previous experiment, a fall in total credit. In the following years the lower level of investment continues to exert a negative impact on the demand for credit by the private sector.

"Balanced budget" increase of the interest rate

The worsening of the PSBR resulting from the increase of the interest rate might conceivably trigger a counterbalancing increase in taxes or an equivalent reduction in expenditures. As a result, the positive impulse of the increase of the flow of interest payments on consumption expenditures would disappear, and a larger negative effect on GDP would be observed. The latter, however, is not independent from the choice of the counterbalancing item in the public sector accounts. To gauge these differences, two simulations have been performed. In the first, the increase in the flow of interest payments (due to the higher interest rates, netting out the effects of the resulting larger stock of debt) was offset with a reduction of government purchase of goods and services. In the second the balancing was obtained by raising direct taxes on households.

These experiments have been conducted neglecting the likely beneficial effects on interest and exchange rates - via a reduction of risk premia - due to the tighter control on the PSBR. Caution should therefore be exercised in drawing implications for policy choices.

The results of the two experiments are rather different, particularly in the first two to three years of the exercise.

In the first case - decrease in public consumption - the drop in GDP is fairly large: 0.61% in the first year, 1.34% in the second year; moreover, GDP is still almost one percentage point below the baseline after seven years. This reflects a standard "balanced budget" property of the model, whereby the propensity to spend out of disposable income is less than one, and therefore the (positive) impact on GDP of an increase in transfers (the interest payments) is smaller than the (negative) impact of a reduction in public consumption. As the flow of interest payments keeps being larger than its baseline values for a long period - due to the accumulated larger debt - the "balanced budget" effect keeps being operative and explains the higher persistence of the contractionary effect of the temporary tightening of the monetary policy. As compared with the experiment discussed in the previous section, the larger shortfall of GDP from the baseline is in turn responsible of greater multiplier/accelerator effects, and of a more pronounced increase of the unemployment rate, that drives the prices down by more. It is worth noting that lower prices (and lower inflation rates) exert a positive pressure on consumption, as they produce capital gains on the nominally fixed components of the financial wealth.

In the second case - increase of household taxes - the offsetting change does not impinge upon differences in the propensities to spend of different agents (indeed, the estimated propensity to consume out of the flow of interest payments on the public debt is slightly smaller than the propensity out of the other components of the disposable income, and a little bit of the Haavelmo effect is therefore still at work). The drop of GDP in the first year is nearly the same as that observed in the experiment commented in the previous section. This result was to be expected, as changes in the disposable income are estimated to affect consumption expenditures with a considerable lag. In the second year the effect is somewhat more apparent, and the fall of GDP reaches 0.66%. In the following years the shortfall from the baseline shrinks a bit, but it still amounts to almost half a percentage point by the year 2000.

ERM-coordinated response of the exchange rate

As discussed above, the BIS research protocol requires an experiment of "coordinated response of the exchange rate", mostly for comparability reasons. Indeed, the great uncertainty surrounding the exchange rate determination mechanisms and the widespread poor performance of models thereof suggest not to put too much emphasis on differences in the effectiveness of monetary policy and in its transmission channels that depend, in a crucial way, from (estimated or assumed) different responses of the exchange rate. Therefore, a common exchange rate path, aside from realism, would enhance the comparability across countries.

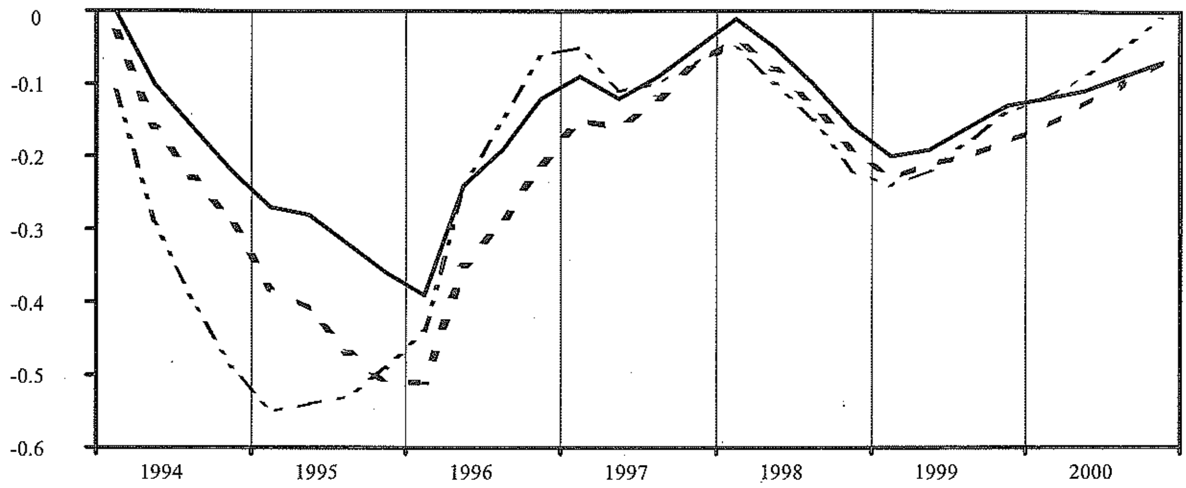
The pattern of response of the nominal exchange rate assumed for this exercise implies a gradual appreciation, taking place in the first two years - that is, as long as the interest rate is higher than in the baseline - followed by a depreciation that however does not quite bring the exchange rate back to its baseline level (at least not in the horizon considered for the exercise).

As the thrust of the exercise is on the comparison across countries, it is of little interest in the present paper to discuss in detail the response pattern of the main macroeconomic variables to the policy shock (see Table I.3); indeed, they are not different from the ones presented above. It is only worth mentioning that, to the extent that a gradual response of the exchange rate is considered more realistic - when compared with the two "extremes" of no-change and of continuous fulfilment of the no-arbitrage condition - the response pattern of the economy might acquire some independent interest. To this effect, we just mention that, as documented in Figure 1, the intermediate nature of the hypothesis on the exchange rate is mapped, by the BIQM simulation, into a roughly intermediate response of the macroeconomy.

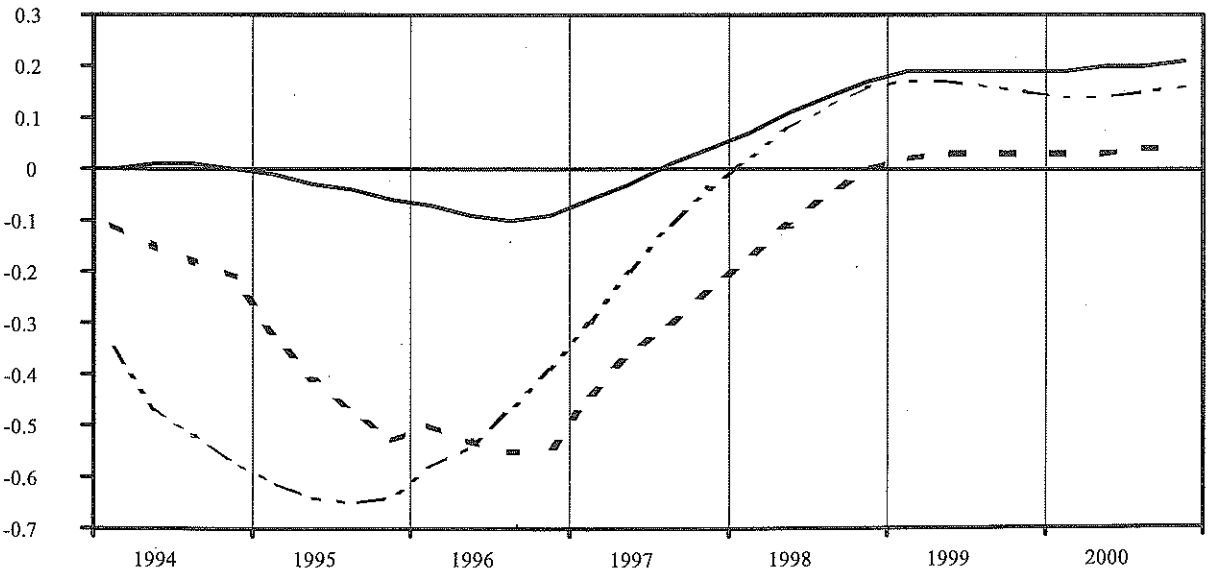
Figure 1

——— Exchange rate at baseline values
— · · — Fully endogenous exchange rate
- - - - - ERM coordinated

GDP
(percentage deviations from baseline)



Consumption prices
(percentage deviations from baseline)



VI. THE TRANSMISSION CHANNELS

The mechanisms through which the monetary policy change affects real GDP have been described in the previous section in some detail. A synthetic measure of those mechanisms can be obtained by explicitly grouping them into transmission channels and computing, by appropriately simulating the model (see the technical note by Mauskopf and Siviero, 1994), the contribution of each channel to the deviations of GDP from its baseline values. In addition, the overall contribution of each channel can be attributed to the changes in the different GDP components. This section is devoted to this aim.

The channels through which monetary policy affects the economy in the BIQM have been already defined (see Section III.1); however, in interpreting the results reported below some clarification is in order.

As already mentioned, the model does not permit a clear distinction between the wealth and the direct (substitution) interest rate effects on consumption. This is mostly due to the fact that only a small fraction (mainly long-term bonds) of total wealth is measured at market prices, so that in the specification of the demand for non-durables the explicit introduction of the interest rate is meant to capture not only the substitution effect but also the change in the value of net wealth that follows a change in interest rates. The wealth and substitution channels have therefore been collapsed into the single "direct effect of interest rate" channel.

The demand for durables is viewed as an investment decision on the part of households, so that changes in consumption of durables due to interest rate change are included in the cost of capital channel. By the same token, the effects of a change in interest rates on the demand for inventories are included in this channel.

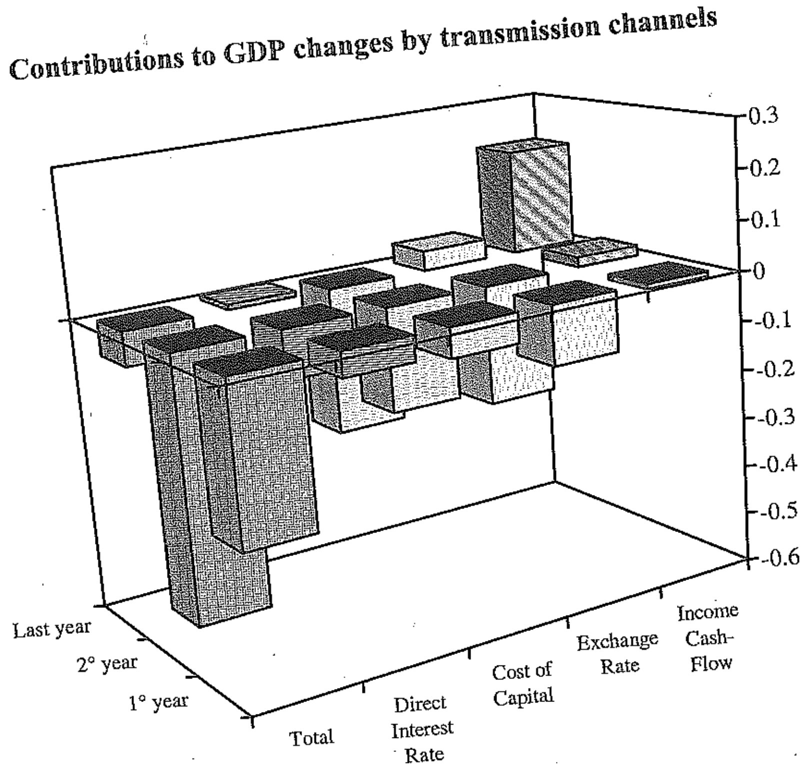
The income/cash flow channel includes changes in the streams of interest payments between the private sector on one side and the foreign and public sectors on the other. It does not include the change of interest payments from firms to the banking sector; however, as explained above, those interest payments have been kept exogenously fixed at their baseline values in the basic exercises.

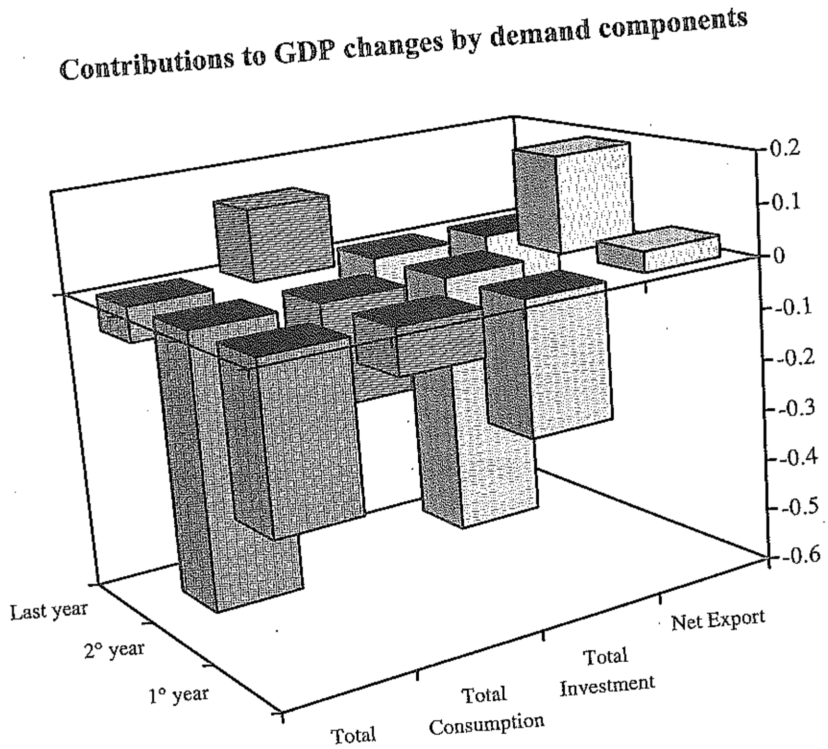
1. Quantifying the transmission channels

Table III presents the results of the decomposition of the overall effect of the monetary impulse. The sums by column indicate the contribution to the GDP changes of each channel - that is, the effect of activating that channel on every GDP component. The sums by row indicate the contribution to the GDP changes that is transmitted via each component of GDP - that is, when all channels are activated.

In the short run, the exchange rate channel is the most important one in determining the overall contractionary effect of monetary policy (Table III; Figure 2). In the first two years its contribution is - 0.21% and - 0.24%, respectively, corresponding to about two-thirds and one-half of the overall deviation of GDP from the baseline (respectively, - 0.32% and - 0.53%). The channel combines the effect of the loss in competitiveness (in the two years, out of the total contribution, to net exports can be attributed - 0.05% and - 0.07%) with the rise in real interest rates due to the fall in prices and the reduction in profits; both effects exert a negative influence on investment (contributing to the total drop of GDP by - 0.11% and - 0.17%, respectively). The contribution of the channel dies out from the third year, as the initial shock is reverted.

Figure 2


Contributions to GDP changes by transmission channels
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
Last year
2° year
1° year
Total
Direct Interest Rate
Cost of Capital
Exchange Rate
Income Cash-Flow


Contributions to GDP changes by demand components
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
Last year
2° year
1° year
Total
Total Consumption
Total Investment
Net Export

Starting from the second year, the cost of capital channel gains in importance - its contribution being - 0.21. Eventually it becomes the dominant one, with a contribution of about - 0.3 in the last few years of the experiment. The persistency of the monetary impulse channelled through the cost of capital is due to the putty-clay nature of the investment process and the long lags thus implied. In terms of sectoral breakdown, it operates mainly by reducing investment (- 0.23 in the second year, around - 0.4 subsequently) and consumption of durables (the latter mostly in the first two years). An offsetting influence comes, as expected, from the real trade balance: given the high import content of Italian investments, the drop of the latter induces a strong reduction of imports that partly counteracts the negative contribution of this channel.

The direct effect of the interest rate operates mainly in the short run. In the first two years its contribution is about one-fifth of the total. Later, when the interest rate is back to the baseline, this channel is negligible. It is interesting to note that the direct negative effect of interest rates on consumption dominates the positive one channelled through the disposable income for the first two years of the experiment.

The income channel, though slow to appear - as expected with agents smoothing consumption over their life cycle - becomes very important starting in the third year of the experiment, almost completely balancing the negative effect coming from the other channels. This result can be explained recalling the main features of the Italian financial structure previously described, and in particular the high level of the public debt, which is the largest source of interest payments to the private sector.

VII. CONCLUSIONS

The merit of the BIS exercise in assessing the role of monetary policy lies in the use of the most appropriate set of "observations" available to this end. As a matter of fact, in the BIS project monetary policy is described and measured through the lenses used by the same subjects responsible for its design and implementation, namely the central banks.

The lenses might be clouded or provide a distorted picture of reality. However, those are after all the lenses used by the monetary authorities, and only wearing them can one obtain a good "inside view" of how monetary policy is conceived to influence the economy.

There is, however, an important limitation to this research agenda.

The lenses - or, abandoning the metaphor, the model - might be known to have some specific distortions, black spots or deficiencies that, precisely because of their being known, are "discounted" according to procedures little formalised and systematic, and thus difficult to replicate. In particular, we would argue that often the model is only used to provide alternative descriptions, the outer boundaries of the "possibility field" within which the policy action has to be steered.

A specific instance of this approach in the use of the model has been already referred to: the response of the exchange rate to the interest rate is subject to severe uncertainties, with periods of negative correlation adjacent to periods in which the correlation is reversed, and the alternative assumptions formulated in this paper - as well as many others routinely explored - are meant to remind of these uncertainties. Other areas in which the mechanisms embodied in the model are suspected not to reflect accurately the actual working of the economy are the determination of loan rates and credit flows - where more work is required to identify the impact of a "credit channel" - the wage bargaining process - in which the formal indexation mechanism, that played an important role in the 1970s and in the 1980s, is no longer in place - the possible presence of a forward looking component in income expectations - following a more vivid recognition of the need for a fiscal adjustment.

More generally, and more pervasively, an area of relatively larger uncertainty in the ability of the model to capture the working of the economy is identified by the role of expectations and their interactions with the policy choices. The critique raised by Lucas, though having the great merit of warning about a mechanic use of estimated models, is too simplistic in identifying "the" correct response of expectations to changes in policy.[8] The reciprocal influences among policy announcements, expectations and policy implementation are all too complex, and it is often much more informative to generate a whole range of possible responses to the policy changes than simply assuming, say, rational expectations.

From this viewpoint, the effects of monetary policy discussed in this paper can be criticised as missing the possibility that tighter monetary policy might act, via expectations, on the reduction of the risk premia on government securities, or might anchor the wage bargaining or the price setting, or, on the opposite side, might be perceived as increasing the burden of fiscal stabilisation and thus might lead to an increase of the risk premia.

Our reply, already alluded to, is that this analysis provides only a building block of an eventual (quantitative) assessment of monetary policy. A complete assembly has yet to come.

8 Another aspect of the "Lucas proposal", as might be called the methodological approach engendered by the Lucas critique, that is at best simplistic, if not *tout-court* unacceptable, is the use of the representative agent framework. In particular, as argued by Kirman (1993), even accepting the highly restrictive set of assumptions under which a representative agent would be exactly identified, his identification is in general not invariant to policy changes - precisely the same problem encountered with non-rational expectations. Moreover, there is no guarantee that the welfare judgments of the representative agent would coincide with those of the society he represents - indeed, examples can be given where the opposite occurs.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Two-year shock to policy-controlled interest rate (exchange rate fixed at the baseline value)

Deviations from baseline[1]	1994	1995	1996	1997	1998	1999	2000
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Three-month Treasury bill	0.79	1.01	0.23	0.01	0.00	0.00	0.00
Long-term Treasury bond	0.68	0.88	0.29	0.00	0.01	0.04	- 0.04
3. Other interest rates (%)							
Bank lending rate	0.63	0.89	0.23	- 0.22	- 0.09	0.04	- 0.03
Deposit rate	0.43	0.72	0.25	- 0.02	- 0.01	0.06	0.00
4. Real interest rates							
Real short-term interest rate (%)	0.96	1.01	0.05	- 0.08	- 0.14	- 0.07	- 0.01
Real long-term interest rate (%)	0.65	0.89	0.33	- 0.08	- 0.13	- 0.03	- 0.05
User cost of capital	2.35	3.45	1.44	0.04	- 0.20	- 0.13	- 0.22
5. Exchange rates							
Nominal effective exchange rate[2]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate[2]	0.00	- 0.03	- 0.06	- 0.01	0.07	0.11	0.12
Lira-Deutsche Mark exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lira-US dollar exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Money and credit							
Monetary aggregate							
M_2	- 0.20	- 0.81	- 0.83	- 0.16	- 0.12	0.08	0.23
Total domestic credit	0.06	0.24	0.49	0.79	1.00	1.05	1.13
Private	0.00	- 0.17	- 0.48	- 0.32	0.00	0.00	0.05
Public	0.10	0.50	1.11	1.53	1.68	1.78	1.91

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates appreciation.

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in the policy-controlled interest rate (exchange rates endogenous)							
Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Three-month Treasury bill	0.79	1.01	0.23	0.01	0.00	0.00	0.00
Long-term Treasury bond	0.62	0.77	0.36	0.18	0.06	0.03	- 0.08
3. Other interest rates (%)							
Bank lending rate	0.63	0.90	0.26	- 0.17	- 0.07	- 0.01	- 0.05
Deposit rate	0.42	0.72	0.28	0.03	0.02	0.03	- 0.02
4. Real interest rates							
Real short-term interest rate (%)	1.47	1.13	- 0.14	- 0.35	- 0.27	- 0.07	0.01
Real long-term interest rate (%)	1.11	0.91	0.20	- 0.18	- 0.21	- 0.04	- 0.07
User cost of capital	2.05	4.16	1.73	- 0.22	- 0.91	- 0.77	- 0.58
5. Exchange rates							
Nominal effective exchange rate[2]	1.72	0.76	0.05	0.00	0.00	0.00	0.00
Real effective exchange rate[2]	0.85	0.02	- 0.32	- 0.11	0.05	0.09	0.08
Lira-Deutsche Mark exchange rate	- 1.69	- 0.76	- 0.05	0.00	0.00	0.00	0.00
Lira-US dollar exchange rate	- 1.69	- 0.76	- 0.05	0.00	0.00	0.00	0.00
6. Money and credit							
Monetary aggregate							
M_2	- 0.61	- 1.66	- 1.33	- 0.26	- 0.13	0.04	0.20
Total domestic credit	- 0.14	0.02	0.48	0.90	1.11	1.17	1.29
Private	- 0.53	- 0.97	- 0.91	- 0.42	- 0.08	- 0.09	0.00
Public	0.10	0.64	1.37	1.77	1.91	2.04	2.21

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates appreciation.

Table I.3

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in the policy-controlled interest rate (ERM coordinated)							
Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Three-month Treasury bill	0.79	1.01	0.23	0.01	0.00	0.00	0.00
Long-term Treasury bond	0.66	0.82	0.26	0.07	0.07	0.05	- 0.07
3. Other interest rates (%)							
Bank lending rate	0.63	0.88	0.24	- 0.19	- 0.08	0.05	- 0.04
Deposit rate	0.43	0.71	0.25	0.01	0.01	0.07	0.00
4. Real interest rates							
Real short-term interest rate (%)	1.13	1.25	0.11	- 0.21	- 0.26	- 0.12	- 0.01
Real long-term interest rate (%)	0.81	1.08	0.36	- 0.15	- 0.20	- 0.07	- 0.07
User cost of capital	2.24	3.50	1.75	0.16	- 0.57	- 0.66	- 0.70
5. Exchange rates							
Nominal effective exchange rate[2]	0.57	1.14	0.72	0.25	0.20	0.23	0.24
Real effective exchange rate[2]	0.30	0.52	0.15	- 0.04	0.09	0.18	0.18
Lira-Deutsche Mark exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lira-US dollar exchange rate	- 1.33	- 2.63	- 1.67	- 0.58	- 0.47	- 0.53	- 0.55
6. Money and credit							
Monetary aggregate							
M_2	- 0.33	- 1.24	- 1.41	- 0.54	- 0.31	- 0.12	0.02
Total domestic credit	0.00	0.10	0.37	0.77	1.04	1.10	1.20
Private	- 0.16	- 0.60	- 0.98	- 0.64	- 0.20	- 0.18	- 0.15
Public	0.10	0.54	1.23	1.71	1.87	1.99	2.16

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates appreciation.

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year shock to policy-controlled interest rate (exchange rate fixed at the baseline value)

Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.12	- 0.31	- 0.24	- 0.09	- 0.08	- 0.17	- 0.10
Private consumption	- 0.15	- 0.35	- 0.12	0.33	0.47	0.26	0.22
Government expenditure	- 0.01	- 0.02	- 0.02	0.00	0.01	0.01	0.01
Private investment	- 0.47	- 1.50	- 1.82	- 1.65	- 1.89	- 1.94	- 1.02
Residential	- 0.13	- 0.42	- 0.58	- 0.63	- 0.55	- 0.35	- 0.05
Non-residential	- 0.61	- 1.89	- 2.25	- 2.00	- 2.35	- 2.47	- 1.34
Inventories (% of real GDP)	- 0.03	- 0.06	0.00	0.01	- 0.03	- 0.04	0.05
Exports	0.07	0.09	- 0.05	- 0.08	0.00	- 0.02	- 0.16
Imports	- 0.26	- 0.84	- 0.75	- 0.17	- 0.12	- 0.38	0.11
2. Unemployment rate (%)	0.11	0.05	0.07	0.07	0.05	0.04	0.01
3. Real disposable income	- 0.07	0.16	0.59	0.47	0.00	- 0.07	0.18
4. Inflation and wages							
GDP deflator	- 0.01	- 0.06	- 0.10	0.00	0.14	0.20	0.23
Consumer prices	0.00	- 0.04	- 0.09	- 0.01	0.12	0.19	0.20
Wages per hour	- 0.02	- 0.07	- 0.13	- 0.08	0.04	0.11	0.12
Unit labour cost	0.09	0.17	0.05	0.02	0.19	0.35	0.32
Import prices	0.00	- 0.03	- 0.04	- 0.02	- 0.01	- 0.01	0.01
5. Government accounts (% of nominal GDP)							
Revenues	0.07	0.18	- 0.02	- 0.10	0.08	0.07	0.00
Primary expenditures	0.05	0.13	0.10	0.01	0.00	0.03	0.00
Interest payments	0.24	0.68	0.63	0.34	0.25	0.24	0.22
Government budget balance[2]	- 0.22	- 0.63	- 0.75	- 0.46	- 0.16	- 0.20	- 0.21
Public sector debt	0.37	1.26	1.90	1.96	1.83	1.95	1.94
6. Foreign transactions (% of nominal GDP)							
Current account	- 0.08	0.07	0.14	0.02	0.03	0.08	- 0.06
Trade balance	0.06	0.17	0.11	0.01	0.03	0.08	- 0.05
Net interest payments abroad	- 0.15	- 0.14	- 0.01	0.00	- 0.01	- 0.02	- 0.02

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates increase of surplus or reduction of deficit.

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in the policy-controlled interest rate (exchange rates endogenous)							
Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.32	- 0.53	- 0.22	- 0.08	- 0.13	- 0.20	- 0.07
Private consumption	- 0.13	- 0.30	0.00	0.38	0.44	0.22	0.23
Government expenditure	- 0.09	- 0.08	- 0.04	- 0.01	0.01	0.01	0.01
Private investment	- 1.10	- 2.29	- 1.95	- 1.72	- 2.28	- 2.28	- 0.86
Residential	- 0.34	- 0.71	- 0.77	- 0.84	- 0.64	- 0.25	0.14
Non-residential	- 1.41	- 2.86	- 2.36	- 2.02	- 2.83	- 2.96	1.20
Inventories (% of real GDP)	- 0.07	- 0.07	0.08	- 0.01	- 0.08	- 0.02	0.09
Exports	- 0.24	- 0.32	- 0.19	0.06	0.17	0.01	- 0.17
Imports	- 0.39	- 0.97	- 0.50	- 0.08	- 0.28	- 0.49	0.24
2. Unemployment rate (%)	0.03	0.11	0.13	0.11	0.09	0.07	0.02
3. Real disposable income	0.07	0.74	0.74	0.12	- 0.31	- 0.11	0.32
4. Inflation and wages							
GDP deflator	- 0.39	- 0.64	- 0.53	- 0.17	0.10	0.16	0.17
Consumer prices	- 0.48	- 0.64	- 0.50	- 0.16	0.10	0.16	0.15
Wages per hour	- 0.36	- 0.77	- 0.63	- 0.31	- 0.05	0.02	0.01
Unit labour cost	- 0.06	- 0.35	- 0.53	- 0.24	0.13	0.27	0.18
Import prices	- 1.40	- 0.84	- 0.16	- 0.02	- 0.01	- 0.02	0.01
5. Government accounts (% of nominal GDP)							
Revenues	0.19	0.08	- 0.08	- 0.03	0.12	0.06	- 0.02
Primary expenditures	0.16	0.24	0.11	0.01	0.00	0.03	- 0.02
Interest payments	0.31	0.77	0.69	0.38	0.30	0.29	0.26
Government budget balance[2]	- 0.28	- 0.93	- 0.88	- 0.42	- 0.18	- 0.26	- 0.25
Public sector debt	1.09	2.48	2.73	2.41	2.21	2.34	2.30
6. Foreign transactions (% of nominal GDP)							
Current account	- 0.03	0.01	0.00	0.02	0.12	0.12	- 0.09
Trade balance	0.08	0.13	0.03	0.02	0.10	- 0.08	- 0.09
Net interest payments abroad	- 0.16	- 0.14	- 0.03	0.00	0.00	- 0.01	- 0.01

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates increase of surplus or reduction of deficit.

Table II.3

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in the policy-controlled interest rate (ERM coordinated)							
Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.18	- 0.44	- 0.34	- 0.12	- 0.11	- 0.20	- 0.12
Private consumption	- 0.14	- 0.30	- 0.01	0.43	0.53	0.30	0.26
Government expenditure	- 0.03	- 0.07	- 0.06	- 0.03	- 0.01	- 0.01	0.00
Private investment	- 0.63	- 1.89	- 2.18	- 1.88	2.15	- 2.23	- 1.22
Residential	- 0.19	- 0.58	- 0.78	- 0.82	- 0.71	- 0.41	- 0.01
Non-residential	- 0.81	- 2.36	- 2.67	- 2.24	- 2.64	- 2.84	- 1.62
Inventories (% of real GDP)	- 0.04	- 0.08	0.01	0.03	- 0.04	- 0.05	0.06
Exports	- 0.04	- 0.24	- 0.44	- 0.27	- 0.03	- 0.04	- 0.22
Imports	- 0.29	- 0.94	- 0.80	- 0.16	- 0.14	- 0.44	0.08
2. Unemployment rate (%)	0.02	0.07	0.11	0.11	0.08	0.07	0.03
3. Real disposable income	0.00	0.45	0.93	0.51	- 0.15	- 0.14	0.23
4. Inflation and wages							
GDP deflator	- 0.13	- 0.38	- 0.51	- 0.31	- 0.06	0.05	0.07
Consumer prices	- 0.16	- 0.43	- 0.53	- 0.33	- 0.08	0.03	0.04
Wages per hour	- 0.13	- 0.43	- 0.62	- 0.47	- 0.21	- 0.09	- 0.08
Unit labour cost	0.03	- 0.07	- 0.38	- 0.37	- 0.05	0.17	0.13
Import prices	- 0.51	- 1.05	- 0.74	- 0.28	- 0.20	- 0.22	- 0.22
5. Government accounts (% of nominal GDP)							
Revenues	0.10	0.19	- 0.06	- 0.12	0.12	0.09	0.00
Primary expenditures	0.08	0.19	0.15	0.03	0.01	0.04	0.01
Interest payments	0.26	0.73	0.69	0.39	0.29	0.29	0.26
Government budget balance[2]	- 0.24	- 0.74	- 0.90	- 0.54	- 0.18	- 0.24	- 0.27
Public sector debt	0.59	1.89	2.70	2.61	2.33	2.42	2.43
6. Foreign transactions (% of nominal GDP)							
Current account	- 0.06	0.08	0.08	- 0.03	0.04	0.11	- 0.05
Trade balance	0.07	0.17	0.07	- 0.03	0.04	0.09	- 0.05
Net interest payments abroad	- 0.15	- 0.14	- 0.01	0.00	0.00	- 0.01	- 0.01

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates increase of surplus or reduction of deficit.

Table III

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in the policy-controlled interest rate (exchange rates endogenous)

	Total (A)	**Income/ cash flow** (B)	**Direct interest rate effect on consumption** (C)	**Cost of capital** (D)	**Discrepancy** (F-B-C-D) (E)	**Total** (F)	**Exchange rate** (G)	**Discrepancy** (A-G-F) (H)
Real GDP: first year after shock*	**- 0.32**	**- 0.01**	**- 0.05**	**- 0.06**	**0.00**	**- 0.12**	**- 0.21**	**0.00**
of which:								
Private consumption	- 0.08	- 0.01	- 0.05	- 0.04	0.00	- 0.10	0.01	0.00
Government expenditure	- 0.01	0.00	0.00	0.00	0.00	0.00	- 0.01	0.00
Investment in machinery	- 0.16	0.00	- 0.02	- 0.05	0.00	- 0.07	- 0.09	0.00
Investment in construction	- 0.03	0.00	0.00	- 0.01	0.00	- 0.01	- 0.02	0.00
Change in inventories	- 0.07	0.00	- 0.01	- 0.02	0.00	- 0.03	- 0.04	0.00
Exports	- 0.07	0.00	0.01	0.01	0.00	0.02	- 0.09	0.00
Imports	0.11	0.00	0.03	0.04	0.00	0.07	0.04	0.00
Real GDP: second year after shock*	**- 0.53**	**0.02**	**- 0.10**	**- 0.21**	**- 0.02**	**- 0.31**	**- 0.24**	**0.02**
of which:								
Private consumption	- 0.19	0.02	- 0.12	- 0.11	- 0.02	- 0.22	0.03	0.01
Government expenditure	- 0.01	0.00	0.00	0.00	0.00	0.00	- 0.01	0.00
Investment in machinery	- 0.35	0.00	- 0.04	- 0.19	- 0.01	- 0.23	- 0.14	0.02
Investment in construction	- 0.08	0.00	- 0.01	- 0.04	0.00	- 0.05	- 0.03	0.00
Change in inventories	- 0.07	0.01	0.00	- 0.06	0.00	- 0.06	- 0.02	0.00
Exports	- 0.09	0.00	0.01	0.02	0.00	0.03	- 0.12	0.00
Imports	0.28	- 0.01	0.06	0.18	0.01	0.24	0.05	- 0.02
Real GDP: third year after shock*	**- 0.22**	**0.12**	**- 0.05**	**- 0.28**	**- 0.02**	**- 0.23**	**0.02**	**0.00**
of which:								
Private consumption	0.00	0.13	- 0.07	- 0.10	- 0.02	- 0.07	0.08	- 0.01
Government expenditure	- 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Investment in machinery	- 0.26	0.06	- 0.02	- 0.29	- 0.01	- 0.25	- 0.02	0.01
Investment in construction	- 0.13	0.01	- 0.01	- 0.11	0.00	- 0.11	- 0.02	0.00
Change in inventories	0.08	0.02	0.02	- 0.04	0.00	0.00	0.09	- 0.01
Exports	- 0.06	- 0.01	- 0.01	0.01	0.00	- 0.01	- 0.05	0.00
Imports	0.14	- 0.08	0.03	0.25	0.01	0.22	- 0.07	0.00

Table III (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in the policy-controlled interest rate (exchange rates endogenous)

	Total (A)	**Income/ cash flow** (B)	**Direct interest rate effect on con- sumption** (C)	**Cost of capital** (D)	**Discre- pancy** (F-B-C-D) (E)	**Total** (F)	**Exchange rate** (G)	**Discre- pancy** (A-G-F) (H)
Real GDP: fourth year after shock*	**- 0.08**	**0.19**	**0.00**	**- 0.28**	**0.00**	**- 0.09**	**0.05**	**- 0.04**
of which:								
Private consumption	0.24	0.23	0.01	- 0.03	0.00	0.21	0.09	- 0.06
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Investment in machinery	- 0.16	0.08	0.02	- 0.28	0.00	- 0.18	0.03	- 0.02
Investment in construction	- 0.19	0.02	0.00	- 0.17	0.00	- 0.16	- 0.03	0.00
Change in inventories	- 0.01	0.00	0.02	- 0.01	0.01	0.01	- 0.01	- 0.01
Exports	0.02	- 0.01	- 0.01	- 0.01	0.00	- 0.02	0.04	0.01
Imports	0.02	- 0.13	- 0.04	0.22	0.00	0.05	- 0.06	0.04
Real GDP: fifth year after shock*	**- 0.13**	**0.20**	**0.03**	**- 0.30**	**0.00**	**- 0.08**	**- 0.02**	**- 0.03**
of which:								
Private consumption	0.28	0.25	0.05	- 0.01	0.00	0.30	0.02	- 0.04
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Investment in machinery	- 0.26	0.04	0.03	- 0.28	0.00	- 0.21	- 0.03	- 0.02
Investment in construction	- 0.21	0.02	0.00	- 0.20	0.00	- 0.18	- 0.03	0.00
Change in inventories	- 0.08	- 0.03	0.00	0.00	0.00	- 0.03	- 0.06	0.01
Exports	0.05	0.01	0.00	- 0.01	0.00	0.00	0.05	0.00
Imports	0.08	- 0.10	- 0.05	0.20	- 0.01	0.03	0.02	0.02
Real GDP: final year after shock*	**- 0.07**	**0.21**	**0.01**	**- 0.30**	**- 0.01**	**- 0.10**	**0.04**	**- 0.01**
of which:								
Private consumption	0.14	0.22	0.02	- 0.09	- 0.02	0.14	- 0.01	0.02
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Investment in machinery	- 0.03	0.03	0.00	- 0.09	0.00	- 0.07	0.05	- 0.02
Investment in construction	- 0.14	0.02	0.00	- 0.17	0.00	- 0.14	0.01	- 0.01
Change in inventories	0.09	0.00	0.01	0.04	0.00	0.05	0.04	- 0.01
Exports	- 0.06	0.00	- 0.01	- 0.05	0.00	- 0.05	- 0.01	0.00
Imports	- 0.07	- 0.07	- 0.02	0.05	0.00	- 0.03	- 0.05	0.01

* Percentage deviations from baseline. Due to rounding errors, the contribution of variables may not add to the total effect.

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Macroeconometric analysis of the transmission mechanism of monetary policy in Japan

Kazuo Momma and Hideaki Shimizu[1]

I. INTRODUCTION

This paper, in accordance with the discussion at the meeting at the BIS on 7th-8th September 1994 on central bank macroeconometric models and the monetary policy transmission mechanism, presents the results and interpretation of our simulations. The experiment conducted here is a temporary increase in the policy-controlled interest rate of 100 basis points during two years, after which the policy rate immediately returns to baseline. The effects of the above policy experiment are simulated under two assumptions regarding exchange rates: (i) with a fully endogenous nominal exchange rate; (ii) with an exogenously fixed nominal exchange rate. Simulation results are traced up to the fifth year.

The rest of the paper is organised as follows. Section II describes some important characteristics of the macroeconometric model used for the simulations. Emphasis is put on the explanation of the financial block, whose structure is crucial for the experiments presented here. Section III gives the results of simulations including the breakdown of the total effect of monetary policy by demand components and by transmission channels. Interpretation of the simulation results from the viewpoint of Japan's financial and economic structure is presented in Section IV, followed by Section V, which points out some important limitations of the analyses. Finally, Section VI briefly concludes the paper.

II. MAJOR CHARACTERISTICS OF BOJMOD

1. Overall nature of the model

The model used for the simulations in this paper is the Bank of Japan Macroeconometric Model (BOJMOD), a medium-sized[2] quarterly model characterised as a short-term Keynesian model. The short-term nature of the model is reflected in two important aspects of its dynamic property.

Firstly, no policy reaction function is incorporated. The operating variable of monetary policy is the uncollateralised overnight call rate, which is given exogenously. This means, on the other hand, that the monetary aggregate is left endogenous in the model. As for fiscal policy, tax revenue is endogenously generated while nominal government expenditure is fixed exogenously. This results in the existence of an automatic fiscal balance stabilising effect, but only to the extent that tax revenue moves with national income.

Secondly, the supply side of the economy is not specifically embodied. While the working population, an exogenous variable, acts as a ceiling to economic expansion to some extent, the non-existence of the explicit production function and, therefore, of potential GDP weakens the

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1 The views expressed are those of the authors and do not necessarily represent those of the Bank of Japan.

2 BOJMOD comprises 67 statistically estimated equations and 120 identities. Estimation is performed mostly through OLS with occasional use of the Cochrane-Orcutt method.

model in terms of its dynamic property to return autonomously to a sustainable path. In other words, a medium-term steady state is not necessarily guaranteed.

These fundamentally short-term properties of the model would warrant some caution for the interpretation of medium-term simulations if the shock given to the model were large and sustained. In the case of simulations in this paper, however, the dynamic property of the model will not cause a big problem since the shock is relatively small and temporary, with simulation results being reported only to the fifth year.

It is also worth noting that the loose constraint from the supply side implies that the simulation results are not much dependent on initial conditions or the baseline. Taking this into consideration, we set up a baseline only under initial conditions actually prevailing at the beginning of 1994. We do not perform simulations under any alternative initial conditions or baselines.

2. Structure of the financial block[3]

Following are some important points about the financial block of BOJMOD which crucially affect the results of monetary policy experiments.

Firstly, long-term interest rates are the key variable in terms of the monetary policy process working through the economy. There are two rates: the ten-year government bond yield as the representative market rate and the long-term prime lending rate as the representative bank lending rate.[4] The latter directly influences residential and non-residential investments while the former affects net exports through the exchange rate, and private consumption through stock price.

Secondly, the ten-year government bond yield, in turn, is determined most importantly by the three-month CD rate, the representative short-term market interest rate. Distributed lags of as much as three quarters are assumed between the three-month CD rate and the ten-year government bond yield. A key assumption here is that expectations held by bond traders are totally adaptive to changes in short-term rates of the recent past. In other words, no forward-looking expectations are formulated in the model.

Thirdly, in accordance with the portfolio approach, the real exchange rate of the United States dollar vis-à-vis Japanese yen[5] is determined by the real long-term interest rates differential between the United States and Japan as well as risk premium as measured by Japan's cumulative current account balance.[6]

Fourthly, while changes in asset prices such as stock and land prices affect private consumption through changes in household wealth, the business sector is assumed not to be influenced by asset prices. Also ignored in the model are any private sector debt variables. What is called the balance sheet problem, therefore, cannot be explicitly described by the model.

Fifthly, no direct channel from monetary aggregates, M_2+CDs, to the real economy and prices is assumed in the model. This, however, does not necessarily mean that the model ignores the importance of the relationship between economic activity and money. Long-term interest rates and asset prices, the financial variables which critically influence the real economy, are at the same time the key determinants of M_2+CDs. Consequently, in the model M_2+CDs behaves like a mirror of

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3 See Chart 1 for an overview of the financial block.

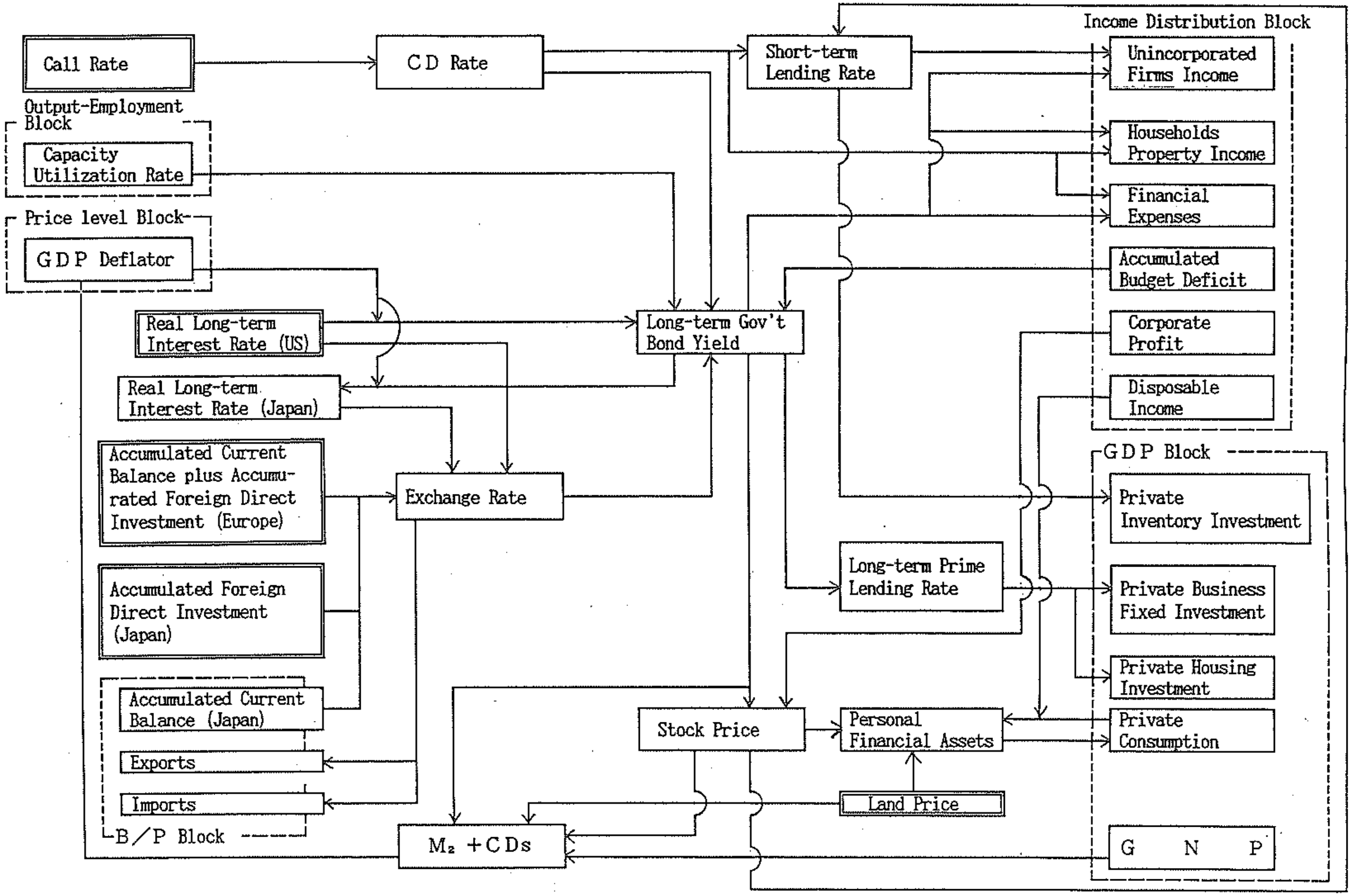
4 In the model, the latter is exclusively determined by the former mostly contemporaneously and partially with a one-quarter lag.

5 The model assumes that the US dollar does not change on a nominal basis against any currencies other than yen. The effective exchange rate of yen, therefore, is equal to the bilateral dollar/yen rate by the definition.

6 More precisely, measurement of risk premium also includes the cumulative current account balances of major European countries. The idea is that Japanese yen is more substitutable with major European currencies than with the US dollar.

Chart 1

Overview of the financial block of the BOJMOD



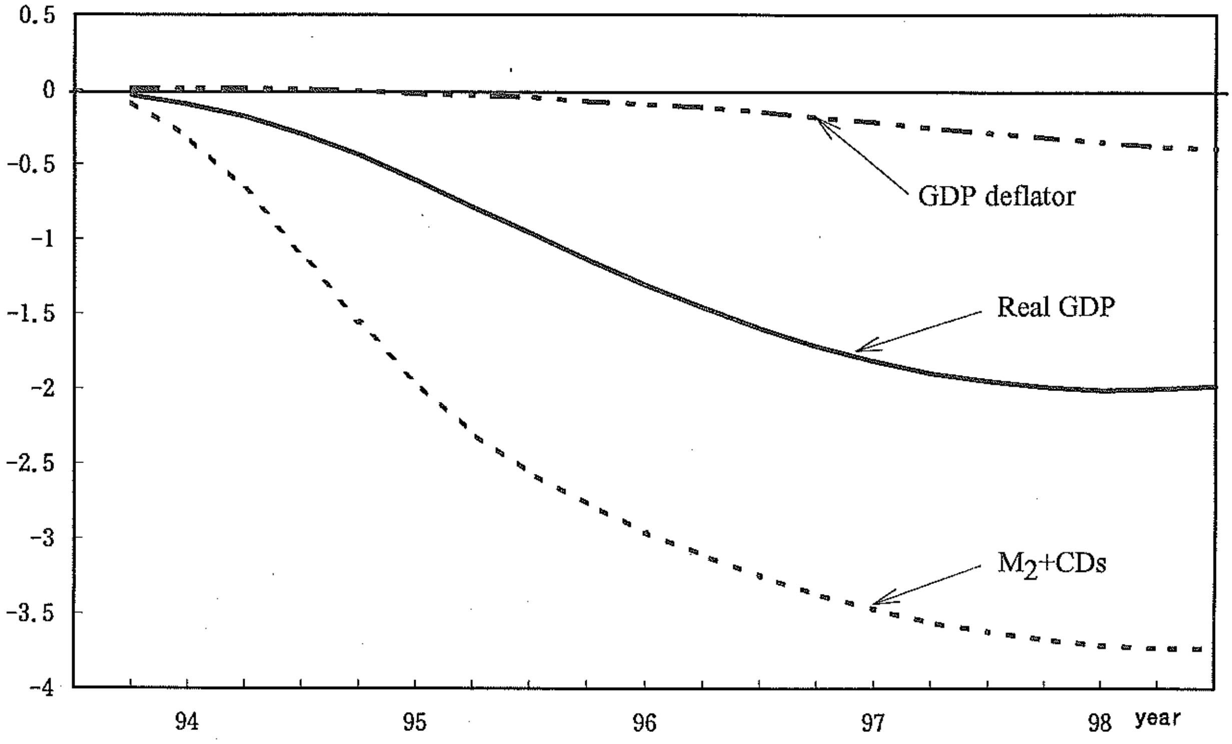
indicates a exogenous variable

economic activity. Responses of M_2+CDs, real GDP, and the GDP deflator to a shock in the call rate (Chart 2) show that M_2+CDs, under the dynamic property of the model, seems to be a contemporaneous indicator of real GDP and a leading indicator of the GDP deflator.

Chart 2

Money, prices and the real economy

(response to 100 basis point increase in the overnight call rate; % change from baseline)



Sixthly, the model does not incorporate deposits, loans, or any other balance sheet variables of the financial sector. This substantially limits the ability of the model to analyse the behaviour of banks. Although the margin between the short-term lending rate and three-month CD rate is modelled to reflect general stock price developments as a proxy for perceived credit risk, the short-term lending rate plays a considerably less significant role in the model than the long-term lending rate.

III. SIMULATIONS

1. Exogenous variable assumptions

Assumptions regarding selected exogenous variables through 1998 are described in Table 1. The assumed path for the US thirty-year government bond yield is taken from the Mid-Session Review of the 1995 US Budget, while oil prices, other foreign prices, and world import volume are based on World Economic Outlook (IMF, May 1994). As for government expenditure, the assumption for the immediate future is based on information available at the time of writing. Government expenditure on and after the fourth quarter of 1995 is simply assumed to grow at the constant rate on a nominal basis.

Table 1

Baseline values of selected exogenous variables

	1993	1994	1995	1996	1997	1998
1. **Foreign interest rates (%)**						
US Government bond yield (30-year constant maturities)	6.6	7.2	7.4	7.4	7.4	7.4
2. **Oil prices and other commodity prices**						
Oil price[1] (%)	- 8.3	- 5.3	5.9	1.5	1.5	1.5
3. **Foreign prices**						
Import price index of Japan (excluding crude oil)[1] (%)	3.8	2.9	1.8	1.6	1.6	1.6
4. **Foreign output**						
World imports (excluding Japan)[1] (%)	2.4	5.7	6.1	6.3	6.3	6.3
5. **World trade**						
6. **Other important exogenous variables**						
Nominal government expenditure[1] (%)	9.1	5.2	5.0	4.7	4.7	4.7
Yen-dollar exchange rate (¥/$)[2]	111.2	101.8	98.0	98.0	98.0	98.0

[1] Year-to-year change. [2] Applicable only in the case of exogenous exchange rates.

2. Simulation results

Financial variables

Table I.1 shows the response of financial variables under an endogenous exchange rate. A change in the policy-controlled interest rate (overnight call rate) induces a simultaneous and almost one-to-one (0.92%) change in the representative three-month interest rate (CD rate). The change in the three-month CD rate, in turn, causes a gradual change in long-term interest rates. The upward deviation of the representative long-term interest rate (ten-year government bond yield) from its baseline is about one third (0.34%) that of the call rate at the first year and one half (0.50%) for the second. The government bond yield remains somewhat higher than its baseline even in the third year because it is adjusted to the three-month CD rate only gradually. Bank lending rates, both short and long term, exhibit developments quite similar to respective representative rates, with a somewhat lagged response particularly notable in the case of the short-term rate.

The nominal effective exchange rate of yen, which is by definition equal to the nominal bilateral dollar-yen rate, appreciates almost 2% from the baseline at the second year, after which it returns towards the baseline but only partially owing to the increased nominal cumulative current account caused by the earlier appreciation of yen.

Stock prices respond to the long-term interest rate quite significantly with a more than 13% decline from the baseline at the second year.[7]

The representative monetary aggregate, measured by M_2+CDs, shows the widest negative deviation from the baseline at the third year, the timing of which coincides with the maximum negative deviation of real GDP. The response of real GDP is discussed below in detail.

In the case of an exogenous exchange rate (Table I.2), financial variables do not respond much differently from what they do under an endogenous exchange rate.

7 Estimated parameters of the stock price equation are naturally affected by developments during the so-called "bubble-economy" at the late 1980s and subsequent sharp reversal. This implies that the parameters might be somewhat overestimated to the extent that some unusual elements were at work in the markets.

Economic variables

Table II.1 summarises the behaviour of economic variables under an endogenous exchange rate. What should be noted is the significant time lag between monetary policy and when its effect is fully felt throughout the economy. Real GDP declines from the baseline by more than 1.2% at the third year and almost the same magnitude of negative deviation remains at the fourth year. Even at the fifth year, when a full two years had already passed after the policy had returned to the baseline, a negative deviation of real GDP by 0.6% still existed.

Among GDP components, inventory investment most swiftly reacts to a policy change since it is the only component modelled to react directly to the short-term lending rate rather than the long-term rate. Inventory investment, although notable for its prompt reaction, is not necessarily a major factor dragging down the whole economy since its share of GDP is rather small. Instead, non-residential investment is by far the largest factor contributing to the negative deviation of GDP, followed by private consumption and then residential investment.[8]

Although government expenditure on a real basis shows a positive contribution to GDP,[9] this is simply because nominal expenditure stays at a level exogenously given on the one hand and the deceleration of inflation is caused endogenously in the model on the other.

The deviation of real exports is negative due to the appreciation of the yen. Real imports, however, also negatively deviate from the baseline for the first four years because the negative effect of decreased domestic demand outweighs the positive impact of the yen's appreciation. The increased value of yen stimulates real imports but with a considerable time lag of as much as twelve quarters. While both real exports and imports decrease, the overall effect on real net exports is slightly negative. It should be noted, however, that the nominal trade balance, both in dollar amount and as a percentage of nominal GDP, positively deviates from the baseline. This is because improved terms of trade, expressed as a ratio of export prices to import prices, more than offset the decrease in real net exports.

Regarding domestic prices, the negative deviation from the baseline becomes maximum at the final year(s) of the simulation. This reflects the fact that, in the model, price developments lag real economic activity so that the deflationary spiral between consumer prices and wages is still at work even after real GDP has already started to recover towards the baseline.

An alternative simulation with a fixed nominal exogenous exchange rate (Table II.2) results in somewhat smaller negative deviation of GDP from the baseline. This is almost fully explained by the positive, instead of negative, deviation of net exports. Domestic components of GDP are not much different no matter whether an endogenous or exogenous exchange rate is assumed.

3. Analysis of transmission channels

Table III.1 shows the contribution to GDP deviation by component as well as transmission channel. The breakdown by transmission channel is obtained by using the full-model method suggested in the note by E. Mauskopf and S. Siviero. The direct interest rate channel on consumption is not reported in our case since the structure of our model allows us to ascribe any direct effect on consumption to either the income/cash flow channel or wealth channel.

It is clearly illustrated that the cost of capital, which is defined as the real long-term lending rate in our model, plays by far the largest role. The contribution of the cost of capital channel at the third year, when GDP displays maximum deviation from the baseline, accounts for nearly 50%

8 On a contribution basis, the deviation of GDP at the third year, -1.23%, is decomposed as follows: non-residential investment -0.65%, private consumption -0.36%, residential investment -0.18%.

9 A partial automatic stabilising effect stemming from fiscal balances briefly mentioned on page 436 does not appear here but is rather reflected in lower tax, higher household disposable income, and then larger private consumption.

of the deviation. In particular, residential and non-residential investment are directly influenced by the cost of capital channel because the real long-term lending rate is included in the equations determining each of these two components.

The income/cash flow channel, which primarily captures the effect on corporate earnings after interest, also directly affects non-residential investment. A negative contribution from the income/cash flow channel to private consumption might be counter-intuitive since the household sector is a net interest receiver even after taking into account the fact that unincorporated enterprises are included in the household sector for GDP statistics. The negative sign can be understood as follows: the reduction in non-residential investment is of such a magnitude as to suppress overall economic activity. This, in turn, reduces employee income, more than offsetting any increase in household financial income. The net result is lower household disposable income and then decreased consumption.

The wealth channel, contrary to the cost of capital and income/cash flow channels, first affects private consumption directly. Then a decrease in corporate sector expenditures is induced as a reaction to lower final demand.

It should also be noted that the exchange rate channel exerts as much influence on overall GDP as the income/cash flow or wealth channel. The breakdown of demand components, however, shows a significantly different pattern. While the exchange rate channel mainly works through net exports, the income/cash flow and wealth channels are effective through domestic components.

With respect to the dynamics of the relative importance of the four transmission channels, the cost of capital channel mainly determines the dynamic pattern of GDP deviation, although in later years, in particular the fifth, the cost of capital channel becomes unimportant while the effects from the other three channels are more persistent.

IV. INTERPRETATION

In this section, the principal results of the above model experiments will be interpreted from the viewpoint of the structure of the Japanese economy and financial markets.

Firstly, model analysis reveals that there is an approximate two to three year time lag between monetary policy and the full response of the economy to it. While the length of the time lag appears longer than that of other major countries, we are not quite sure whether it is truly a reflection of the economic and/or financial structure of Japan or if it is simply due to the model. All we can say is that the simulation results are fairly consistent with what we have experienced during the most recent business cycle. Under strong expansion in the late 1980s, the call rate started to gradually rise as early as mid-1987 and full-scale monetary tightening accompanied by successive official discount rate hikes began in mid-1989. Nevertheless, it was only in mid-1991 that a significant deceleration in real GDP growth became apparent. Furthermore, while monetary policy easing started in mid-1991, clear signs of economic recovery only emerged in 1994. Admittedly, however, if there is any bias in the model about policy time lag, overestimation rather than underestimation of length is more likely since forward-looking expectations concerning financial variables are not explicitly formulated in the model. The notable increase in the long-term bond yield which has actually been observed since early 1994 strongly indicates the working of forward-looking expectations in the *real* bond market.

Secondly, non-residential investment is the most important demand component in the process of monetary policy permeating the economy. This reflects the fact that the cyclical dynamism of the Japanese economy has been primarily governed by plant and equipment investment and private consumption generally has been working towards stabilising economic cycles. Economic dynamism of this kind, however, is probably more a common feature of any industrialised economy than a special characteristic of the Japanese economy.

Thirdly, the principal channels of monetary policy transmission to non-residential investment are the cost of capital, measured by the real long-term lending rate, and income/cash flow. This is reasonably consistent with our empirical knowledge that business investment has been closely correlated with the difference between the return on fixed assets of the corporate sector and the long-term prime lending rate. It should be noted that the long-term prime lending rate can be considered a proxy for the cost of not only borrowing from banks but also the issue of securities in the capital market, since it moves flexibly enough to reflect the government bond yield prevailing in the market. We have to admit, of course, that this measurement of cost of capital may still be too simple in the sense that it ignores the cost of equity. Although a partial justification for this simplification can be found in the fact that stock prices are closely correlated with long-term interest rates, the failure to take equity cost into explicit consideration makes it impossible, for example, to analyse the implication of the flood of convertible and warrant debentures during the "bubble" years.

Fourthly, the cost of capital is also the pivotal transmission channel of monetary policy to residential investment. This is mainly because the standard interest rate on lending from the Housing Loan Corporation, a long-term officially determined fixed interest rate, is usually set at a level that is in line with the long-term bond yield in the market. As far as housing loans provided by private financial institutions are concerned, flexible, rather than fixed, interest rates are used most commonly.

Finally, the fifth point we would like to refer to is the wealth channel. The significance of this channel illustrates an important effect of stock price changes on household financial assets and, in turn, private consumption. For a long time in Japan, the general view had been that the wealth effect was not very important. Recent experience during the "bubble era", and its unwinding, however, has highlighted the potentially important effects of asset price oscillation on the real economy including private consumption. Although our empirical work on this issue is not necessarily conclusive, we find that the explanatory power of stock prices could not be rejected under some specifications of the private consumption equation. We are not really confident about the appropriateness of the magnitude of the parameters because the relationships between financial and economic variables during the most recent boom and bust cycle might have been somewhat distorted by exceptional forces, like unusually large swings in psychology, and thus might not have accurately reflected the financial and economic structure of Japan. In any event, however, the accumulation of financial assets by the household sector, the gradual progress and recent completion of deposit interest deregulation, as well as growing public interest in better fund management, all suggest that the increasing influence of asset prices on the real economy is likely to become a trend.

V. LIMITATIONS OF ANALYSIS USING BOJMOD

Whereas the ultimate goal of the simulations in this paper is to highlight how the financial structure of Japan affects the transmission mechanism of monetary policy, there are some notable analytical limitations based on the use of BOJMOD. The problems essentially arise from the fact that the model is not necessarily an accurate picture of the economy and financial markets. A simplification, which is inevitable to keep the model operational, forces us to omit many details of the real world. Below we specify some important limitations.

Firstly, while the model is reasonably capable of describing transmission from the policy-controlled interest rate to market interest rates, and from lending rates to the real economy, the process in between, namely transmission from market interest rates to lending rates is essentially beyond the scope of the model. This is because the financial block of BOJMOD, as we mentioned in Section II.2, is a relatively compact one, composed only of major interest rates.

Secondly, partly related with the first point, the so-called balance sheet problem cannot be explicitly analysed in the model since the model does not incorporate debt variables of either the non-financial or financial sector. As far as the household sector is concerned, the balance sheet problem does not seem to have been of significance in Japan anyway. On the corporate side, however, considerable anecdotal evidence suggests that the balance sheet deterioration, particularly of real estate-related industries, has been among the factors accentuating and prolonging the adjustment process of Japan's economy the last few years. Furthermore, a separate empirical analysis conducted by the Research and Statistics Department, although not very conclusive, indicates the possibility that the capital to asset ratio, and therefore the weight of non-performing loans, are affecting banks' attitude toward lending.

Having pointed out those important problems, however, we still believe that the model analysis in this paper satisfactorily reveals how monetary policy is transmitted through financial markets and the overall economy. Even insufficient description of bank behaviour, although depriving the analysis of some potentially interesting points, may not be a critical drawback because the pronounced stagnation of money and credit in recent years is more likely a demand-side phenomenon than a supply-side one.

VI. CONCLUDING REMARKS

Using our macroeconometric model, BOJMOD, we examined the effect of a temporary increase in the policy-controlled interest rate of 100 basis points during two years. We found there is a significant time lag of two to three years between a monetary policy change and the full reaction of the economy to it. We also found non-residential investment to be the most crucial demand component for the transmission of monetary policy. As for transmission channels, the cost of capital channel was found to be the most important. While the model analysis conducted here naturally has many limitations, it has quite satisfactorily revealed some meaningful findings.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates endogenous)

Deviations from baseline[1]	1994	1995	1996	1997	1998
1. Policy-controlled interest rate (%)					
Call rate (overnight, uncollateralised)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Three-month CD rate	0.92	0.92	0.00	0.00	0.00
Government bond yield	0.34	0.50	0.17	0.02	0.04
3. Other interest rates (%)					
Contracted interest rate on short-term loans	0.64	0.86	0.16	- 0.14	- 0.17
Long-term prime lending rate...................	0.28	0.49	0.21	0.02	0.03
4. Real interest rates					
CD rate minus year-to-year change of GDP deflator (%)	0.92	0.96	0.10	0.10	0.04
Government bond yield minus year-to-year change of GDP deflator (%)	0.33	0.54	0.27	0.12	0.07
5. Exchange rates					
Nominal effective exchange rate[2]	1.07	1.91	1.46	1.18	0.96
Real effective exchange rate[2]	0.99	1.73	1.19	0.91	0.73
Yen-dollar exchange rate	- 1.07	- 1.91	- 1.46	- 1.18	- 0.96
6. Asset prices and wealth					
Stock prices (Nikkei Heikin)	- 6.91	-13.41	- 9.81	- 1.72	3.42
7. Monetary aggregate					
M_2+CDs	- 0.55	- 2.10	- 2.48	- 1.37	- 0.55

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates an appreciation.

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates exogenous)

Deviations from baseline[1]	1994	1995	1996	1997	1998
1. Policy-controlled interest rate (%)					
Call rate (overnight, uncollateralised)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Three-month CD rate	0.92	0.92	0.00	0.00	0.00
Government bond yield............................	0.37	0.52	0.15	0.02	0.03
3. Other interest rates (%)					
Contracted interest rate on short-term loans	0.65	0.87	0.16	- 0.16	- 0.17
Long-term prime lending rate...................	0.31	0.50	0.20	0.02	0.02
4. Real interest rates					
CD rate minus year-to-year change of GDP deflator (%)....................................	0.93	0.97	0.10	0.11	- 0.01
Government bond yield minus year-to-year change of GDP deflator (%)	0.37	0.56	0.26	0.13	0.02
5. Exchange rates					
Nominal effective exchange rate[2].............					
Real effective exchange rate[2]....................	- 0.00	- 0.01	- 0.07	- 0.13	- 0.08
Yen-dollar exchange rate..........................					
6. Asset prices and wealth					
Stock prices (Nikkei Heikin).....................	- 7.35	-13.93	- 9.75	- 1.26	3.37
7. Monetary aggregate					
M_2+CDs	- 0.59	- 2.16	- 2.43	- 1.18	- 0.32

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates an appreciation.

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates endogenous)

Deviations from baseline[1]	1994	1995	1996	1997	1998
1. Real GDP and its components[2]					
Real GDP	- 0.16	- 0.70	- 1.23	- 1.16	- 0.59
Private consumption	- 0.08	- 0.36	- 0.64	- 0.67	- 0.41
Government expenditure	0.02	0.09	0.22	0.31	0.28
Private investment	- 0.39	- 1.85	- 3.14	- 2.73	- 1.11
Residential	- 0.65	- 2.86	- 3.52	- 2.17	- 1.23
Non-residential	- 0.19	- 1.41	- 2.90	- 2.76	- 1.17
Inventory formation (% GDP)	- 8.94	- 8.08	- 7.33	- 5.85	2.69
Exports	- 0.15	- 0.42	- 0.57	- 0.49	- 0.34
Imports	- 0.02	- 0.24	- 0.40	- 0.08	0.34
2. Unemployment rate (%)	0.01	0.02	0.03	0.02	- 0.00
3. Real disposable income	- 0.12	- 0.39	- 0.71	- 0.82	- 0.53
4. Inflation and wages					
GDP deflator	0.01	- 0.03	- 0.13	- 0.23	- 0.27
Consumer prices	- 0.02	- 0.11	- 0.25	- 0.37	- 0.37
Wages/earnings	- 0.05	- 0.26	- 0.60	- 0.82	- 0.71
Unit labour cost	0.05	0.13	- 0.03	- 0.40	- 0.60
Import prices	- 1.07	- 1.96	- 1.48	- 1.20	- 0.97
5. Government accounts (% of nominal GDP)					
Revenues	- 0.01	- 0.03	- 0.07	- 0.09	- 0.04
Primary expenditures	0.02	0.11	0.20	0.20	0.11
Interest payments					
Government budget balance[3]	- 0.03	- 0.14	- 0.28	- 0.28	- 0.15
Public sector debt					
6. Current account (% of nominal GDP)[3]	0.00	0.04	0.05	0.02	- 0.02
Trade balance[3]	0.00	0.02	0.04	0.02	- 0.01
Net interest payments abroad					

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] All GDP components should be reported as deviations from baseline. [3] A positive number indicates an improvement.

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates exogenous)

Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components[2]					
Real GDP	- 0.12	- 0.59	- 1.01	- 0.80	- 0.23
Private consumption	- 0.08	- 0.37	- 0.63	- 0.57	- 0.27
Government expenditure	0.01	0.05	0.15	0.22	0.18
Private investment	- 0.37	- 1.83	- 3.05	- 2.42	- 0.67
Residential	- 0.68	- 2.96	- 3.28	- 1.55	- 0.58
Non-residential	- 0.17	- 1.40	- 2.86	- 2.53	- 0.83
Inventory formation (% GDP)	- 7.84	- 6.67	- 6.79	- 5.20	4.64
Exports	0.00	0.01	0.02	0.05	0.07
Imports	- 0.11	- 0.61	- 1.12	- 1.00	- 0.44
2. Unemployment rate (%)	0.00	0.02	0.03	0.02	- 0.00
3. Real disposable income	- 0.12	- 0.34	- 0.59	- 0.62	- 0.28
4. Inflation and wages					
GDP deflator	0.00	- 0.05	- 0.15	- 0.25	- 0.25
Consumer prices	- 0.00	- 0.04	- 0.14	- 0.25	- 0.23
Wages/earnings	- 0.03	- 0.16	- 0.43	- 0.61	- 0.45
Unit labour cost	0.05	0.18	0.04	- 0.35	- 0.47
Import prices	0.00	0.00	0.00	0.00	0.00
5. Government accounts (% of nominal GDP)					
Revenues	0.00	- 0.03	- 0.08	- 0.09	- 0.04
Primary expenditures	0.02	0.11	0.19	0.16	0.06
Interest payments					
Government financial deficit[3]	- 0.03	- 0.14	- 0.26	- 0.25	- 0.10
Public sector debt					
6. Current account (% of nominal GDP)[3]	0.01	0.06	0.12	0.10	0.04
Trade balance[3]	0.01	0.05	0.08	0.07	0.03
Net interest payments abroad					

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] All GDP components should be reported as deviations from baseline. [3] A positive number indicates an improvement.

Table III.1

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates endogenous)

	Total	Income/ cash flow	Wealth	Cost of capital	Exchange rate	Discre- pancy
Real GDP: first year after shock*	**- 0.16**	**- 0.03**	**- 0.02**	**- 0.07**	**- 0.05**	**0.01**
of which:						
Private consumption	- 0.05	- 0.02	- 0.02	- 0.01	- 0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.09	- 0.02	0.00	- 0.07	- 0.01	0.01
Residential private investment	*- 0.03*	*- 0.01*	*- 0.00*	*- 0.03*	*- 0.00*	*0.01*
Non-residential private investment	*- 0.04*	*- 0.01*	*- 0.00*	*- 0.02*	*- 0.01*	*0.00*
Inventory formation	*- 0.02*	*- 0.00*	*0.00*	*- 0.02*	*- 0.00*	*0.00*
Exports	- 0.02	- 0.00	- 0.00	- 0.00	- 0.02	0.00
Imports	0.00	0.00	0.00	0.01	- 0.01	0.00
Real GDP: second year after shock*	**- 0.70**	**- 0.12**	**- 0.11**	**- 0.35**	**- 0.15**	**0.03**
of which:						
Private consumption	- 0.20	- 0.04	- 0.08	- 0.07	- 0.01	0.00
Government expenditure	0.02	0.00	0.00	0.01	0.01	0.00
Private investment	- 0.50	- 0.09	- 0.05	- 0.33	- 0.04	0.01
Residential private investment	*- 0.15*	*- 0.01*	*- 0.01*	*- 0.13*	*- 0.01*	*0.01*
Non-residential private investment	*- 0.30*	*- 0.08*	*- 0.04*	*- 0.17*	*- 0.02*	*0.01*
Inventory formation	*- 0.05*	*- 0.00*	*- 0.00*	*- 0.03*	*- 0.01*	*- 0.01*
Exports	- 0.06	- 0.00	- 0.00	- 0.00	- 0.06	0.00
Imports	0.04	0.02	0.02	0.05	- 0.05	0.00
Real GDP: third year after shock*	**- 1.23**	**- 0.27**	**- 0.22**	**- 0.56**	**- 0.23**	**0.05**
of which:						
Private consumption	- 0.36	- 0.08	- 0.12	- 0.14	- 0.03	0.01
Government expenditure	0.04	0.01	0.01	0.02	0.01	- 0.01
Private investment	*- 0.89*	*- 0.23*	*- 0.13*	*- 0.50*	*- 0.07*	*0.04*
Residential private investment	*- 0.18*	*- 0.01*	*- 0.02*	*- 0.14*	*- 0.02*	*0.01*
Non-residential private investment	*- 0.65*	*- 0.20*	*- 0.10*	*- 0.33*	*- 0.04*	*0.02*
Inventory formation	*- 0.06*	*- 0.02*	*- 0.01*	*- 0.03*	*- 0.01*	*0.01*
Exports	- 0.08	- 0.00	- 0.00	- 0.01	- 0.07	0.00
Imports	0.06	0.04	0.03	0.08	- 0.09	0.00

Table III.1 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates endogenous)

	Total	Income/ cash flow	Wealth	Cost of capital	Exchange rate	Discre-pancy
Real GDP: fourth year after shock*	**- 1.16**	**- 0.32**	**- 0.23**	**- 0.41**	**- 0.24**	**0.04**
of which:						
Private consumption	- 0.37	- 0.10	- 0.11	- 0.12	- 0.05	0.01
Government expenditure	0.05	0.01	0.01	0.02	0.01	0.00
Private investment	- 0.78	- 0.26	- 0.15	- 0.32	- 0.07	0.02
Residential private investment	*- 0.11*	*- 0.02*	*- 0.02*	*- 0.04*	*- 0.02*	*- 0.01*
Non-residential private investment	*- 0.63*	*- 0.22*	*- 0.12*	*- 0.26*	*- 0.05*	*0.02*
Inventory formation	*- 0.04*	*- 0.02*	*- 0.01*	*- 0.02*	*0.00*	*0.01*
Exports	- 0.07	- 0.01	- 0.01	- 0.03	- 0.03	0.01
Imports	0.01	0.04	0.03	0.04	- 0.10	0.00
Real GDP: fifth year after shock*	**- 0.59**	**- 0.20**	**- 0.19**	**- 0.10**	**- 0.13**	**0.03**
of which:						
Private consumption	- 0.22	- 0.07	- 0.09	- 0.03	- 0.05	0.02
Government expenditure	0.05	0.01	0.01	0.02	0.01	0.00
Private investment	- 0.31	- 0.14	- 0.12	- 0.03	- 0.05	0.03
Residential private investment	*- 0.06*	*- 0.02*	*- 0.02*	*- 0.01*	*- 0.02*	*0.01*
Non-residential private investment	*- 0.26*	*- 0.11*	*- 0.09*	*- 0.04*	*- 0.03*	*0.01*
Inventory formation	*0.01*	*- 0.01*	*- 0.01*	*0.02*	*0.00*	*0.01*
Exports	- 0.05	- 0.02	- 0.01	- 0.03	0.01	0.00
Imports	- 0.05	0.01	0.01	- 0.03	- 0.04	0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table III.2

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates exogenous)

	Total	**Income/ cash flow**	**Wealth**	**Cost of capital**	**Discre- pancy**
Real GDP: first year after shock*	**- 0.12**	**- 0.02**	**- 0.02**	**- 0.07**	**- 0.01**
of which:					
Private consumption	- 0.05	- 0.02	- 0.02	- 0.01	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.08	- 0.02	0.00	- 0.07	0.01
Residential private investment	- 0.03	- 0.01	- 0.00	- 0.03	0.01
Non-residential private investment	- 0.03	- 0.01	- 0.00	- 0.02	0.00
Inventory formation	- 0.02	- 0.00	0.00	- 0.02	0.00
Exports	0.00	0.00	0.00	0.00	0.00
Imports	0.02	0.00	0.00	0.01	0.01
Real GDP: second year after shock*	**- 0.59**	**- 0.11**	**- 0.11**	**- 0.34**	**- 0.03**
of which:					
Private consumption	- 0.21	- 0.04	- 0.08	- 0.07	- 0.02
Government expenditure	0.01	0.00	0.00	0.01	0.00
Private investment	- 0.48	- 0.09	- 0.05	- 0.33	- 0.01
Residential private investment	*- 0.15*	*- 0.01*	*- 0.01*	*- 0.13*	*0.00*
Non-residential private investment	*- 0.29*	*- 0.08*	*- 0.04*	*- 0.17*	*0.00*
Inventory formation	*- 0.04*	*- 0.00*	*- 0.00*	*- 0.03*	*- 0.01*
Exports	0.00	0.00	0.00	0.00	0.00
Imports	0.09	0.02	0.02	0.05	0.00
Real GDP: third year after shock*	**- 1.01**	**- 0.25**	**- 0.21**	**- 0.53**	**- 0.02**
of which:					
Private consumption	- 0.35	- 0.08	- 0.12	- 0.14	- 0.01
Government expenditure	0.03	0.01	0.00	0.01	0.01
Private investment	- 0.87	- 0.23	0.11	- 0.49	- 0.04
Residential private investment	- 0.17	- 0.01	- 0.01	- 0.14	- 0.01
Non-residential private investment	- 0.64	- 0.20	- 0.09	- 0.32	- 0.03
Inventory formation	- 0.06	- 0.02	- 0.01	- 0.03	0.00
Exports	0.00	0.00	0.00	0.00	0.00
Imports	0.18	0.05	0.04	0.09	0.00

Table III.2 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: A temporary increase in the call rate of 100 basis points during two years (exchange rates exogenous)

	Total	Income/ cash flow	Wealth	Cost of capital	Discre-pancy
Real GDP: fourth year after shock*	**- 0.80**	**- 0.29**	**- 0.20**	**- 0.33**	**0.02**
of which:					
Private consumption	- 0.32	- 0.10	- 0.11	- 0.12	0.01
Government expenditure	0.04	0.01	0.01	0.02	0.00
Private investment	- 0.70	- 0.25	- 0.14	- 0.30	- 0.01
Residential private investment	*- 0.08*	*- 0.02*	*- 0.02*	*- 0.04*	*0.00*
Non-residential private investment	*- 0.58*	*- 0.21*	*- 0.11*	*- 0.25*	*- 0.01*
Inventory formation	*- 0.04*	*- 0.02*	*- 0.01*	*- 0.01*	*0.00*
Exports	0.01	0.00	0.00	0.00	0.01
Imports	0.16	0.05	0.04	0.07	0.00
Real GDP: fifth year after shock*	**- 0.23**	**- 0.14**	**- 0.15**	**0.01**	**0.05**
of which:					
Private consumption	- 0.15	- 0.07	- 0.08	- 0.02	0.02
Government expenditure	0.03	0.01	0.01	0.01	0.00
Private investment	- 0.19	- 0.12	- 0.10	0.00	0.03
Residential private investment	*- 0.03*	*- 0.02*	*- 0.02*	*0.00*	*0.01*
Non-residential private investment	*- 0.19*	*- 0.10*	*- 0.08*	*- 0.03*	*0.02*
Inventory formation	*0.03*	*- 0.00*	*- 0.00*	*0.03*	*0.00*
Exports	0.01	0.00	0.00	0.00	0.01
Imports	0.07	0.03	0.03	0.01	0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Interest rate transmission in the Netherlands: results for the Nederlandsche Bank's model MORKMON II

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I. INTRODUCTION

This paper presents the results of an empirical analysis of interest rate transmission in the Netherlands, based on policy simulations with the Nederlandsche Bank's macroeconometric model MORKMON II. The main aim of this analysis is to provide an insight into the possible economic consequences of a change in the policy-controlled interest rate. To this end, two policy experiments were performed, as agreed upon in the BIS simulation comparison project on central bank macroeconometric models and the monetary policy transmission mechanism, in which context this study has been conducted. Both policy experiments concern a temporary rise in the short-term interest rate. The first experiment assumes a simultaneous reaction of the exchange rate against non-ERM currencies, while in the second experiment nominal exchange rates remain unchanged. As the analysis is based on MORKMON II, the results obtained are conditional upon the theoretical framework underlying this model.

The next section deals with the design of the policy experiments conducted and the specific assumptions used. Section III briefly describes the main features of the model MORKMON II, with special emphasis on its structural characteristics, the modelling of the monetary sector and the channels of monetary transmission. Section IV discusses the simulation results and addresses the role of the financial structure of the Dutch economy in obtaining these results. Section V focuses on the interest rate transmission channels *per se* and on the relative importance of their contribution to the final effects on real GDP and its components. Section VI presents a summary of the main findings and briefly evaluates the role of specific underlying assumptions and model properties for the outcomes of the policy experiments.

II. THE POLICY EXPERIMENTS

The empirical analysis in this study concentrates on the effects of a temporary change in the policy-determined interest rate on the Dutch economy. In the case of the Netherlands, the policy experiments agreed upon in the BIS simulation comparison project result in the following two simulations:

(i) a temporary increase in the short-term interest rate of 100 basis points in 1994 and 1995, assuming endogenous nominal exchange rates between ERM and non-ERM currencies;

(ii) a temporary increase in the short-term interest rate of 100 basis points in 1994 and 1995, assuming fixed nominal exchange rates.

The effects of the interest rate changes in the model MORKMON II are highly symmetrical, so that the results presented here may - apart from the sign - be considered equally representative for interest rate decreases.

The point of impact of the experiments is the short-term three-month deposit interest rate. This rate depends on the Nederlandsche Bank's monetary policy of stabilising the exchange rate of the

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guilder against the Deutsche Mark. This policy is effected by managing money market interest rates vis-à-vis their German counterparts. In MORKMON II, this monetary policy is described by means of a policy reaction function for the short-term interest rate (see Section III). The experiments have been implemented by exogenising this reaction function and subsequently raising short-term interest rates.

The baseline projection for 1994 and 1995 is based on information concerning actual developments in the Netherlands and the world economy up to the first quarter of 1994. Assumptions on interest rates and exchange rates reflect actual developments up to August 1994 as much as possible. The baseline projections of exogenous foreign output, trade and prices, as summarised in Table 1, are mainly based upon developments described in the IMF World Economic Outlook of April 1994, which have been interpreted in terms of the relevant model variables. For the period 1996-2000 technical assumptions are used such as constant nominal exchange rates and interest rates, a 2% annual inflation rate and a 2.5% annual rate of real growth. Earlier results have shown the model outcomes to be rather insensitive to alternative initial conditions, as long as these conditions do not deviate radically from those incorporated in the original baseline.

Table 1

Baseline values of selected exogenous variables

(changes in percentages, unless otherwise stated)

	1993	1994	1995	1996	1997	1998	1999	2000
1. Foreign interest rates (%)								
Short-term interest rate: Germany	7.2	5.2	5.0	5.0	5.0	5.0	5.0	5.0
Long-term interest rate: Germany	6.5	6.7	7.0	6.5	6.5	6.5	6.5	6.5
Short-term interest rate: United States	3.2	4.5	5.0	5.0	5.0	5.0	5.0	5.0
Long-term interest rate: United States	5.9	6.9	7.0	6.5	6.5	6.5	6.5	6.5
2. Oil prices and other commodity prices								
Import price energy in guilders	-8.5	-1.3	3.6	1.9	1.9	2.0	2.0	2.0
Import price commodities in guilders	-2.3	1.6	3.5	2.0	2.0	2.0	2.0	2.0
3. Foreign prices								
Export price competitors in guilders	-2.2	2.6	2.0	2.0	2.0	2.0	2.0	2.0
Import price consumer goods	-1.0	1.8	1.7	2.0	2.0	2.0	2.0	2.0
Import price investment goods	-1.5	1.5	1.7	2.0	2.0	2.0	2.0	2.0
4. Foreign output								
Real GDP OECD	1.0	2.0	2.5	2.5	2.5	2.5	2.5	2.5
5. World trade								
World trade volume relevant to Dutch exports	-1.8	3.5	5.5	3.5	3.5	3.5	3.5	3.5
6. Other important exogenous variables								
Guilder per Deutsche Mark (parity, level)	1.127	1.127	1.127	1.127	1.127	1.127	1.127	1.127
Dollar per Deutsche Mark (level)	1.653	1.626	1.560	1.560	1.560	1.560	1.560	1.560

The simulation period is 1994-2000, starting in the first quarter of 1994. The temporary short-term interest rate rise of 100 basis points relates to the period 1994-95. After 1995, the short-term rate instantly returns to its base level. As term-structure effects in the Netherlands are highly dependent on their German counterparts, the term-structure outcomes generated by the Bundesbank model (Jahnke and Reimers, 1994) are used as input to our model simulations for the Netherlands. According to these results, a 100 basis points increase in the German policy-controlled interest rate results in a 20 to 25 basis points rise of the long rate, which implies a considerable flattening of the yield curve. In both simulation experiments, we ignore the effects of foreign interest rate changes on foreign output and prices, which are exogenous to the model.

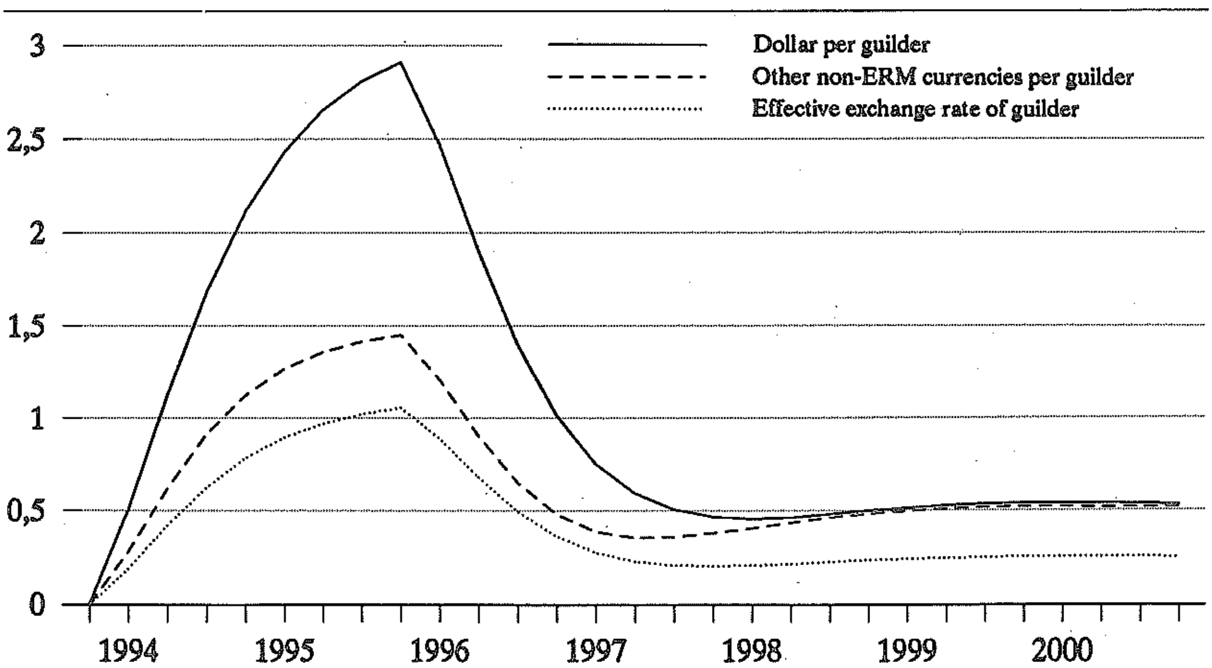
In the first experiment, all countries currently participating in the ERM raise short-term interest rates in a way which is consistent with fixed nominal exchange rates between ERM currencies. This implies that all ERM countries increase their short-term interest rates by 100 basis points. We further assume that the interest rate rise is attended by an appreciation of ERM currencies against the dollar and other non-ERM currencies. This appreciation is derived from the simulation results for the exchange rates generated by the Bundesbank model (Jahnke and Reimers, 1994), and comes rather close to those generated by the model MEFISTO of the Banque de France (Cordier and Ricart, 1994). As a result of this procedure, which enhances the comparability of the policy experiments for the Netherlands, Germany and France, the cumulated nominal effective appreciation of the guilder compared to baseline amounts to 0.8% at the end of 1994 and reaches a maximum of just over 1.0% at the end of 1995, as shown in Chart 1. Thereafter, with short-term interest rates returning instantly to their baseline levels, the effective appreciation stabilises at 0.2% in the years 1998-2000. In the second policy experiment, both domestic and foreign short-term interest rates are raised by 100 basis points, in line with the assumption of fixed nominal exchange rates.

In both simulations, we abstract from fiscal policy rules which ensure intertemporal budget solvency. In the present Dutch context such rules may equally well imply automatic cuts of expenditures or increases in tax rates, of which the latter are most prominent in other models that do have endogenous fiscal solvency rules. Furthermore, since in both policy experiments deficits and debts deviate only modestly from baseline levels, incorporating fiscal solvency rules has only limited effects on the results. In the standard model version used here, tax rates, real government consumption as well as some minor types of nominal government outlays (certain types of income and capital transfers not related to social security) remain at their baseline levels. Approved budgets for the latter outlays are assumed to be unchanged. Other government expenditure categories are endogenous in the model.

Chart 1

Response of exchange rates to a 100 basis points increase in short-term interest rates in 1994 and 1995

(percentage deviations from baseline)



III. A BIRD'S-EYE VIEW OF THE MODEL MORKMON II

MORKMON II, acronym for the Dutch equivalent of Monetary-Real Quarterly Model for the Netherlands, is a quarterly macroeconometric policy model used for short and medium-term forecasting and policy analysis. The model consists of about 400 equations, of which 80 are estimated behavioural equations. A detailed description of the model including a full listing of the equations and a number of simulation experiments can be found in Fase *et al.* (1992). MORKMON II is the updated and improved version of its predecessor, which has been used at the Nederlandsche Bank since the early 1980s.

Broadly speaking, the model fits the modern-Keynesian tradition. Apart from the usual demand-side effects, supply-side effects play an important role in goods and labour markets. Moreover, wealth effects and income effects ensuing from interest and dividend payments are incorporated. In view of the latter, stock and bond markets are explicitly modelled including valuation and exchange rate effects. Expectations are adaptive and sometimes modelled implicitly by means of related variables. The simulation properties of MORKMON II appear to be relatively insensitive to the incorporation of forward-looking model-consistent expectations (Bikker *et al.*, 1993). For the open economy of the Netherlands the main candidates for model-consistent expectations, such as the long-term interest rate, exchange rates and prices, essentially depend on foreign (German) variables exogenous to the model.

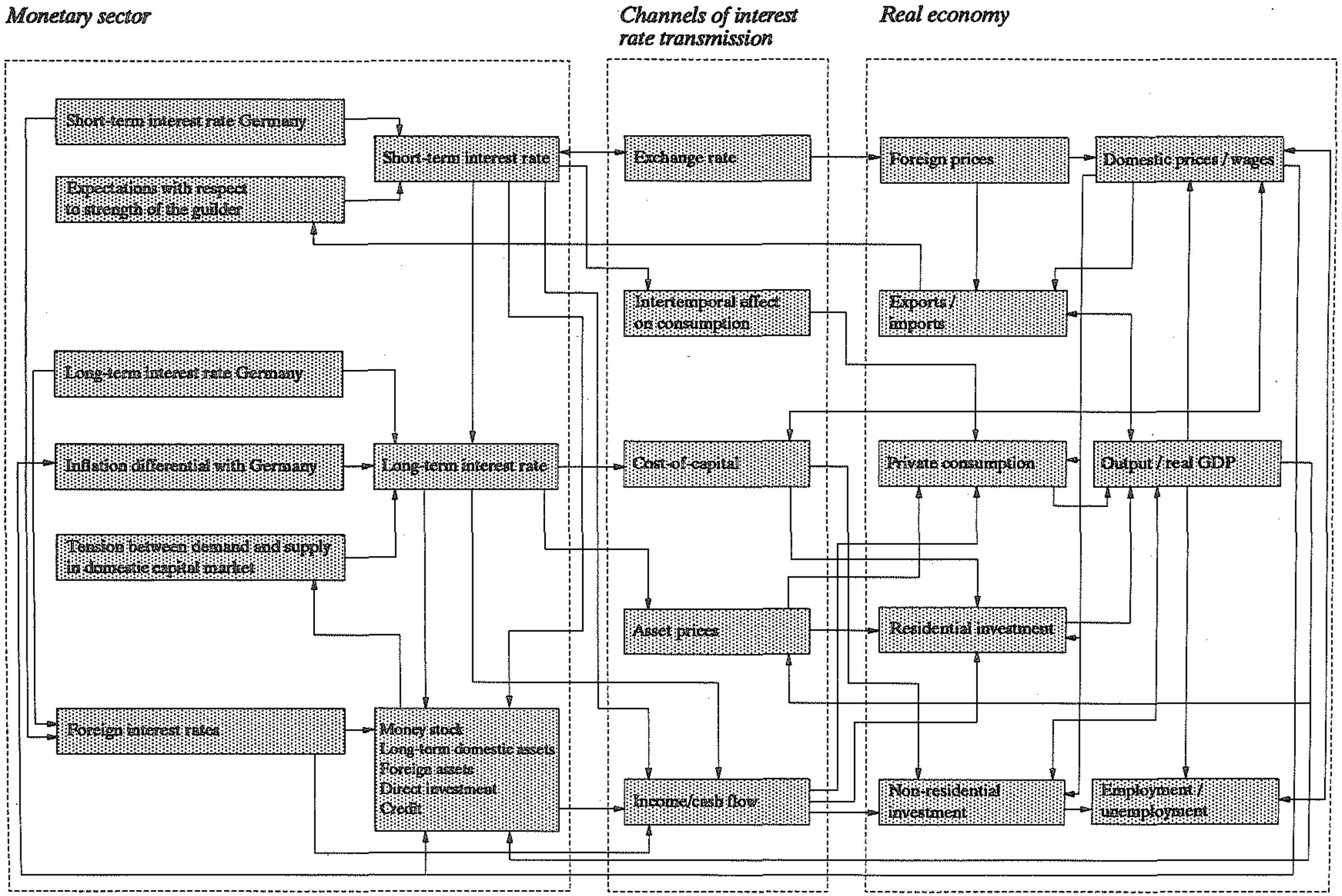
At the core of the monetary sector of MORKMON II are the supply of and the demand for financial assets present on the balance sheets of seven sectors: households, firms, pension funds including life insurance companies, banks, the central bank, the public sector and the foreign sector. There are about fifteen types of assets. The central interest rates are the money market or short-term rate (three-month deposit rate) and the capital market or long-term rate (yield on government bonds with an original maturity of ten years). The short-term interest rate follows from a policy reaction function, which reflects the monetary policy of stabilising the exchange rate of the guilder vis-à-vis the Deutsche Mark. It is directly attuned to the corresponding German rate, apart from expectations regarding the relative weakness or strength of the guilder, which are modelled as varying with the (lagged) spot premium of the guilder against the Deutsche Mark and the balance of trade.

The long-term interest rate strongly depends on the German long-term rate. Additional explanatory variables are exchange rate expectations, measured by the inflation differential with Germany, and tensions between supply and demand in the domestic capital market. The long-term interest rate also represents the interest rates charged on long-term credit and mortgages to enterprises, households and the public sector. Other interest rates considered in the model are the rate on short-term bank credit, which depends on the short-term interest rate and the discount rate on promissory notes, the rates on demand deposits and time deposits, which are closely connected to the short-term interest rate, and the rate on savings deposits, which depends on both short and long-term market rates. The determination of these interest rates reflects the banks' price-setting behaviour and is broadly consistent with the results of a recent survey on bank behaviour in the Netherlands (Swank, 1994).

The financial behaviour of households, firms, pension funds and banks is described by Brainard-Tobin (1968) type portfolio models (Fase, 1979 and 1984; Bikker and Van Els, 1993). The allocation of assets depends on the relevant interest rates, with gross substitution holding in the long run, and on other explanatory variables such as nominal GNP and the output gap, the latter measuring the state of the business cycle. Within this framework, liquid assets held by the private sector - M_2 and M_3 - are determined. The monetary sector of MORKMON II also contains behavioural equations for asset prices, the dollar exchange rate, short and long-term credit demand by households and firms, trade credit, and direct investment of the foreign sector. A flow of funds like system of equations describes the flows of interest and dividend payments between the seven sectors considered. This system, which is rather unique in its completeness, is based on the allocation of assets and liabilities across sectors and makes it possible to quantify in detail the income effects of interest and dividend changes on expenditure.

Chart 2

Interest rate transmission in MORKMON II



As said before, the real sector is modelled in a modern-Keynesian way. Real GDP is demand-determined in the short run because of sticky wages and prices in the non-tradables sector in particular. In the longer run, supply factors do affect output through the influence of the endogenous output gap, defined as the rate of capacity utilisation, on prices, non-residential private investment, import demand and exports. Potential output depends on real wages, real capital costs and accumulated capital within a vintage-model framework. Prices are modelled as costs plus a mark-up, which depends on the output gap and prices of foreign competitors. Wage determination reflects the bargaining process between employers and employees, incorporating hysteresis and Phillips curve effects of unemployment, and the shifting of taxes and social security premiums.

As Chart 2 shows, monetary transmission in MORKMON II mainly operates through interest rate transmission channels, of which the quantitative significance is further discussed in Section V. These channels consist of the exchange rate, the intertemporal substitution of consumption and savings, the (user) cost of capital, house prices and financial asset prices, and the income and cash-flow channel. Changes in the money stock affect real economic activity only indirectly via income and cash-flow effects. Given the exchange rate policy and the high degree of capital mobility, the money stock is to a large extent endogenous. The availability of credit and equity, which constitute important monetary transmission channels in modern business cycle theories based on asymmetrical information, adverse selection and moral hazard in financial markets (Bernanke, 1983; Greenwald and Stiglitz, 1993), does not influence real economic activity explicitly. Elements of credit and equity rationing, for which some evidence has been found for the Netherlands (Swank, 1994), are captured, however, by the use of firms' after-tax cash flow and cumulated savings as the main financial indicators determining non-residential private investment in both the short and the long run. This is in line with the relatively strong preference of Dutch firms for financing investment from internally generated funds (De Haan, Koedijk and de Vrijer, 1994).

MORKMON II has no explicit steady state. However, long-run properties have been taken into account by using error correction specifications, modelling short-term dynamics and adjustment towards long-term equilibrium relationships. The main equilibrium-restoring mechanisms in the labour and goods market are the endogenous unemployment rate and the degree of capacity utilisation which show up in the equations for wages, prices, imports of goods and non-residential investment. Apart from these mechanisms, other long-term relationships are important to the model's simulation properties. Cost and price equations are homogeneous with respect to (foreign) price variables. Purchasing power parity holds for prices of traded goods, with export prices being almost instantly fully determined by foreign competitors' prices. Private consumption features homogeneity in disposable income and wealth. Portfolio behaviour of households, enterprises, pension funds and banks is based on gross substitution of assets (Bikker and Van Els, 1993). Long-run money neutrality has not been imposed.

IV. SIMULATION RESULTS AND THE ROLE OF FINANCIAL STRUCTURE

This chapter analyses the impact of the policy experiments on the Netherlands' economy according to the model MORKMON II, also in connection with the financial structure of the Dutch economy. As stated before, in designing the simulations the effects of a foreign interest rate rise on world trade and prices are ignored. Hence, if higher interest rates reduce world trade growth, and according to many world models they do, the effects on the Dutch economy reported in this section will underestimate the true adverse impact on real GDP. Another general remark concerns the openness of the Netherlands' economy, with total imports amounting to 46% of GDP in 1993. This implies that the effects of the policy experiments are passed on to foreign countries to a considerable extent.

1. Endogenous exchange rates vis-à-vis non-ERM currencies

The simulation outcomes for the first policy experiment are reported in Tables I.1 and II.1. The temporary 100 basis points increase in short-term interest rates results in a rise of the long-term interest rate of 26 basis points in 1994 and 31 basis points in 1995. The increase in the rates of short-term lending and time deposits, set by banks, follows the increase in money market rates. Due to a small reduction in inflation, the rise of the real long-term interest rate slightly exceeds the increase in the nominal rate. The reduction in inflation is caused by the nominal effective appreciation of the guilder. In the medium term, the real effective exchange rate approximately returns to its baseline level. Owing to higher long-term interest rates and the lower general price level, stock prices and house prices fall below their baseline levels. The reduction in stock and bond prices causes households' financial wealth to decrease initially. This reduction is followed by a recovery to above-baseline levels in 1997-2000, mainly owing to a higher propensity to save, caused by higher real interest rates, and an improvement in household net investment income.

M_2 and M_3 initially rise due to the increase in the short-term interest rate, which considerably exceeds that of the long rate. Households and firms reallocate their portfolios, raising the share of liquid assets at the cost of capital market investments or long-term savings deposits. Thus, the rise of M_2 and M_3 mainly stems from the flattening of the yield curve, which largely originates from Germany. With stronger term-structure effects, money holdings would have dropped below baseline levels. The initial increase in M_2 and M_3 is consistent with the semi-elasticities for short-term and long-term interest rates in money-demand equations for the Netherlands (Fase and Winder, 1993). In 1996, when short-term rates return to baseline levels, M_2 falls below its base value in line with transactions demand. In contrast, M_3 remains just above baseline due to the sluggish reallocation of savings between short-term and long-term saving deposits in response to changes in the term structure. The reduction in domestic bank credit to the private sector is caused by the increase in interest rates, the long rate in particular, the decline of house prices and the reduction in expenditure.

The temporary rise of domestic interest rates and the effective appreciation of the guilder initially have a modest negative impact on real activity. The sluggish negative response of real GDP in the first year is caused to some extent by the lagged impact of the decline of the cash flow of non-financial enterprises on non-residential investment. In 1995, the reduction in real GDP reaches a maximum of -0.18%. A similarly small effect of short-term interest rate shocks results from an analysis with a VAR model for the Netherlands (Boeschoten *et al.*, 1994). The main contributors to the decline of GDP are residential and non-residential investment and private consumption (see also Table III.1). Despite the effective nominal appreciation of the guilder, the contribution of exports to the decline of GDP in 1994 is small. This reflects the fact that Dutch exporters almost instantly adjust their prices to those of foreign competitors. In 1995, as the decrease in capacity utilisation forces producers to seek additional sales abroad, exports are even above baseline. Owing to the effective appreciation of the guilder, the deflators of GDP and private consumption fall. In the long run, domestic prices tend to move in line with foreign prices. The reduction in wages is caused by both lower prices and higher unemployment. Government finances deteriorate mainly due to the rise of the long-term interest rate. In 1996, at the maximum, the central government financial deficit and the public sector debt are 0.19% of GDP and 0.79% of GDP above baseline, respectively.

2. Fixed nominal exchange rates

The results for the second policy experiment are presented in Tables I.2 and II.2. With inflation almost unchanged, nominal and real interest rates move in parallel. As there is no fall in prices, the increase in the real long-term interest rate and the user cost of capital is smaller than in the case of endogenous exchange rates, while the reduction in asset prices and households' wealth in 1994 and 1995, which is caused by the increase in long-term interest rates, is also more modest than for the first policy experiment. M_2 and M_3 initially rise owing to the increase in short-term interest rates, which again clearly exceeds the increase in long-term interest rates. After 1995, M_2 returns to its baseline level; for M_3, adjustment takes more time for reasons already discussed in Section 1.

In the absence of exchange rate effects, the negative response of real GDP, reaching a maximum impact of -0.14% in 1996, is smaller than in case of endogenous exchange rates. Again, private consumption, residential and non-residential investment are the main contributors to the reduction in real GDP. The private consumption deflator slightly exceeds baseline levels, owing to the increase in the user cost of capital. This increase offsets the negative impact on prices of lower wages and the larger output gap. The increase in the central government financial deficit and the stock of public debt is fairly small, with maximum effects amounting to about 0.10% of GDP and 0.30% of GDP, respectively.

The results of both experiments suggest that, with temporary interest rate shocks, real GDP eventually returns to its baseline level, even when nominal prices stabilise below baseline. This is due to fact that in the long run relative (factor) prices and the real effective exchange rate remain unchanged. Hence, long-term aggregate supply is not affected. Given the equilibrium-restoring mechanisms at work, this implies that real GDP cannot permanently deviate from baseline either. Medium-term deviations from base levels mainly reflect the internal dynamics of the model.

3. The role of financial structure

Given the policy of the monetary authorities to stabilise the exchange rate vis-à-vis the Deutsche Mark, Dutch short and long-term interest rates are highly dependent on their German counterparts. In addition, due to the fact that there are no restrictions on international capital market transactions, the Dutch long-term interest rate is hardly affected by changes in the tension between supply and demand in the domestic capital market. In this sense, domestic financial structure is not a crucial factor in the determination of long-term interest rates and the term structure in the Netherlands.

Focusing explicitly on interest rate transmission, it may be concluded that in the Netherlands financial structure limits the impact of short-term interest rate changes on real activity. In particular, the significance of the income channel for the transmission of changes in short-term interest rates is mitigated by the fact that the balance sheets of most sectors are dominated by assets and liabilities whose yields are mainly determined by capital market rates. Noteworthy in this respect is that short-term debt plays a rather modest role in the balance sheets of households and firms. In 1993, short-term credit amounted to less than 10% of total borrowing by households and about 15% of total borrowing by firms including equity raised. For the government sector, in 1993 short-term debt was about 1% of total government debt (see also Boeschoten *et al.*, 1993). This relatively strong orientation of the private and public sector towards long-term borrowing has been stimulated, among other things, by the conduct of monetary policy in the Netherlands since the Second World War (Mallekoote and Moonen, 1994).

The importance of the exchange rate as a channel of interest rate transmission on real economic activity is limited first and foremost by the fact that the Netherlands' most important trading partners - Germany, Belgium and France - participate in the ERM. On the other hand, owing to large holdings of foreign assets by the private sector, financial structure reinforces the impact of exchange rate changes on real activity. For households, non-financial firms and pension funds, these holdings, including direct investment, amounted to over Fl. 250 billion in 1990 (50% of GDP, see Sparling, 1993). Hence, an appreciation of the guilder clearly results in a decrease in private sector wealth and in interest and dividend income received from the foreign sector. This will have a negative impact on real activity, although the accompanying reduction in the general price level will mitigate the real effects.

As may be expected from the foregoing, changes in long-term interest rates have a bigger impact on the real economy than equivalent changes in short-term interest rates. Indeed, simulations with MORKMON II show that an increase in long-term interest rates by 1 percentage point, with short-term interest rates unchanged, results in a decline of real GDP by 0.5%, whereas an increase in short-term interest rates by 1 percentage point, with long-term rates fixed, has almost no impact on real GDP. Moreover, these results are fairly consistent with impulse response effects generated by a VAR model for the Netherlands (Boeschoten *et al.*, 1994).

With government debt almost completely long-term financed, government finances are not affected by changes in the short-term interest rate itself. Since government debt is fully denominated in guilders, the sensitivity of the budget to changes in exchange rates is also limited. On the other hand, changes in the dollar exchange rate do affect government finances through the substantial government receipts from sales of natural gas, the price of which is based on the dollar price of crude oil. Nonetheless, the main reason for the worsening of government finances in both policy experiments is the increased burden of interest payments due to the higher long-term interest rate.

Finally, the net debtor position of non-financial enterprises and the net creditor position of households have consequences for the transmission of interest rate changes on the real economy, as changes in net investment income of these sectors affect non-residential investment and private consumption, respectively. On the other hand, pension funds, which are by far the largest net creditors and benefit most from an increase in interest rates, contribute at least in the short run only marginally to changes in real GDP. In the medium term, however, they will reduce pension premiums in response to higher long-term interest rates, resulting in lower total wage costs for firms and higher disposable incomes for households. The net creditor position of pension funds thus contributes to the recovery of real GDP in the course of time.

V. RELATIVE IMPORTANCE OF CHANNELS OF INTEREST RATE TRANSMISSION

The structure of MORKMON II allows for attributing the total effects of the simulated interest rate changes on real activity to the following five transmission channels:

(i) the income channel, which captures the impact of interest rate changes on the flows of interest and dividend payments between sectors and on pension premiums paid by employers and employees;

(ii) the wealth channel, representing the impact of interest rate changes on expenditure through the response of financial asset prices and house prices and, hence, the value of households' wealth;

(iii) the direct interest rate channel on consumption, which captures the intertemporal substitution effect of the change in interest rates on private consumption;

(iv) the cost-of-capital channel, capturing the effects of the user cost of capital on non-residential investment and on prices, as well as the direct effects of the change in interest rates on residential investment and inventory formation;

(v) the exchange rate channel, which represents all effects triggered by the response of exchange rates to the change in interest rates.

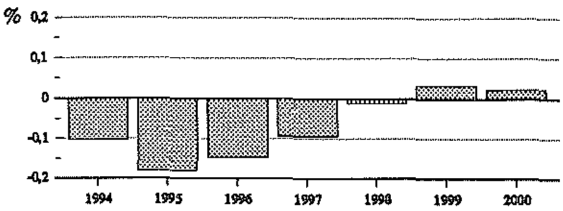
For both policy experiments considered, the relative importance of each of these channels has been investigated by means of a decomposition. To that end, each of the channels has been simulated separately against the baseline projection. This has been done by allowing the interest rate changes to affect only one channel at a time, using the full simultaneous structure of the model when simulating these changes (see Mauskopf and Siviero, 1994). Due to the interaction between different channels, the decomposed contributions do not necessarily add up to the simulated total effects. The residual effects in the underlying analysis are, however, small in magnitude, although they tend to increase somewhat towards the end of the simulation period. An alternative approach is to eliminate

Chart 3

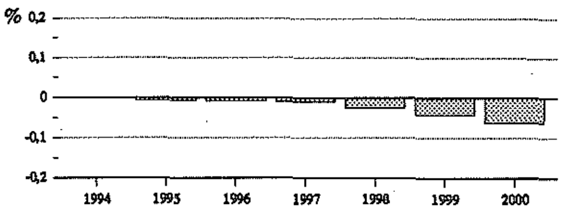
Decomposition of effects of 100 basis points increase in short-term interest rate in 1994 and 1995

Endogenous exchange rates

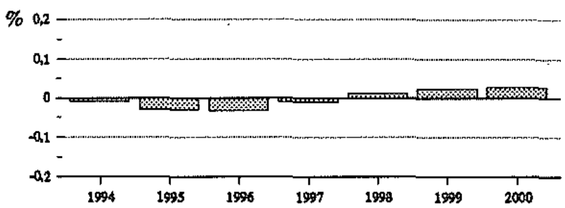
Effects on real GDP



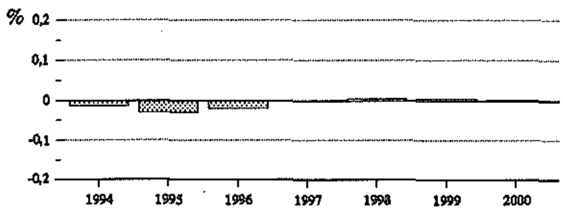
Contribution income/cash flow channel



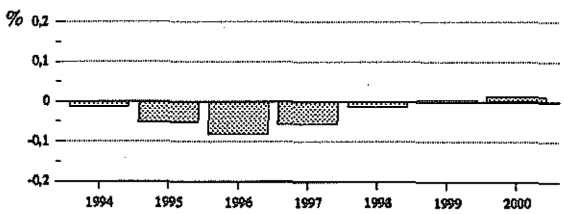
Contribution wealth channel



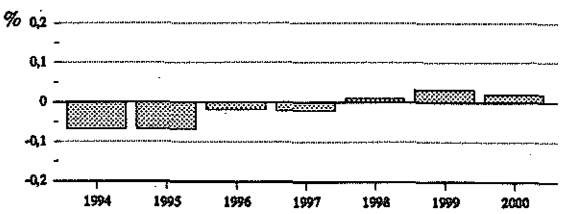
Contribution direct effect on consumption



Contribution cost-of-capital channel

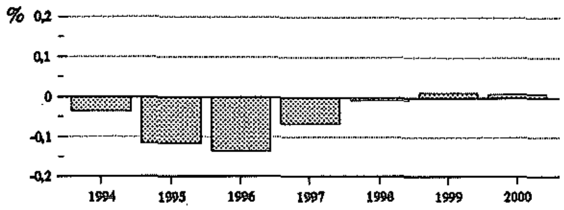


Contribution exchange rate channel

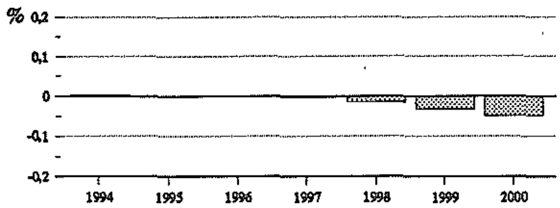


Fixed nominal exchange rates

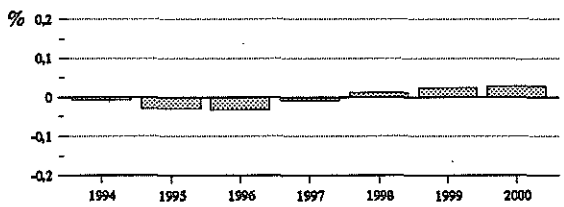
Effects on real GDP



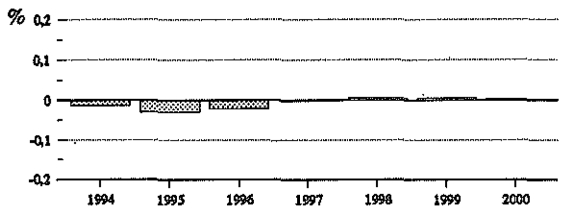
Contribution income/cash flow channel



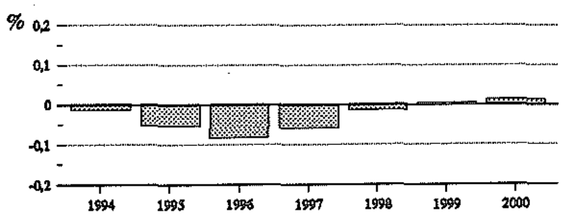
Contribution wealth channel



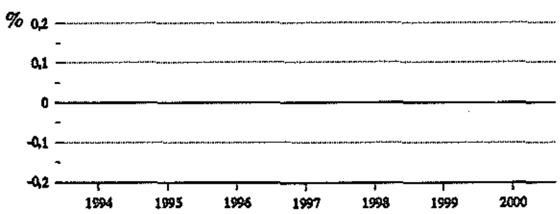
Contribution direct effect on consumption



Contribution cost-of-capital channel



Contribution exchange rate channel



each of the channels successively. In that case, the contributions exactly add up to the total effect. The disadvantage of this approach, however, is that the importance of the channels depends on the sequence of elimination.

As Chart 3 and Tables III.1 and III.2 illustrate, the quantitative contributions of each individual transmission channel to the change in GDP, with the exception of the exchange rate channel, are quite similar for both policy experiments. In the short run, the exchange rate channel is the dominant contributor to the decline of real GDP. This channel is mainly driven by the increase in imports owing to the effective appreciation of the guilder. In year two, one-third of the reduction in GDP is accounted for by the wealth channel and the intertemporal substitution effect, both of which affect consumption, one-third by the exchange rate channel, and one-third by the cost-of-capital channel. The latter channel runs through both investment categories, residential investment in particular. In year three, the cost-of-capital channel has become the major contributor, accounting for more than half of the reduction in GDP. The contribution of the income/cash flow channel in the first four years is almost nil. A closer look reveals that negative cash flow effects on non-residential investment are balanced by positive income effects on private consumption. Households' disposable income benefits from increasing receipts on short-term and long-term assets exceeding interest payments on mortgages, which rise only gradually. Towards the end of the simulation period, the cash flow channel becomes more important, in particular by further depressing non-residential investment. This reflects the net debtor position of non-financial enterprises. However, all other transmission channels now contribute positively to real GDP, which reaches a level just slightly above that in the baseline.

VI. EVALUATION

The results of the present analysis show that a change in the policy-determined short-term interest rate *per se* only slightly affects real economic activity in the Netherlands. This is mainly due to the financial structure, with short-term borrowing playing a relatively modest role in the balance sheets of the private and public sector. The principal effects of a change in the short-term interest rate are indirect, in the sense that they arise through the response of the long-term interest rate and - depending on the development of foreign interest rates - the exchange rate. These two variables play a key role in the transmission process. According to the two policy experiments considered, a temporary 1 percentage point increase in the short-term rate leads to a 0.2% or 0.1% decrease of GDP at maximum, depending on whether the exchange rate of ERM countries vis-à-vis non-ERM countries is endogenous or kept constant. The response of the economy to an interest rate rise is rather sluggish, partly because the decline of non-financial enterprises' cash flow affects non-residential investment with a lag. Apart from the exchange rate channel, the contributions of the other channels of interest rate transmission to the change in real GDP are remarkably similar for both policy experiments.

Like all the results presented in this paper, these findings are conditional on a great number of assumptions. The first layer of these assumptions concerns the use of the macroeconometric model MORKMON II. Apart from the specific characteristics embodied in this model, dealt with in Section III, also more general aspects have to be mentioned, like the implicit assumption of the validity of policy simulation experiments in the first place (contrary to the Lucas-critique), and the difficulty of taking credibility effects into account. Another issue, which relates to the model, is the absence of credit-supply effects on investment. These effects may be important to small firms in particular, although there is no empirical evidence on the magnitude of these effects and measures for the availability of credit are difficult to obtain.

A second layer of assumptions concerns the design of the policy experiments, which to some extent reflects the necessity of comparability with the results for the other countries participating in the BIS simulation comparison project. In this context, at least four issues have to be mentioned. The first and in this context probably most important one is the term-structure effect. On the basis of simulation results by the Bundesbank model, a 1 percentage point increase in the short-term interest rate is assumed to be attended by a 0.2 percentage point increase in the long-term rate. As recent experiences have again shown, the yield curve depends on a wide range of factors and is very sensitive to changes in expectations and sentiments, and therefore relatively difficult to model or forecast, especially in the short run. Due to the key role of the long-term interest rate in the transmission process in the Netherlands, the term-structure effect is of crucial importance to the results of the policy experiments considered here. If a 1 percentage point increase in the short-term interest rate would, for instance, lead to a 1 instead of a 0.2 percentage point increase in the German long-term interest rate, then the maximum impact on GDP would more than double from -0.2% to -0.5%.

A second source of uncertainty, also related to expectations formation, are the assumptions regarding the response of exchange rates to changes in interest rates. If, for instance, exchange rates instantly jump, as is in accordance with forward-looking behaviour and open interest parity, then the exchange rate channel may be more pronounced than it is in the simulation results presented here.

A third source of uncertainty is the response of government financing to interest rate changes. In our policy experiments, it has been assumed that the rise of government expenditure is financed by issuing long-term government debt. Alternatively, one may postulate that it is financed by higher income taxes, as is done in models using fiscal solvency rules. In that case, the adverse effects of higher interest rates on real activity would be stronger than presented here. The additional decrease in real GDP will, however, not exceed 0.1% in the case of endogenous exchange rates and will even be smaller in the case of fixed nominal exchange rates.

A fourth source of possible distortion of the results, which is related to the design of the experiments, is the fact that the effects of a foreign interest rate rise on world trade and prices have been ignored. Insofar as higher interest rates reduce world trade growth, the effects on the Dutch economy presented in this study underestimate the true adverse impact of an interest rate rise on real GDP. This element is of particular interest to an open economy, like that of the Netherlands. If, alternatively, we allow for the responses of world trade and prices as computed by means of the multi-country model NIGEM (NIESR, 1994), then the decline of real GDP in the Netherlands amounts to approximately 0.4% instead of 0.18% as reported in the present study.

The former considerations and sensitivity analysis point to some of the main uncertainties surrounding the results of the policy experiments. They suggest that the interest rate transmission effects presented here are underestimating rather than overestimating the true effects. On the other hand, the outcomes of a number of recent empirical studies, such as a VAR analysis of monetary transmission and money demand and other research, suggest that the results for the Netherlands obtained by the macroeconometric policy model MORKMON II regarding the transmission of interest rate changes are quite robust.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)							
Three-month interest rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Long-term interest rate	0.26	0.31	0.05	0.02	- 0.02	0.00	0.04
3. Other interest rates (%)							
Short-term bank lending rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Time deposit rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
4. Real interest rates							
Real long-term interest rate (%)	0.27	0.39	0.18	0.11	- 0.01	- 0.03	0.04
User cost of capital	0.21	1.04	1.56	0.85	- 0.41	- 0.77	- 0.30
5. Exchange rates							
Nominal effective exchange rate	0.51	1.00	0.62	0.23	0.21	0.23	0.23
Real effective exchange rate	0.38	0.65	0.27	0.00	- 0.06	- 0.06	0.01
Guilder per Deutsche Mark	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Guilder per US dollar	- 1.33	- 2.70	- 1.69	- 0.58	- 0.47	- 0.53	- 0.54
6. Asset prices and wealth							
Stock prices	- 0.72	- 1.83	- 1.72	- 1.03	- 0.64	- 0.49	- 0.49
House prices	- 0.16	- 1.13	- 1.84	- 1.52	- 1.14	- 0.81	- 0.71
Households' financial wealth	- 0.78	- 1.05	- 0.18	0.35	0.72	0.68	0.44
Value stock of houses owned by households	- 0.16	- 1.14	- 1.86	- 1.56	- 1.16	- 0.83	- 0.72
7. Net interest and dividend receipts (% GDP)							
Households	0.06	0.09	0.05	0.02	0.02	0.02	0.01
Non-financial enterprises	- 0.21	- 0.14	0.04	- 0.04	- 0.06	- 0.06	- 0.05
Foreign sector	0.11	0.15	0.05	0.02	0.03	0.04	0.05
8. Money and credit							
M_2	0.63	0.52	- 0.56	- 0.69	- 0.46	- 0.28	- 0.21
M_3	0.34	0.43	0.12	0.05	0.04	0.07	0.05
Domestic bank credit to private sector	- 0.07	- 0.36	- 0.82	- 0.94	- 0.84	- 0.64	- 0.47
Domestic bank credit to government	- 1.06	- 1.25	1.04	0.01	0.10	0.44	0.16

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Two-year increase in domestic and foreign interest rates (exchange rates exogenous)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)							
Three-month interest rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Long-term interest rate	0.28	0.36	0.04	- 0.02	0.00	0.02	0.03
3. Other interest rates (%)							
Short-term bank lending rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Time deposit rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
4. Real interest rates							
Real long-term interest rate (%)	0.28	0.35	0.02	- 0.04	0.00	0.04	0.04
User cost of capital	0.22	0.70	0.96	0.72	0.25	0.02	0.05
5. Exchange rates							
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	0.02	0.06	0.07	0.04	0.00	- 0.01	0.00
Guilder per Deutsche Mark	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Guilder per US dollar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Asset prices and wealth							
Stock prices	- 0.69	- 1.63	- 1.23	- 0.45	- 0.24	- 0.24	- 0.26
House prices	- 0.13	- 0.99	- 1.54	- 1.08	- 0.64	- 0.41	- 0.34
Households' financial wealth	- 0.73	- 0.76	0.44	0.98	1.12	1.05	0.93
Value stock of houses owned by households	- 0.13	- 0.99	- 1.56	- 1.12	- 0.67	- 0.43	- 0.36
7. Net interest and dividend receipts (% GDP)							
Households	0.06	0.09	0.05	0.02	0.02	0.02	0.01
Non-financial enterprises	- 0.17	- 0.09	0.03	- 0.06	- 0.07	- 0.06	- 0.06
Foreign sector	0.00	0.00	- 0.02	- 0.03	- 0.04	- 0.03	- 0.03
8. Money and credit							
M_2	0.58	0.67	- 0.07	- 0.15	0.00	0.03	0.00
M_3	0.36	0.69	0.59	0.51	0.46	0.42	0.35
Domestic bank credit to private sector	- 0.05	- 0.29	- 0.64	- 0.64	- 0.46	- 0.28	- 0.16
Domestic bank credit to government	- 1.60	- 2.85	0.05	0.57	0.68	0.57	0.40

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)

Deviations from baseline[1]	1994	1995	1996	1997	1998	1999	2000
1. Real GDP and its components							
Real GDP	- 0.10	- 0.18	- 0.15	- 0.09	- 0.01	0.03	0.02
Private consumption	- 0.05	- 0.16	- 0.22	- 0.18	- 0.04	0.10	0.10
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	0.00	- 1.14	- 2.21	- 1.32	- 0.33	- 0.02	0.00
Non-residential private investment	- 0.24	- 0.91	- 1.23	- 0.75	0.06	0.84	1.04
Inventory formation (% GDP)	- 0.03	- 0.00	0.03	- 0.00	- 0.01	0.01	0.01
Exports of goods and services	- 0.04	0.05	0.10	0.06	0.02	- 0.03	- 0.07
Imports of goods and services	- 0.01	- 0.09	- 0.22	- 0.20	- 0.02	0.17	0.19
2. Unemployment rate (%)							
Registered unemployment rate	0.07	0.13	0.12	0.07	0.03	0.02	0.02
3. Real disposable income							
Real disposable wage income per employee	0.05	- 0.01	- 0.19	- 0.19	0.00	0.04	- 0.07
4. Inflation and wages							
GDP deflator	- 0.08	- 0.36	- 0.47	- 0.35	- 0.32	- 0.26	- 0.16
Private consumption deflator	- 0.13	- 0.35	- 0.35	- 0.23	- 0.27	- 0.29	- 0.22
Wage rate in enterprises	- 0.06	- 0.32	- 0.53	- 0.48	- 0.38	- 0.29	- 0.20
Unit labour cost in enterprises	- 0.01	- 0.28	- 0.55	- 0.51	- 0.43	- 0.35	- 0.24
Import price of goods	- 0.51	- 1.00	- 0.62	- 0.23	- 0.21	- 0.23	- 0.23
5. Government accounts (% of nominal GDP)							
Revenues (tax plus non-tax)	0.00	0.01	0.02	0.02	0.03	0.03	0.02
Primary expenditures	0.04	0.08	0.08	0.04	0.02	0.01	0.00
Interest payments	0.03	0.10	0.13	0.13	0.12	0.11	0.11
Central government financial deficit[2]	0.03	0.12	0.19	0.16	0.12	0.10	0.10
Public sector debt	0.17	0.56	0.79	0.78	0.78	0.76	0.74
6. Current account (% of nominal GDP)							
Trade balance	0.02	0.09	0.13	0.10	0.01	- 0.08	- 0.10
Net interest payments by foreign sector	- 0.03	- 0.08	- 0.06	- 0.03	- 0.03	- 0.04	- 0.04

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign). [2] The central government financial deficit is a major policy variable in the Netherlands; due to statistical distortions and differences in measurement (cash versus transactions based), the deficit may differ from the balance of primary expenditures plus interest payments minus revenues.

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Two-year increase in domestic and foreign interest rates (exchange rates exogenous)

Deviations from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.04	- 0.12	- 0.14	- 0.07	- 0.01	0.01	0.01
Private consumption	- 0.08	- 0.25	- 0.26	- 0.10	0.03	0.11	0.11
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.02	- 1.30	- 2.54	- 1.32	- 0.03	- 0.02	- 0.15
Non-residential private investment	- 0.17	- 0.61	- 0.75	- 0.43	- 0.02	0.34	0.46
Inventory formation (% GDP)	- 0.01	- 0.00	0.01	- 0.00	- 0.00	0.01	0.00
Exports of goods and services	- 0.00	0.01	0.10	0.01	- 0.01	- 0.04	- 0.05
Imports of goods and services	- 0.07	- 0.26	- 0.32	- 0.16	0.02	0.11	0.11
2. Unemployment rate (%)							
Registered unemployment rate (%)	0.02	0.06	0.08	0.04	0.01	0.01	0.01
3. Real disposable income							
Real disposable wage income per employee	0.00	- 0.05	- 0.11	- 0.06	0.05	0.06	0.00
4. Inflation and wages							
GDP deflator	0.00	- 0.01	- 0.03	- 0.03	- 0.01	0.02	0.05
Private consumption deflator	0.02	0.05	0.06	0.04	0.00	- 0.01	0.01
Wage rate in enterprises	0.00	- 0.05	- 0.12	- 0.12	- 0.07	- 0.02	0.01
Unit labour cost in enterprises	0.01	- 0.02	- 0.11	- 0.13	- 0.09	- 0.04	- 0.00
Import price of goods	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Government accounts (% of nominal GDP)							
Revenues (tax plus non-tax)	0.02	0.04	0.03	0.01	0.02	0.02	0.01
Primary expenditures	0.02	0.03	0.04	0.01	0.00	0.00	- 0.01
Interest payments	0.02	0.08	0.10	0.10	0.09	0.08	0.09
Central government financial deficit[2]	0.01	0.06	0.10	0.08	0.07	0.06	0.07
Public sector debt	0.03	0.16	0.29	0.30	0.29	0.30	0.32
6. Current account (% of nominal GDP)							
Trade balance	0.03	0.12	0.15	0.07	- 0.01	- 0.06	- 0.06
Net interest payments by foreign sector	0.06	0.05	0.00	0.02	0.03	0.02	0.02

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign). [2] The central government financial deficit is a major policy variable in the Netherlands; due to statistical distortions and differences in measurement (cash versus transactions based), the deficit may differ from the balance of primary expenditures plus interest payments minus revenues.

Table III.1

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)							
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy**
Real GDP: first year after shock*	**- 0.10**	**0.00**	**- 0.01**	**- 0.01**	**-0.01**	**- 0.07**	**0.00**
of which:							
Private consumption	- 0.03	0.02	- 0.02	- 0.03	- 0.00	0.02	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.00	0.00	- 0.00	0.00	- 0.00	0.00	0.00
Non-residential private investment	- 0.03	- 0.02	- 0.00	- 0.00	- 0.00	- 0.01	0.00
Inventory formation	- 0.03	0.00	0.00	0.00	- 0.02	- 0.01	0.00
Exports	- 0.03	- 0.00	0.00	0.00	- 0.00	- 0.02	0.00
Imports	0.01	- 0.00	0.01	0.02	0.02	- 0.04	- 0.00
Real GDP: second year after shock*	**- 0.18**	**- 0.01**	**- 0.03**	**- 0.03**	**- 0.05**	**- 0.07**	**0.01**
of which:							
Private consumption	- 0.10	0.03	- 0.08	- 0.08	- 0.02	0.05	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.06	0.00	- 0.01	- 0.00	- 0.06	0.00	0.00
Non-residential private investment	- 0.11	- 0.05	- 0.00	- 0.01	- 0.03	- 0.04	0.01
Inventory formation	- 0.00	- 0.00	0.00	- 0.00	- 0.00	- 0.00	- 0.00
Exports	0.03	- 0.00	0.01	0.01	- 0.00	0.02	- 0.00
Imports	0.06	0.01	0.05	0.05	0.06	- 0.10	- 0.01
Real GDP: third year after shock*	**- 0.15**	**- 0.01**	**- 0.03**	**- 0.02**	**- 0.08**	**- 0.02**	**0.02**
of which:							
Private consumption	- 0.13	0.03	- 0.10	- 0.05	- 0.04	0.02	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.11	0.00	- 0.01	- 0.00	- 0.11	0.00	0.02
Non-residential private investment	- 0.15	- 0.05	0.00	- 0.01	- 0.05	- 0.06	0.01
Inventory formation	0.03	- 0.00	- 0.00	- 0.00	0.02	0.02	- 0.00
Exports	0.07	- 0.00	0.01	0.01	0.00	0.06	- 0.00
Imports	0.15	0.01	0.07	0.04	0.10	- 0.06	- 0.02

Table III.1 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in interest rates (non-ERM exchange rates endogenous)

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Cost of capital**	**Exchange rate**	**Discre-pancy**
Real GDP: fourth year after shock*	**- 0.09**	**- 0.01**	**- 0.01**	**- 0.00**	**- 0.06**	**- 0.02**	**0.01**
of which:							
Private consumption	- 0.11	0.02	- 0.04	- 0.00	- 0.04	- 0.04	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.06	0.00	- 0.01	- 0.00	- 0.06	- 0.00	0.00
Non-residential private investment	- 0.09	- 0.03	0.01	- 0.00	- 0.04	- 0.04	0.02
Inventory formation	- 0.00	0.00	- 0.00	- 0.00	- 0.00	- 0.00	0.00
Exports	0.04	- 0.01	0.01	0.00	0.01	0.04	- 0.00
Imports	0.13	0.01	0.03	0.01	0.08	0.02	- 0.01
Real GDP: fifth year after shock*	**- 0.01**	**- 0.03**	**0.01**	**0.00**	**- 0.01**	**0.01**	**0.00**
of which:							
Private consumption	- 0.02	0.01	0.01	0.02	- 0.02	- 0.02	- 0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.02	0.00	- 0.01	- 0.00	0.00	- 0.00	- 0.01
Non-residential private investment	0.01	- 0.05	0.02	0.00	0.01	0.02	0.01
Inventory formation	- 0.01	0.00	- 0.00	0.00	- 0.00	- 0.01	0.00
Exports	0.02	- 0.02	0.00	- 0.00	0.00	0.03	0.00
Imports	0.01	0.03	- 0.01	- 0.01	- 0.00	- 0.00	0.00
Real GDP: final year after shock*	**0.02**	**- 0.06**	**0.03**	**0.00**	**0.01**	**0.02**	**0.02**
of which:							
Private consumption	0.06	- 0.03	0.05	0.02	0.01	0.01	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential private investment	- 0.00	- 0.00	- 0.00	- 0.00	- 0.01	0.00	0.01
Non-residential private investment	0.13	- 0.06	0.02	- 0.01	0.07	0.08	0.03
Inventory formation	0.01	- 0.00	0.00	0.00	0.00	0.01	- 0.00
Exports	- 0.05	- 0.03	- 0.00	- 0.01	- 0.01	- 0.01	0.01
Imports	- 0.13	0.07	- 0.05	- 0.01	- 0.05	- 0.06	- 0.02

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table III.2

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in domestic and foreign interest rates (exchange rates exogenous)

	Total	Income/ cash flow	Wealth	Direct interest rate effect on con-sumption	Cost of capital	Exchange rate	Discre-pancy
Real GDP: first year after shock*	**- 0.04**	**0.00**	**- 0.01**	**- 0.01**	**- 0.01**	**0.00**	**- 0.00**
of which:							
Private consumption	- 0.05	0.02	- 0.02	- 0.03	- 0.00	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Residential private investment	- 0.00	0.00	- 0.00	- 0.00	- 0.00	0.00	0.00
Non-residential private investment	- 0.02	- 0.01	- 0.00	- 0.00	- 0.00	0.00	0.00
Inventory formation	- 0.01	0.00	0.00	0.00	- 0.02	0.00	0.00
Exports	- 0.00	- 0.00	0.00	0.00	- 0.00	0.00	0.00
Imports	0.05	- 0.00	0.01	0.02	0.02	0.00	0.00
Real GDP: second year after shock*	**- 0.12**	**- 0.00**	**- 0.03**	**- 0.03**	**- 0.05**	**0.00**	**- 0.00**
of which:							
Private consumption	- 0.15	0.04	- 0.08	- 0.08	- 0.02	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Residential private investment	- 0.06	0.00	- 0.01	- 0.00	- 0.06	0.00	0.00
Non-residential private investment	- 0.08	- 0.04	- 0.00	- 0.01	- 0.03	0.00	0.00
Inventory formation	- 0.00	- 0.00	0.00	- 0.00	- 0.00	0.00	- 0.00
Exports	0.01	- 0.00	0.01	0.01	- 0.00	0.00	0.00
Imports	0.17	0.01	0.05	0.05	0.06	0.00	0.00
Real GDP: third year after shock*	**- 0.14**	**- 0.00**	**- 0.03**	**- 0.02**	**- 0.08**	**0.00**	**0.00**
of which:							
Private consumption	- 0.15	0.04	- 0.10	- 0.05	- 0.04	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Residential private investment	- 0.12	0.00	- 0.01	- 0.00	- 0.11	0.00	0.00
Non-residential private investment	- 0.09	- 0.04	0.00	- 0.01	- 0.05	0.00	0.01
Inventory formation	0.01	- 0.00	- 0.00	- 0.00	0.02	0.00	- 0.00
Exports	0.02	- 0.01	0.01	0.01	0.00	0.00	0.00
Imports	0.21	0.00	0.07	0.04	0.10	0.00	- 0.00

Table III.2 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Two-year increase in domestic and foreign interest rates (exchange rates exogenous)

	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption	Cost of capital	Exchange rate	Discrepancy
Real GDP: fourth year after shock*	**- 0.07**	**- 0.00**	**- 0.01**	**- 0.00**	**- 0.06**	**0.00**	**0.00**
of which:							
Private consumption	- 0.06	0.03	- 0.04	- 0.00	- 0.04	0.00	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Residential private investment	- 0.07	0.00	- 0.01	- 0.00	- 0.06	0.00	0.00
Non-residential private investment	- 0.05	- 0.03	0.01	- 0.00	- 0.04	0.00	0.01
Inventory formation	- 0.00	0.00	- 0.00	- 0.00	- 0.00	0.00	- 0.00
Exports	0.01	- 0.01	0.01	0.00	0.01	0.00	0.00
Imports	0.11	- 0.00	0.03	0.01	0.08	0.00	- 0.01
Real GDP: fifth year after shock*	**- 0.01**	**- 0.02**	**0.01**	**0.00**	**- 0.01**	**0.00**	**0.01**
of which:							
Private consumption	0.02	0.02	0.01	0.02	- 0.02	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Residential private investment	- 0.00	0.00	- 0.01	- 0.00	0.00	0.00	0.00
Non-residential private investment	- 0.00	- 0.04	0.02	0.00	0.01	0.00	0.01
Inventory formation	- 0.00	0.00	- 0.00	0.00	- 0.00	0.00	- 0.00
Exports	- 0.01	- 0.01	0.00	- 0.00	0.00	0.00	0.00
Imports	- 0.01	0.02	- 0.01	- 0.01	- 0.00	0.00	- 0.01
Real GDP: final year after shock*	**0.01**	**- 0.05**	**0.03**	**0.00**	**0.01**	**0.00**	**0.02**
of which:							
Private consumption	0.07	- 0.02	0.06	0.02	0.01	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	- 0.00
Residential private investment	- 0.01	- 0.00	- 0.00	- 0.00	- 0.01	0.00	0.00
Non-residential private investment	0.06	- 0.05	0.02	- 0.01	0.07	0.00	0.02
Inventory formation	0.00	- 0.00	0.00	0.00	0.00	0.00	0.00
Exports	- 0.04	- 0.03	- 0.00	- 0.01	- 0.01	0.00	0.01
Imports	- 0.07	0.06	- 0.05	- 0.01	- 0.05	0.00	- 0.02

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

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A macroeconomic evaluation of the Spanish monetary policy transmission mechanism

Ricardo Mestre[1]

I. INTRODUCTION

The present document describes the impact of a monetary shock simulated with the MOISEES model, and summarises the conclusions that can be drawn from the exercise. The original definition of the shock, suggested by the BIS, envisaged a temporary and a permanent interest rate increase both with fully flexible and fixed exchange rates. The experiment had to be carried out with the macroeconomic models of a number of central banks, and an important aspect was to differentiate clearly between the responses attributable to the structure of the models and to the true underlying financial structures.

The two simulations outlined in the document exactly match the final agreed-upon definition of the shocks: a temporary increase in the (nominal) intervention rate in 1994-95, and an immediate return to baseline; and the same exercise with a path of foreign interest rates compatible with a stable nominal exchange rate. Further evidence is gathered by decomposing the channels of transmission of the shock.

The note is structured as follows. A second section, following this one, will outline the general properties of the MOISEES model. The particularities of the model will be linked to its background: the specific needs it was to cover, and its usage. A brief explanation of some of its most important blocks will be given, with special emphasis on the financial block, and the most important planned improvements will be summarised. A third section will discuss the actual simulations performed, and the changes in the model that a proper handling of the exercise made necessary. Results of the chosen simulations will be discussed in this section, as will further evidence gathered through additional experimentation. A fourth section will describe an attempt at decomposing the most important channels of transmission of the monetary shock, and their relation to the true underlying channels, indicating the most troublesome points of the procedure. The last section will summarise the main conclusions of the exercise.

II. GENERAL STRUCTURE OF THE MODEL

1. General background to the model

The MOISEES model was first estimated in the Spanish Ministry of Economy at the end of the 1980s. Its main use there was to simulate alternative scenarios, always with a baseline constructed around a forecast not directly related to the model itself. The rationale behind its structure was that a small, highly aggregated general-equilibrium model was better suited to the calibration of fiscal policy than a huge macroeconomic model or a host of small partial-equilibrium models. The fiscal sector, or fiscal block, of the model was large relative to the rest of the model, as this was one of

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the characteristics that could help in introducing specific fiscal policy shocks into the model. The monetary block, on the other hand, was extremely poor due to the lack of financial structure, as this was not a major issue at the Ministry.

The model was lent to the Bank of Spain, where a major respecification is being undertaken in order to turn it into a more manageable tool for monetary policy analysis. The Research Department of the Bank of Spain has other quantitative tools, and the model is not meant to replace all these but rather to complement them in those fields where it may have some advantages. In particular, the model is not used, nor will it be used in the near future, for regular monetary policy programming, for which partial-equilibrium, medium to short-term models are preferred. The implication of this complementarity is that the model is not expected to depict the short-run impact of an alternative scenario as accurately as other tools at the Bank, while its long-run behaviour has to be carefully gauged as this is the field where the model can excel. The model is, as a consequence, increasingly becoming a long-run analysis tool. This is the justification of the widespread use of co-integration techniques in the re-estimation of the model.

The model is annual, with an historical database beginning in 1964, although some series go as far back as 1954. Most of the structure of the model closely follows the current National Accounts structure, the database being a homogenised version of the Spanish National Accounts based in 1986. As a consequence, the real economy (real output and demand) is better portrayed than the financial side of the economy. The MOISEES model is from this point of view a fairly standard macroeconomic model. We plan soon to introduce some Financial Accounts considerations as an important add-on to the structure of the model. These and other changes will be explained in a later section.

2. Brief description of blocks in the model

This section will give a rough description of the general structure of the model, and the different blocks incorporating it. Rather than going into detail, a comprehensive bibliographic reference will be given. All we need for this document is a general understanding of some key points of its structure that will help us in the comprehension of the transmission of the particular shock envisaged.

The model was built at the Ministry of Economy around a particular supply block that embraced the idea that the economy is bound to undergo all kinds of shortages. Three types of shortage were envisaged for individual firms: a shortage of demand, a shortage of labour supply and a shortage of capital stock. Aggregate supply was considered to undergo all three shortages to differing degrees, as the share of firms enduring a specific type of shortage is time-varying. The shortage of demand is considered to be a Keynesian regime, while a capital stock shortage is considered to be a potential-output regime and a shortage of labour supply a classical regime. The final outcome after aggregating firms is an economy where an equilibrium is never fully reached, as there will always be firms undergoing some kind of shortage. Within this framework, the interesting point is what kind of shortage is proportionately the most important. This is a key consideration when judging if fiscal policy has to affect demand (a mostly Keynesian economy, or an economy under a strong Keynesian regime), the labour market (a mostly classical economy) or the capital markets (an economy nearing its potential output point). The underpinnings of this block are explained in full detail in other publications (see [1], [3] and [6]).

Another important block, both for understanding the model and for its great implications in the simulations that follow, is the wages-prices formation mechanism. Two equations concur in determining the price and nominal wage level, following the Layard-Jackman-Nickell framework. An explicit wage-bargaining process is modelled, and the relative strength of labour unions and firms is a key factor explaining the wage-price spiral. Other important factors are the tax wedge, productivity growth and the unemployment level. The short-run Phillips curve has explicitly some degree of slope. A problem with this type of framework is the indetermination of what sets the price level: at first glance it seems that the general price level is fully determined in the labour market; but this may be misleading, as in a general-equilibrium framework both equations may only be explaining the wage-price spiral, but not the specific level at which it is happening. This particular point was worth testing thoroughly, and after much experimentation the conclusion was reached that the price level was uniquely determined by the level of liquid assets. The model was found to have a neutral monetary policy in the long-run (see [10]).

The demand block is quite standard: a private consumption equation, a business and a residential investment equation, and equations for both imports and exports. A relevant fact in the consumption equation is the particular role played by wealth; wealth as included in the model embraces all forms of assets in private hands. In particular, it includes all liquid asset holdings, not netted out with credits, implying strongly non-rational agents. This is not the case, as the variable has been included in the equation to ensure that a long-run unit elasticity of consumption and disposable income is achieved. As will be shown later, the long-run impact of wealth on consumption is not an outstanding feature in the simulations. This is not the case in the short run, though. Accelerations in wealth greatly affect the short-run behaviour of consumption, and this is mainly felt in the second year after a monetary shock is given. This factor may be more related to the model than to the real economy, as alternative specifications of the equation, particularly when net financial wealth is included, change this behaviour significantly.

The business investment equation is much more straightforward, and its response seems to capture well the general behaviour of this aggregate. Residential investment, however, lacks a proper housing prices variable, although this may be a factor of secondary importance. Unfortunately, the model lacks endogenous mortgage rates.

The trade balance is determined by one equation explaining imports, and another explaining exports of goods and services excluding tourism. This exclusion may be relevant once the exchange rate is allowed to move. Both equations show great sensitivity to changes in competitiveness, and imports show a significant short-run response to changes in business investment, a most relevant factor affecting the outcome of most of the simulations carried out with the model.

The fiscal block has no behavioural equations, but it has a lot of reaction functions that attempt to mirror some of the simplest rules followed by the fiscal authorities in setting spending. These rules vary with the particular component, but most of them are set as a proportion of lagged nominal GDP (implying a decision rule that sets spending the year before it is actually spent). Government revenues react to the economic situation in a quite automatic way, the only exception being direct taxes. Indirect taxes, social security revenues and other important components are directly linked to the variables they tax (consumption, employee compensation, etc.). Direct taxes, on the other hand, are linked to nominal GDP with an elasticity implying a positive and lasting effect of inflation. This relatively strong non-neutrality of direct taxes has far-reaching implications in the long-run behaviour of the model. This matter will be thoroughly addressed. The final picture is that of real spending and revenues with some degree of inertia in nominal terms. The implications are that the Government is impacted in the short run by a fall in inflation.

Net government interest payments are fully modelled, including an implied interest rate that closely follows the long-term interest rate of the model, and an endogenous debt.

A good general account of the full model may be found in [3].

3. The financial block

The financial block merits special attention. Its structure is unrealistically simple, first because of the aim the model was designed to fulfil, but also because of the important changes the financial markets endured until the late 1980s, precluding a detailed description of the financial markets (see [11]). Lack of data was the main factor behind the original specification of this block.

Two possible monetary policy settings were defined: an exogenous long-term interest rate, or an exogenous M_2 supply. When interest rates were stable, a demand for real M_2 was included in the model; when M_2 was exogenous, an equation linking the long-term interest rate to M_2 (and other variables) replaced the other equation. Both were roughly the inverse of the other equation. A further equation explained the demand for liquid assets other than M_2 included in ALP, the broadest aggregate. M_2 was perfectly controlled by the monetary authority - once exogenous - but the full aggregate ALP was always determined within the model. A PPP equation was used for the exchange rate, although most simulations were carried out with fixed nominal exchange rates.

This particular financial block is being overhauled, with the inclusion of a demand for ALP compatible with the standard framework at the Bank of Spain, the inclusion of credit demand, and a full endogenisation of net financial wealth. Carrying out the current exercise with liquid assets modelled as two separate components, though, is not a major problem, as its goal is carefully to decompose the channels of transmission of monetary policy. Our purpose is to analyse the agents' decision-taking process, not to try to forecast the behaviour of a particular monetary aggregate.

Ongoing financial deregulation in Spain has had a strong impact on the conduct of monetary policy. The general framework used for the current exercise, for which the block has been revised, is that of a central bank that issues or withdraws money through the interbank lending market. The central bank controls the money it supplies adjusting an intervention rate (the three-month interbank lending rate, one of the most directly affected by actual intervention rates, see [2]), the only short-term interest rate appearing in the model. The other two important interest rates that have a role in the model, the banking institution deposits rate and the medium to long-term public debt implied rate - including only public debt in domestic private hands - react to changes in the intervention rate and the short-term interest rate of the Deutsche Mark and dollar in the Euro-market. The implied rate of the gross public debt moves closely in line with the long-term interest rate. This framework is only valid starting in the latter half of the 1980s, so the new equations included in the model cover a short span of time, and their statistical strength is a matter for conjecture. It is, though, as good a representation of the current procedure for conducting monetary policy as can be obtained today.

There is some criticism as to the appropriateness of the financial block described. First, because data on monetary aggregates - starting in 1964 - include a long period of strong government intervention and barely significant financial markets. Interest rates of all kinds, too, were mainly set by the authorities. Second, because the extremely recent but deep-seated deregulation process is still affecting the elasticities in the equations involved in the block, and may strongly affect the size and timing of the simulated shock for the period for which the simulations have been carried out. In order to ease this issue, some experimentation was performed with other models used in the Research Department of the Bank of Spain, and a check was made that interest rate responses were very similar in all cases. As expected, there were some differences in the behaviour of the monetary aggregates (ALP) and in the impact of the simulated shock on real output and inflation, although the MOISEES model may be depicting these last two variables better.

4. Planned improvements

As mentioned, the model is undergoing a major revision. Its current version includes a totally new demand block, with equations not only re-estimated but re-specified: consumption is now split into durables and non-durables, although an equation for total consumption remains for certain specific simulations; residential investment includes a housing price variable linked to financial variables; imports are split into energy and non-energy imports, etc. The supply block is being totally rewritten in a more traditional framework, placing special emphasis on explicitly modelling a tradables and a non-tradables (protected) sector. The financial block will be re-estimated along the lines defined by the financial model used for monetary programming, and will explicitly model the behaviour of banking institutions, including both the monetary aggregates and their counterparts -

banking sector credits - and the interrelatedness of interest rates. The current exercise may serve as a stepping-stone in this process.

An additional but important improvement ranking high on our agenda is the change of data frequency. Most of the new equations have been estimated in both annual and quarterly data. Unfortunately, the Spanish Quarterly National Accounts are still incomplete.

III. SIMULATIONS

Besides the changes and improvements currently being introduced into the model, the relative scantness of its current financial block prompted the idea that some sort of enrichment was needed for this exercise. First, it was necessary to link the exchange rate to the foreign interest rate differential. Next, the transmission mechanism linking the intervention rate and other domestic interest rates had to be greatly improved, in order to substantiate the overall behaviour of the financial block. Finally, the neutral fiscal policy envisaged in the first exposition of the exercise led us to experiment with different behaviours of direct taxes, as they are currently much too sensitive to the general (nominal) level of activity.

1. Changes undertaken for the exercise

The first step was to stretch the baseline until at least the year 2000. This was done by first tailoring the Bank of Spain forecast, closely in line with the Government's convergence plan, to the requirements of the model; and further, to extend it to the year 2020, in order to be able to analyse the long-run behaviour of the model. We needed a reliable test of the long-run neutrality of a monetary shock, something we expect from our models, to increase our confidence in the outcome of the exercise. This check was made necessary by the changes implemented in the financial block that will be explained later.

Once this step had been covered, the exchange rate depreciation had to be related to changes in the foreign interest rate differential. The model originally included a PPP relationship, a not very helpful equation for this exercise but a tried and tested one. It was decided to use it to model agents' expectations about a future depreciation of the peseta, in order to avoid a future exchange rate irrevocably fixed by monetary authorities. The changes included the modelling of expected currency depreciation with the help of the PPP equation, and the definition of an actual depreciation compatible with the expected future exchange rate and the interest rate differential. Agents in the economy perfectly forecast the exchange rate given the baseline monetary policy, and the current exchange rate is depreciated in order to ensure both that expectations are fulfilled and that actual depreciation coincides with the interest rate differential with the rest of the world. As agents never forecast the monetary policy (they always think it will return to baseline), the monetary authority is able to appreciate the peseta by a given amount, but at the cost of ever-increasing domestic interest rates. It should be stressed that agents never revise their expected future monetary policy, but they adjust their exchange rate expectations should this policy actually change. This means that the credibility of the monetary authorities never changes but always coincides with the credibility level implied in the baseline.

Another absolutely necessary change was to streamline better the relationships among different domestic interest rates. The model originally had two possible monetary policy settings: either the central bank decided on the level of supply of M_2, or the decisions were taken in terms of stabilising the long-term interest rate. The deposit rate was then linked to the long-term rate by a simple reaction function. The first step for improving this set-up was to include a short-term interest rate, for which the three-month intervention rate was chosen, and to include statistically sound equations linking all the different interest rates. The mechanism finally implemented is the following: the long-term interest rate is set according to the domestic short-term interest rate (long-run coefficient of around 0.65) and the foreign interest rate (long-run coefficient of 0.35); the deposit rate is explained by the short-term and long-term interest rates, the former with a greater weight.

Other changes considered but not finally adopted were a more neutral fiscal policy and the definition of monetary policy targeting in terms of real as opposed to nominal interest rates. Direct taxes as modelled are not only affected by the level of activity; they are also very sensitive to changes in inflation. Their first respecification embodied inflation-neutral direct taxes, but historical data did not support this as a good mechanism to isolate them from inflation; an ad hoc gradual return to baseline deficit over GDP was then tried, but the response was slow and mainly felt beyond the year 2000. Finally, direct taxes were left untouched.

2. Description of the simulated shocks

The two exercises finally undertaken incorporated all the changes described. They are a temporary increase in the intervention rate of 100 basis points in 1994 and 1995, and an immediate return to baseline afterwards; and the same shock with a stable nominal exchange rate, thanks to a suitable path of foreign interest rates. Results are presented for the period 1994 to 2000, although simulations have spanned the full baseline length. It is worth noting that the way the exchange rate has been modelled precludes a simple exogenisation of the variable (as the PPP equation now plays the role of the expectations-formation mechanism); alternatively, it was preferred to endogenise[2] the foreign interest rate in order to neutralise the two factors affecting the exchange rate in the model: the interest rate differential in the short run, and the inflation differential in the long run. Obviously, this has consequences that affect the whole simulation.

3. Summary of simulation results

As the two simulations have many points in common, it is probably preferable to give a broader account of the first one, which we think is the most appropriate. The second simulation will be discussed only when significant departures arise. The last sub-section will address additional evidence obtained by repeating the simulations with small changes in the shock definition, the specification of the model or the time horizon.

Asymmetric simulation

Results of the first simulation will be discussed adhering closely to the structure of Tables I and II.

Table I: As previously stated, the three-month interbank lending rate will play in these simulations the role of the policy-set intervention rate. As it is the only short-term interest rate included in the model, the first two lines of the table coincide. They directly show the simulated shock.

The long-term interest rate is the medium to long-term public debt interest rate. It is linked to the domestic and foreign short-term interest rates, increasing some 65 basis points given a sustained shock such as the simulated one. The dynamics of the equation prevent a full impact from being reached, increasing only 48 basis points in 1995 before beginning a gentle return to baseline.

Deposit rates are somewhat less sensitive to the short-term interest rate, but short-run dynamics are stronger. This is the factor explaining the greater inertia of these rates as compared to the long-term rates. They, too, gently return to baseline once the shock is reversed.

2 Rather, the exchange rate equation was inverted in order to have the foreign interest rate as the left-hand variable.

Real interest rates are more sluggish than their nominal counterparts. This is something arguably legitimate, as nothing prevents real interest rates from having more inertia in the short run than nominal interest rates. But it is worth pointing out that the return of real interest rates to baseline is faster if the real intervention rate is the variable targeted by the monetary authority. Real interest rates rebound after 1996, a move generated by the reversal of the shock in that year, but this rebound slowly subsides afterwards. The user cost of capital moves broadly in line with the long-term real interest rate.

The nominal exchange rate moves according to two factors: the increase in domestic interest rates and the fall in domestic inflation. The real exchange rate virtually mimics the short-term interest rate behaviour, as should be expected. The small differences arise because of the dynamics in the PPP equation, a full return to baseline being achieved after the year 2000.

The new path of the wealth variable is mainly explained by changes in households' liquid asset holdings.

Net interest and dividend payments in the household sector move in line with changes in deposit rates and money demand. Dividend payments in real terms react to changes in real economic activity, but are on the other hand not very sensitive to interest rates. They may be under-reacting in this simulation, but changes in their equation, although considered, have finally been dropped. Net interest and dividend payments abroad move in line with the exchange rate; their inclusion in the table is only for the sake of completeness.

Two measures of real monetary aggregates are shown: ALP (roughly equivalent to M_4) and M_2. ALP moves in line with M_2, one of their components, but liquid assets other than M_2 strongly affect them. M_2 falls as the alternative interest rate increases (there is no M_2 "own" interest rate in the model), and reverts to baseline when this movement is reversed. ALP bounces back, as a consequence, because of the implied movement in liquid assets other than M_2. These other liquid assets jump - mainly in the second year - as their own interest rate increases, make a gentle return to baseline afterwards, and finally shoot up again thanks to the fall in inflation. As inflation falls, part of the household assets demand shifts to liquid assets.

Table II: GDP falls slightly for the whole period, a tendency towards a return to baseline appearing at the end of the simulation. The fluctuations it suffers, though, are odd-looking. Two factors explain this: the behaviour of consumption, and particularly its sensitivity to changes in wealth; and the behaviour of imports, itself mainly linked to changes in business investment. GDP falls the first year by 0.05%, almost returns to baseline the following year, has a stronger negative impact on the fourth year, and gently returns to baseline afterwards. Although many of these movements can be explained by the consumption path, they are misleadingly small thanks to the trade balance behaviour: the fall in domestic demand these years is much stronger. The trade balance is itself driven by imports, which are extremely responsive in the short run to changes in business investment. As can be seen, the fall in business investment almost parallels the fall in imports, both factors almost cancelling each other out.

The most troublesome GDP component is no doubt private consumption. It is negatively affected by the increase in interest rates, but positively affected by the increase in financial wealth and dividend and interest payments to households. The appreciation of domestic currency helps further to explain its behaviour. The final outcome is a wandering path for consumption, sometimes above baseline, sometimes under it. The two cases when consumption departs most from its original values, in 1995 and 1997, arise when the full impact of the increase in wealth (1995) or its fall (1997) is felt, wealth being directly affected by changes in the monetary policy. Other major determinants of the increase in consumption in the final years are the ever-falling direct taxes, the main factor explaining the increase in disposable income these years.

Government expenditure (government consumption plus investment) first increases then decreases, very gently in both cases. The main factor behind this is the nominal rigidity affecting most of the expenditure components in the model. Expenditures such as welfare benefits, government investment, and others, are affected by unforeseen changes in inflation.

Total gross private investment falls, driven mainly by business investment, as residential investment increases slightly as a result of the increase in household disposable income. The fall in business investment arises because of the fall in GDP and the increase in the user cost of capital. Changes in inventories are related to the gap between supply and demand, as both aggregates are independently determined in the model. Although inventories always return to baseline, they may be sluggish in doing so.

Exports closely follow the changes in competitiveness, losing ground in 1994-95, and recovering afterwards. Real exports eventually return to baseline, but not before the end of the simulation, as the real exchange rate has not yet returned to base in 2000. Imports are strongly affected by the fall in business investment.

Inflation is constantly below base, but a return to its original values is ultimately achieved around the year 2008, the biggest difference from the baseline arising in 1998. The final effect on prices is, as a consequence, a negative step of about 2.5% of their baseline value. This process is fairly understandable, as the temporary increase in the intervention rate amounts to a negative permanent shift in money supply. The biggest drop in inflation occurs five years after the shock, but it is significant after some two years. One key point explaining price movements is the increasing gap between domestic producer prices and consumer prices, as the share of imports in consumption is relatively large. This factor strongly helps to reduce labour costs measured in producer prices without detriment to the labour market, as pay measured in terms of the consumption deflator is only marginally affected. The only thing preventing a stable real wage in CPI terms is the slightly higher unemployment rate. Most of the exchange rate appreciation effect unfolds in the long run through this channel. Real consumption wages go back to baseline by 2002.

Import prices move in line with the exchange rate, as they are exogenously measured in foreign currency.

Government accounts are negatively and permanently affected, the fiscal deficit undergoing a lasting downward fall of around 0.3% of GDP. Government expenditures consist of government consumption and investment, welfare benefits of all kinds, and smaller items. Although the first component is mainly (but not only) driven by compensation to civil servants, the rest of the components are chosen in nominal terms the year before they are actually spent. If an unforeseen inflation surge occurs, they will marginally grow in real terms. Government revenues, on the other hand, include the public sector disposable income without welfare benefits and net interest payments, which is the third component of government accounts shown in the table. Both net interest payments and direct taxes are heavily affected by the increase in interest rates, the former directly and also through the increase in public debt, the latter due to its high inflation-dependence. The growth in interest payments is specially strong as compared to the GDP growth, although in absolute terms both revenues and expenditures fall by a larger amount.

Finally, the current account is mainly explained by the track followed by the trade balance: an improvement in the initial years, a deterioration afterwards. As exports wander around their baseline values, imports are the key factor justifying the trade balance path. As earlier mentioned, the fall and subsequent recovery of imports is caused by the important changes in business investment. The foreign sector in the MOISEES model is a key growth-limiting factor when demand shocks occur. This seems to be a characteristic of the Spanish economy, rather than a troublesome attribute of the model; nevertheless, the model may be overstating it.

In short, there are three points worth remembering in this simulation: the sluggish inflation-adjustment in the Spanish economy, though this adjustment is complete in the end; the great importance of business investment and of imports in the transmission of the monetary shock; and, finally, the strong short-run effect and significant medium-term effect of the exchange rate. These conclusions are, of course, only related to the Spanish economy inasmuch as the model is a good representation of the economy.

Symmetric simulation

A second simulation was attempted disregarding the exchange rate effects. The first impression was that exogenising the nominal exchange rate would settle the matter and allow a repetition of the former simulation avoiding exchange rate effects. But this is not a correct solution for a model such as MOISEES, because its particular framework precludes a stable exchange rate and an independent monetary policy. As already stated, the original PPP equation is now the expectation-formation mechanism agents use to forecast future exchange rates, and it is understandably rational and desirable that agents should persist in forecasting. It is necessary, then, to devise ways to stabilise the exchange rate while retaining its equation. This can be achieved in the short run by imposing a shift in the foreign interest rate so that the interest rate differential remains unaffected. Unfortunately, agents will expect a future appreciation on the basis of an anticipated fall in future inflation. Two factors can stop this currency appreciation from actually happening: either domestic interest rates are allowed to fall - and this contradicts the simulated shock itself - or foreign interest rates are allowed to increase. The third alternative, having foreign prices decrease in line with domestic prices, was ruled out.

The decision finally adopted was to endogenise foreign interest rates so as to impose a constant nominal exchange rate. Agents' decision-making is not then directly affected, as would have happened with an exogenous exchange rate. The final path of the foreign interest rate was subject to two independent but simultaneous pressures: first, an increase of 100 basis points in 1994 and 1995, to balance the parallel increase in domestic interest rates; second, an increasing divergence from baseline to balance the fall in the inflation differential with the rest of the world. The final situation is that of an artificial appreciation of foreign currencies in relation to the peseta. As the increase in foreign interest rates tightens the monetary conditions, it helps reduce the domestic inflation level and widen the inflation differential. This is clearly a non-sustainable policy. We hope, nevertheless, that results for the first four or five years will remain meaningful, and that this procedure will be more attractive than simply exogenising the nominal exchange rate.

The simulation finally undertaken is a temporary increase of 100 basis points of the intervention rate, in 1994-95, and an immediate return to baseline. This move is complemented by an increase in the foreign interest rate that stabilises the nominal exchange rate for the whole simulation, but otherwise allows agents freely to forecast future exchange rates.

Basically, the outcome differs from the former simulation in two respects: first, the sustained increase in long-term interest rates has a stronger negative impact on the economy, particularly on business investment and imports; second, the fall in inflation is stronger and long-lasting. The increase in the foreign interest rate pushes domestic long-term interest rates and the user cost of capital up, increasing their differential with short-term rates. Falling imports and the gains in competitiveness help in creating a sustained current account surplus.

Focusing on the first four years of the simulation, which are broadly similar in both exercises, the main differences lie in the behaviour of long-term interest rates and of the exchange rate. Long-term interest rates increase more than in the former simulation because of the concurrent increase in foreign and domestic short-term interest rates. The resulting user cost of capital is higher, too, and business investment is very negatively affected. As before, the induced fall in imports strongly smoothes the fall in GDP. On the other hand, the stability of the exchange rate during these initial years of the simulation, as opposed to the strong appreciation in the other simulation, induces a better behaviour in exports. The trade balance improves sharply and lastingly, a distinct feature of this exercise.

Another point worth noting is the behaviour of unit labour costs. In the current simulation, import prices are not allowed to decrease in the early years, and the gap between producer prices and consumer prices remains almost at its baseline value. As unemployment has increased by a large amount, the fall in real labour costs measured in terms of consumption prices is now relatively sizable. This outlines the importance of the gap between production and consumption deflators in a medium-size economy such as Spain, and of the share of imports in consumption.

As in the other simulation, the trade balance has a significant dampening effect, the final impact on GDP being again misleadingly small.

Additional evidence

Results have been reported until the year 2000, but the actual simulations were carried out for the full baseline time span (1994-2020). This has allowed long-run analyses of policy impacts to be performed, and some aspects of the general design of both exercises that were potentially troublesome have been outlined. The first one is the large long-run impact of the non-neutral fiscal policy; the second one is the inconsistent monetary policy implied in the simulations, as the central bank decides its moves in terms of nominal rates in situations of evolving inflations. Both factors worked in the same direction, inducing significant oscillations around the baseline from the year 2008-10, and delaying a return to baseline. A monetary policy set in terms of real intervention rates combined with a more neutral fiscal policy radically changed the final part of the simulation, producing a smoother transition to equilibrium. This monetary policy was incompatible with the exercise, and was merely adopted for the gathering of additional evidence.

Some simulations were performed with different direct tax rules, in order to ease the non-neutrality of fiscal policy. After much testing, the most satisfactory of them was a derivation of the original reaction function that ensured a gradual return to the baseline ratio of direct taxes over GDP. Unfortunately, the time taken for this outline to work out, forcing a return to the aforementioned baseline ratio, was such that no relevant differences in results were found by the year 2000. The outline was finally dropped, but we have been very careful in stressing the importance of the non-neutrality of fiscal policy wherever it was felt necessary.

Another more fruitful experiment involved repeating the asymmetric simulation - the first one - starting in different years, in order to measure the importance of the business cycle in the model and, hopefully, in the economy. The simulation was repeated starting every year from 1986 to 1994, each time with a seven-year horizon to match the original shock definition. Figure 1 shows the consecutive paths for the GDP deflator inflation rate for each simulation; Figure 2 shows the percentage deviations of real GDP itself. In general terms, 1989 may be considered as the peak and 1993 as the trough in the Spanish business cycle, with 1987 and 1990-91 as turning-points.

The general conclusion that can be drawn from the experiment is the relatively long lags needed by a monetary shock to be fully felt, either in inflation or activity. Almost nothing happens the first two years, and five years elapse before the shock is reversed and a gentle return to baseline commences. Another striking point is the extreme importance of a correct timing of monetary policy changes. In general terms, the model implies that these policy changes may be dealt with at least two years in advance of the actual inflation surge happening: the position in the business cycle two to five years after the original shock is given determines the strength of the response. Unfortunately, the model implies that the bigger the fall in inflation, the bigger the disruption in real economic activity. It may be stressed, though, that the simulated shock may not be the most appropriate description of monetary shocks as they actually unfold.

Figure 1

GDP deflator inflation rate over different horizons

(absolute deviations over baseline)

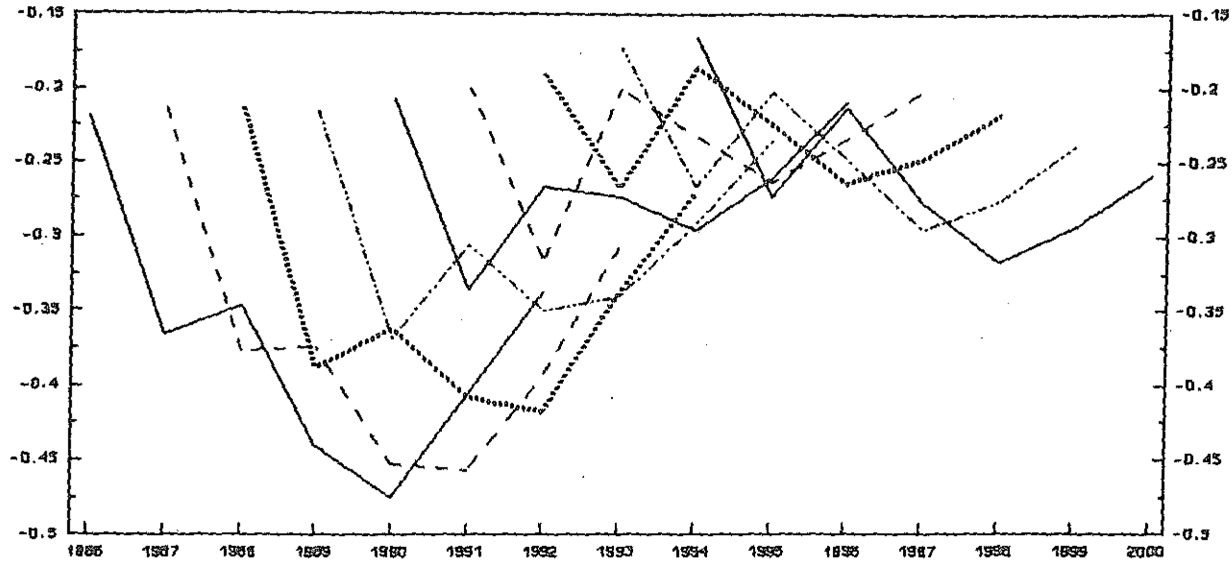
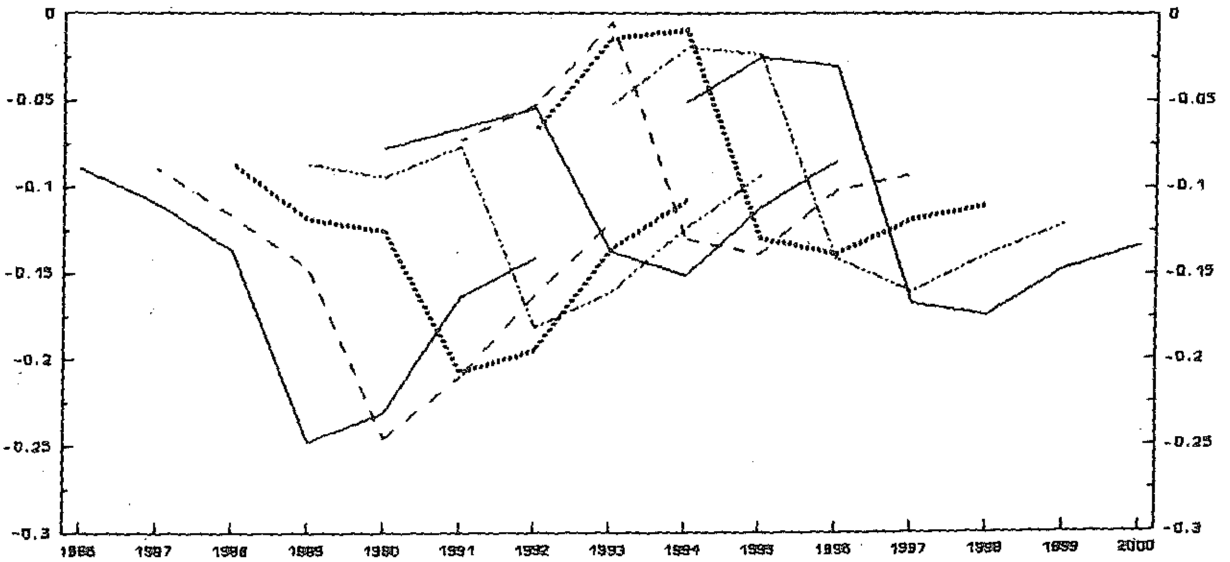


Figure 2

GDP over different horizons

(percentage deviations over baseline)



IV. DECOMPOSITION OF THE CHANNELS OF TRANSMISSION

The discussion in the previous section is meant to be of use for understanding the mechanisms set in motion by the monetary shock, at least as the model describes them. Some key points have already been made, such as the apparent importance of the impact on business investment or the discernible effect of changes in the exchange rate. But further insight can be obtained by a close scrutiny of the workings of each identifiable channel of transmission. Focusing on the impact of the simulated shock on economic activity - real output - this section will try to evaluate the relative importance of some of the most relevant monetary policy transmission channels. It has to be stressed that no channel-decomposition will be attempted with the impact on prices, although this is a sensible analysis to perform. This has been a choice, rather than an imposition, as the techniques that will be described in the next few pages can be employed for all kinds of decomposition.

In a highly aggregated and non-linear model such as MOISEES, it is impossible to decompose solely the final impact into a number of complementary channels of transmission. First of all, non-linearity precludes independent channels that add up exactly to the full impact; furthermore, the chosen channels may not be the only ones. It is necessary, then, to decide what channels are worth describing, and in a second step precisely to define them and the way they are to be isolated. In short, we need to implement a particular mechanism to identify the agreed-upon channels, even though there may be no consensus on the relevant channels or the appropriateness of the method. The decomposition adopted for this exercise, whose results will be discussed, has been implemented by means of repeating the asymmetric simulation - the first one - shutting down each time all the channels except the one under scrutiny (see [9]). Results are then compared to the baseline. An alternative was to simulate with all the channels at work except one, and compare results with the full impact case. Both methods numerically coincide in a linear model.

After a careful study of the model, the following channels were found to be decomposable:

- a substitution effect in consumption;
- an income effect in consumption and residential investment;
- a wealth effect, again in consumption;
- a user-cost-of-capital effect in business investment;
- an exchange rate effect;
- and a public debt effect, independent from the wealth effect.

As the last one did not greatly affect results, its decomposition was finally abandoned. Consideration was given, but finally dropped, to including the substitution effect and the user-cost-of-capital effect under a single heading. Each channel was decomposed exogenising the right variables in the right equations: the direct impact of interest rates on consumption as substitution effect; dividend and net interest payments as income effect; wealth and the inflation tax in consumption as wealth effect; and so on. Each time, the variable exogenised was the intervention rate or a closely related interest rate. For instance, the exchange rate effect was decomposed exogenising the domestic short-term interest rate in the exchange rate behavioural equation, but allowing it to adjust to PPP factors. As a check on the soundness of the outline, we verified that GDP was not affected by this particular change in monetary policy when all the channels were shut down.

Table III shows the resulting decomposition in terms of the contribution of each variable to the change in GDP. It is easy to verify that all the channels do not add up to the full effect, and sometimes the discrepancy is rather large. The exercise, though, remains meaningful in general terms, and the hints offered by a close analysis of the table are worth the trouble. As additional evidence was gathered by repeating the exercise with different decomposition strategies, the following lines will confine the discussion to the features common to all of the decompositions addressed.

First and foremost, the user-cost-of-capital channel is the most striking feature of the table. Its full impact in the short run is relatively small, but only because of the sharp decrease in imports that almost compensates for the fall in investment. As the short-run movement in imports is driven by business investment itself, the user-cost-of-capital effect is clearly the most powerful channel of transmission. As imports return to their new long-run equilibrium level, the user-cost-of-capital effect emerges as the one most affecting GDP.

The second most important channel is very probably the exchange rate channel. The exchange rate works through the model in two different directions: it immediately alters the trade balance through changes in competitiveness, and it sets labour costs in motion as the gap between consumption prices and output prices changes. The share of imports in consumption turns out to be an important factor in the model in explaining the rather deep and long-lasting effect of this channel, a most understandable feature for a medium-size open economy such as Spain's.

The wealth channel mostly affects the economy through sharp but short-lived changes in consumption. These changes are a direct consequence of the high short-run elasticity of wealth accelerations in the consumption function, mostly felt in 1995 and 1997, the years following the shock itself and its reversal. The importance of this channel is probably related to the specification of the consumption equation, and may accordingly be overstated. The rest of the channels are of lesser importance, the only point worth noting being the changes in the income effect when the decomposition strategy is changed. This channel does not appear as significant in the table shown, but this is not the case for other decompositions - where it has a meagre positive impact in the initial years - although it always remains a small-size channel.

Two likely misleading factors in the exercise that are worthy of mention are the very small size of the shocks we are trying to decompose, and the sensitivity of some of them to small changes in the decomposition strategy or in the specification of the model. Both characteristics may imply that some of the decomposed channels are dependent on the model, and only faintly related to the economy. The whole table, indeed, may be totally misleading or inaccurate. There is, though, a robust fact that withstands these considerations: the importance of the user-cost-of-capital channel and the exchange rate channel. Both channels have constantly remained the most significant channels in all the derivations of the original exercise that have been undertaken. The general feeling is, then, that this exercise reveals some important factors of the Spanish economy.

V. MAIN CONCLUSIONS

One of the main drawbacks of macroeconomic models is their inability to give a detailed picture of the impact of a specific shock. One of their main strengths, however, is their ability to take into account all the possible channels of transmission at the same time, even though some channels may be better modelled than others. The main aim of the current exercise is to describe these channels when a monetary policy shock is faced, and the way they work in the model, relating these points to the real behaviour of the economy. The MOISEES model describes an economy with a slow inflation-adjusting process when a monetary shock occurs, but eventually leading to a full return of output to its baseline value. The shock affects demand in the short run mainly through business investment, although the extremely sensitive imports help reduce the initial impact. The exchange rate is an important factor both in the short run, where it affects the trade balance, and the medium term, as the gap between real labour costs and real take-home pay varies. Different decompositions of the channels of transmission have coherently shown that the user-cost-of-capital channel-related to business investment - and the exchange rate channel are the most important ones. This is probably the outstanding feature of the exercise.

Other important evidence is the extreme sensitivity of the impact to the business cycle. Neither inflation nor output are noticeably affected until at least two years have elapsed from the actual shock occurring, but afterwards the size of the impact is strongly and directly related to the cycle. The implication of this sensitivity is that monetary policy has to be set around two years in advance of the inflation surge. Unfortunately, we have not been able to analyse the impact of a change in the credibility of the central bank, which is probably a most relevant factor.

The exercise is not problem-free, and this is a point that must not be concealed. The impact on GDP is too small to be considered as totally accurate, or unaffected by the specific implementation of the shock. The financial block, though fine-tuned for this exercise, is still too sketchy, and lacks some important refinements. Further, the financial deregulation process still taking place in Spain may be affecting the size and timing of the impact. On the other hand, a number of different studies, not directly related to this one, show evidence that does not contradict our main results. We feel, therefore, that these results outline facts that pertain to the Spanish economy, and that the exercise is in general meaningful.

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Asymmetric temporal interest rate increase							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Representative three-month interest rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Representative long-term interest rate	0.37	0.48	0.18	0.10	0.06	0.03	0.02
3. Other interest rate (%)							
Deposit rate	0.17	0.36	0.24	0.08	0.03	0.02	0.01
4. Real interest rates							
Real short-term interest rate (%)	1.28	1.28	0.13	0.30	0.34	0.31	0.28
Real long-term interest rate (%).............	0.65	0.77	0.30	0.40	0.40	0.35	0.29
User cost of capital (%)	0.62	0.64	0.16	0.31	0.31	0.28	0.24
5. Exchange rates							
Nominal effective exchange rate	1.16	1.41	0.60	0.86	1.16	1.44	1.70
Real effective exchange rate	0.99	0.98	- 0.04	- 0.05	- 0.06	- 0.06	- 0.06
6. Asset prices and wealth							
Wealth variables in the consumption function	- 0.10	- 0.01	0.14	- 0.08	- 0.20	- 0.10	- 0.00
7. Net interest and dividend payments							
Household sector	0.30	0.58	0.51	0.61	0.95	1.25	1.48
Non-financial enterprises							
Abroad	- 0.73	- 0.57	0.37	0.43	0.54	0.70	0.87
8. Monetary aggregates							
ALP	- 0.22	0.20	0.80	0.30	- 0.03	0.22	0.44
M_2	- 0.63	- 1.26	- 1.16	- 0.86	- 0.36	- 0.09	- 0.08

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Symmetric temporal interest rate increase with endogenous foreign interest rate							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Market-determined interest rates (%)							
Representative three-month interest rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Representative long-term interest rate	0.70	0.86	0.28	0.27	0.33	0.40	0.48
3. Other interest rate (%)							
Deposit rate	0.17	0.42	0.32	0.11	0.07	0.07	0.08
4. Real interest rates							
Real short-term interest rate (%)	1.05	1.07	0.11	0.27	0.33	0.31	0.27
Real long-term interest rate (%).............	0.75	0.93	0.39	0.55	0.66	0.71	0.76
User cost of capital (%)	0.67	0.82	0.33	0.44	0.53	0.58	0.64
5. Exchange rates							
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	- 0.05	- 0.12	- 0.22	- 0.49	- 0.82	- 1.12	- 1.38
6. Asset prices and wealth							
Wealth variables in the consumption function	- 0.17	- 0.22	- 0.09	- 0.38	- 0.67	- 0.64	- 0.62
7. Net interest and dividend payments							
Household sector	0.10	0.25	0.17	0.19	0.51	0.82	1.04
Non-financial enterprises							
Abroad	0.05	0.12	0.22	0.49	0.81	1.11	1.38
8. Monetary aggregates							
ALP	- 0.38	- 0.29	0.34	- 0.28	- 0.94	- 0.75	- 0.60
M_2	- 0.80	- 1.75	- 1.57	- 1.25	- 0.94	- 0.81	- 1.02

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Asymmetric temporal interest rate increase							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP and its components							
Real GDP	- 0.05	- 0.02	- 0.03	- 0.17	- 0.17	- 0.15	- 0.13
Private consumption	- 0.04	0.19	0.16	- 0.14	0.05	0.16	0.10
Government expenditure	0.09	0.09	0.05	0.05	- 0.00	- 0.03	- 0.05
Private investment	- 0.43	- 0.88	- 1.01	- 0.92	- 0.49	- 0.15	- 0.03
Residential	0.09	0.27	0.31	0.21	0.11	0.07	0.12
Non-residential	- 0.62	- 1.27	- 1.41	- 1.24	- 0.64	- 0.20	- 0.06
Inventories							
Exports	- 0.26	- 0.52	- 0.30	0.03	0.17	0.23	0.22
Imports	- 0.43	- 0.69	- 0.63	- 0.42	0.27	0.57	0.45
2. Unemployment rate (%)	0.02	0.03	0.05	0.09	0.09	0.05	0.02
3. Real disposable income	0.13	0.16	0.06	0.01	0.00	0.05	0.09
4. Inflation and wages							
GDP deflator	- 0.16	- 0.42	- 0.63	- 0.90	- 1.20	- 1.48	- 1.73
Consumer prices	- 0.26	- 0.54	- 0.66	- 0.95	- 1.28	- 1.58	- 1.85
Wages per hour	- 0.26	- 0.57	- 0.78	- 1.15	- 1.53	- 1.85	- 2.10
Unit labour cost	- 0.25	- 0.54	- 0.73	- 1.08	- 1.44	- 1.73	- 1.97
Import prices	- 1.14	- 1.39	- 0.59	- 0.85	- 1.15	- 1.42	- 1.67
5. Government accounts (% of nominal GDP)							
Revenues	- 0.02	- 0.01	- 0.00	- 0.02	- 0.01	- 0.01	- 0.01
Primary expenditures	0.05	0.06	0.06	0.13	0.11	0.09	0.09
Interest payments	- 0.23	- 0.35	- 0.21	- 0.19	- 0.20	- 0.22	- 0.23
Financial deficit	- 0.30	- 0.43	- 0.27	- 0.34	- 0.32	- 0.32	- 0.34
Public sector debt	0.43	0.99	1.36	1.91	2.38	2.81	3.25
6. Current account (% of nominal GDP)	0.17	0.20	0.10	0.11	- 0.07	- 0.15	- 0.12
Trade balance	0.16	0.19	0.10	0.10	- 0.07	- 0.15	- 0.12
Net interest payments abroad	0.01	0.01	- 0.00	- 0.01	- 0.01	- 0.01	- 0.01

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Symmetric temporal interest rate increase with endogenous foreign interest rate

Deviations from baseline*	1994	1995	1996	1997	1998	1999	2000
1. Real GDP and its components							
Real GDP	- 0.05	- 0.01	0.03	- 0.18	- 0.25	- 0.25	- 0.27
Private consumption	- 0.20	- 0.04	0.16	- 0.21	- 0.17	- 0.06	- 0.20
Government expenditure	0.01	- 0.01	0.02	0.08	- 0.00	- 0.07	- 0.11
Private investment	- 0.68	- 1.37	- 1.41	- 1.51	- 1.37	- 1.14	- 1.16
Residential	- 0.01	- 0.01	0.02	- 0.01	- 0.17	- 0.34	- 0.44
Non-residential	- 0.94	- 1.86	- 1.87	- 1.94	- 1.70	- 1.35	- 1.35
Inventories							
Exports	0.02	0.04	0.03	0.17	0.50	0.75	0.91
Imports	- 0.67	- 1.14	- 0.93	- 0.85	- 0.26	0.07	- 0.12
2. Unemployment rate (%)	0.03	0.04	0.05	0.13	0.16	0.15	0.13
3. Real disposable income	- 0.01	0.01	0.03	- 0.06	- 0.16	- 0.18	- 0.19
4. Inflation and wages							
GDP deflator	- 0.05	- 0.12	- 0.22	- 0.49	- 0.82	- 1.12	- 1.38
Consumer prices	- 0.05	- 0.12	- 0.22	- 0.48	- 0.81	- 1.10	- 1.36
Wages per hour	- 0.06	- 0.18	- 0.37	- 0.76	- 1.19	- 1.55	- 1.86
Unit labour cost	- 0.06	- 0.16	- 0.34	- 0.71	- 1.11	- 1.45	- 1.74
Import prices	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Government accounts (% of nominal GDP)							
Revenues	- 0.01	- 0.01	- 0.01	- 0.02	- 0.02	- 0.01	- 0.02
Primary expenditures	0.03	0.01	0.01	0.13	0.13	0.10	0.11
Interest payments	- 0.42	- 0.59	- 0.28	- 0.32	- 0.42	- 0.54	- 0.68
Financial deficit	- 0.47	- 0.61	- 0.30	- 0.48	- 0.57	- 0.66	- 0.81
Public sector debt	0.53	1.12	1.40	2.14	2.91	3.67	4.58
6. Current account (% of nominal GDP)	0.15	0.27	0.22	0.19	0.03	- 0.06	- 0.01
Trade balance	0.15	0.27	0.22	0.19	0.03	- 0.06	- 0.00
Net interest payments abroad	- 0.00	- 0.00	- 0.00	- 0.01	- 0.01	- 0.02	- 0.03

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table III

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Asymmetric temporal interest rate increase						
	Total	**Substi-tution effect**	**Wealth**	**Income/ cash flow**	**Cost of capital**	**Exchange rate**
Real GDP: first year after shock*	**- 0.05**	**- 0.02**	**- 0.01**	**0.00**	**0.01**	**- 0.03**
of which:						
Private consumption	- 0.03	- 0.04	- 0.02	0.00	0.00	0.04
Government expenditure	0.02	0.00	0.00	0.00	0.00	0.02
Private investment	- 0.10	- 0.01	0.00	0.00	- 0.07	0.02
Residential private investment	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Non-residential private investment	*- 0.08*	*- 0.01*	*0.00*	*0.00*	*- 0.05*	*0.02*
Inventories	*- 0.02*	*0.00*	*0.00*	*0.00*	*- 0.02*	*0.00*
Exports	- 0.07	0.00	0.00	0.00	0.00	- 0.07
Imports	0.13	0.02	0.01	0.00	0.07	- 0.03
Real GDP: second year after shock*	**- 0.02**	**- 0.02**	**0.02**	**0.00**	**0.00**	**- 0.06**
of which:						
Private consumption	0.12	- 0.03	0.05	0.00	0.00	0.05
Government expenditure	0.02	0.00	0.00	0.00	0.00	0.02
Private investment	- 0.24	- 0.01	0.00	0.00	- 0.04	0.05
Residential private investment	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
Non-residential private investment	*- 0.18*	*- 0.01*	*0.01*	*0.00*	*- 0.03*	*0.02*
Inventories	*- 0.07*	*0.00*	*- 0.01*	*0.00*	*- 0.01*	*0.02*
Exports	- 0.15	0.00	0.00	0.00	0.00	- 0.14
Imports	0.22	0.01	- 0.02	0.00	0.04	- 0.05
Real GDP: third year after shock*	**- 0.03**	**- 0.01**	**0.02**	**0.00**	**- 0.02**	**- 0.05**
of which:						
Private consumption	0.10	0.03	0.04	0.00	0.00	0.02
Government expenditure	0.01	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.28	0.00	0.01	0.00	- 0.07	0.03
Residential private investment	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
Non-residential private investment	*- 0.23*	*0.01*	*0.01*	*0.00*	*- 0.06*	*0.00*
Inventories	*- 0.06*	*- 0.01*	*0.00*	*0.00*	*- 0.01*	*0.02*
Exports	- 0.09	0.00	- 0.01	0.00	0.00	- 0.07
Imports	0.22	- 0.02	- 0.02	0.00	0.05	- 0.02

Table III (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Asymmetric temporal interest rate increase

	Total	**Substitution effect**	**Wealth**	**Income/ cash flow**	**Cost of capital**	**Exchange rate**
Real GDP: fourth year after shock*	**- 0.17**	**0.01**	**- 0.04**	**0.00**	**- 0.04**	**0.00**
of which:						
Private consumption	- 0.09	0.02	- 0.10	0.00	- 0.01	0.02
Government expenditure	0.01	0.00	0.00	0.00	0.01	- 0.01
Private investment	- 0.26	0.02	0.00	0.00	- 0.31	0.04
Residential private investment	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
Non-residential private investment	*- 0.22*	*0.02*	*- 0.02*	*0.00*	*- 0.23*	*0.04*
Inventories	*- 0.05*	*0.00*	*0.02*	*0.00*	*- 0.08*	*- 0.01*
Exports	0.01	0.00	0.00	0.00	0.00	0.00
Imports	0.16	- 0.02	0.05	0.00	0.26	- 0.05
Real GDP: fifth year after shock*	**- 0.17**	**0.01**	**- 0.02**	**0.00**	**- 0.09**	**0.03**
of which:						
Private consumption	0.03	0.01	- 0.02	0.00	- 0.02	0.04
Government expenditure	0.00	0.00	0.00	0.00	0.01	- 0.01
Private investment	- 0.15	0.01	- 0.02	0.00	- 0.37	0.06
Residential private investment	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
Non-residential private investment	*- 0.12*	*0.01*	*- 0.02*	*0.00*	*- 0.24*	*0.06*
Inventories	*- 0.03*	*0.00*	*0.00*	*0.00*	*- 0.13*	*- 0.01*
Exports	0.06	0.00	0.01	0.00	0.01	0.00
Imports	- 0.11	- 0.01	0.02	0.00	0.28	- 0.06
Real GDP: final year after shock*	**- 0.13**	**0.01**	**0.00**	**0.00**	**- 0.16**	**0.05**
of which:						
Private consumption	0.06	0.00	0.01	0.00	- 0.01	0.04
Government expenditure	- 0.01	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.07	- 0.02	0.02	0.00	- 0.04	- 0.04
Residential private investment	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
Non-residential private investment	*- 0.01*	*- 0.01*	*0.02*	*0.00*	*- 0.04*	*- 0.01*
Inventories	*- 0.06*	*- 0.01*	*0.00*	*0.00*	*0.00*	*- 0.04*
Exports	0.08	0.00	0.00	0.00	0.06	- 0.01
Imports	- 0.20	0.02	- 0.03	0.00	- 0.17	0.07

* Percentage deviations from baseline.

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The formation of interest rates in theory and in Sweden

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I. INTRODUCTION

The main purpose of this paper is to present a general framework within which the formation of interest rates in Sweden can be analysed. The presentation is primarily theoretical and is largely based on the model described in Dillén (1994). On the basis of this framework, the formation of interest rates in Sweden in 1994 is analysed. Such an analysis fulfils two purposes: firstly it is of great interest in itself to try to clarify the dramatic trend on the bond market during 1994, and particularly the rise in long-term interest rates. Secondly, such an analysis elucidates the possibilities and limitations of the modelling possibilities. At the same time it should be recognised that the framework has been created in order to analyse the formation of Swedish interest rates in a long-term perspective, and is therefore larger than what is required for analysing the current interest rate situation.

When designing interest rate models (or models in general), there are two main questions to decide on. How shall the model's general structure be constructed? More precisely, this question means that, on the basis of economic theory, one explains the occurrence of factors which affect the formation of interest rates. It should also be clear in what way these factors are assumed to affect the formation of interest rates. The other question concerns how the factors shall be specified, which in practice means that one describes the dynamic characteristics of the factors, i.e. in what way the factors change during the course of time, which in turn is related to the question of how expectations are formed.

When it comes to the general model structure, this is based on modern financial pricing theory. Moreover, our model describes the formation of interest rates in open economies, and therefore differs from the majority of interest rate models, which limit themselves to analysis of closed economies. The chosen model structure motivates the occurrence of the following factors: global real interest rates, real exchange rates and (domestic) inflation rate. The global real interest rate can be seen as an indicator of the international business cycle which is determined by global required returns and investment opportunities. The real exchange rate is the factor which arises when one moves to studying open economies, and reflects how the real interest rate in a single country differs from the global interest rate. Finally, the inflation rate is a purely nominal factor which arises when nominal interest rates are considered.

The dynamic specification is to a certain degree standard, i.e. the constituent factors are assumed to revert to a stationary level but are constantly disrupted by random but undramatic shocks.[2] However, we will sometimes assume that a factor can jump dramatically on isolated occasions.[3] A well-known example of this which we will study is a devaluation, which means that both the nominal and the real exchange rate will depreciate. Another more topical example is the case where the inflation rate can quickly rise if an inflation target is abandoned. Both these examples can be said to illustrate regime shifts. In view of Sweden's poor reputation for maintaining fixed exchange rates and

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2 In continuous time this means that the factors follow (stationary) diffusion processes (driven by so-called Wiener processes).

3 Formally this means that the factor is driven by a so-called Poisson process.

low inflation, it is difficult to disregard expectations on such regime shifts in the analysis of the formation of Swedish interest rates.

The framework above is thus fairly general and flexible, and contains analysis possibilities over and above what is required for analysing the current situation in Sweden. The possibility of analysing the effect of devaluation expectations is one such example. I believe that it is a great advantage to be able to analyse different monetary regimes within the same model framework, not least because it permits interesting comparisons to be made. In addition, quite a few general implications arise from financial pricing theory, which are noted along the way. Nevertheless, the above-mentioned modelling strategy entails some limitations. In the first place, the monetary effects connected with the demand for money and the role of money in general are not modelled. In particular I will not explicitly consider operational aspects of monetary policy. One result of this is that when I analyse the formation of interest rates in Sweden in 1994, the analysis will mainly focus on long-term interest rates. I think, however, that certain aspects of monetary policy such as the impact on the term structure that originates from changes in the exchange rate or the credibility of monetary policy can be examined in this framework. Moreover, it is my hope that the above-mentioned model framework has a structure which allows monetary mechanisms and operational aspects of monetary policy to also be integrated in future studies. Finally, I will not try to design non-fundamental interest rate models, which are driven more by psychological factors such as shortsightedness and herd behaviour. I will discuss such aspects, however, in connection with the analysis of Swedish interest rates.

The report is organised in the following way. General ideas such as expectations hypothesis and various parity relationships are presented in Section II. General modern financial theory and its implications are also discussed in this section. In Section III, the general model framework is presented along with the constituent factors. In addition, quantitative implications on interest rate formation under standard assumptions concerning factor dynamics are studied to a some extent. The effects of regime shifts of the above-mentioned type are analysed in Section IV. In Section V we try to answer a number of questions concerning interest development in Sweden in 1994 on the basis of the analysis from earlier sections. We also depart from the model framework and discuss whether non-fundamental reasons of a more psychological nature, such as shortsightedness and herd behaviour, are required in order to explain the observed interest rate trend. Finally, our examination is summarised in Section VI. An appendix gives the theoretical foundation for the model and analyses the size of various risk premia.

II. THEORETICAL OVERVIEW

An overview of various interest rate theories is presented in this section. First, the expectations hypothesis and certain parity relationships are presented. This is followed by a brief review of the modern interest theories developed by financial economists. Finally, I evaluate and discuss the implications of these theories. In the theoretical section, the term interest rate refers to the yield provided by zero coupons.[4] I thus use the yield curve to refer to the relationship between yields of zero coupon bonds and time to maturity. In Section V, in which I move on to a discussion of the development of Swedish interest rates in 1994, I refer to the actual interest rate, which in the case of long-term interest rates are based on bonds with coupons. Even though it is possible to adjust these coupon payments, the quantitative significance of such an adjustment is so small that it is of no great importance for the analysis carried out in Section V.[5]

4 If the price at time t of a nominal zero coupon bond with maturity T is denoted by $B(t,T)$, the (continuously compounded) yield, $r(t,T)$, can be written as $r(t,T) = -\ln[B(t,T)]/(T-t)$, where ln denotes the natural logarithm. Sometimes one prefers to express interest rates and bond prices in discrete time and in that case the relationship between the interest rate and the bond price takes the form $B(t,T) = [1+ r(t,T)]^{-(T-t)}$, where T-t now represents the number of periods (often years) until maturity.

5 In Svensson (1993a), various methods of adjusting for coupon payments are described.

1. Expectations hypothesis and parity relationships

An idea which recurs in many forms in bond and interest theory is that the expected return should be largely the same for different types of bonds. Relationships which describe such ideas are often called parity relationships. One example of such a parity relationship is the expectations hypothesis. The expectations hypothesis states that the relationship between long-term and short-term interest rates is as follows:

$$r(t,T) = \frac{1}{T-t}\sum_{s=t}^{T-1} E_t\left[r(s)\right] + \varphi_{tp}(t,T) \tag{1}$$

where $r(t,T)$ = nominal yield (or interest rate) at date t on a zero coupon bond that matures at date T, i.e. time to maturity is T-t periods

$r(s) \equiv r(s,s+1)$ = the nominal short-term interest rate, i.e. the yield on a nominal bond that matures next period[6]

$E_t[X]$ denotes expectation of a stochastic variable X contingent on information available at date t

$\varphi_{tp}(t,T)$ = "term premium"

The insight behind this relationship (1) is that the yield on a long-term bond should largely correspond to the expected yield if the investment was instead made in short-term bonds period for period up until the maturity date of the long-term bond. In addition to this, there is also a term premium which can be either positive or negative.[7] In the older literature it is usually assumed that this premium reflects compensation for the risk involved in holding long-term bonds, in which case the premium is positive. I will assume below that this premium, as well as any other (risk) premium, is low and I refer to Section V.6 for a discussion of these assumptions. It is worth noting that the reasoning behind the expectations hypothesis for nominal interest rates can also be applied to real interest rates. The relationship between real interest rates and nominal interest rates is usually illustrated with the help of the Fisher hypothesis, as below:

$$r(t,T) = R(t,T) + \pi(t,T) + \varphi_{\pi}(t,T) \tag{2}$$

where $R(t,T)$ = real yield (or interest rate) at date t on a real (indexed linked) zero coupon bond that matures at date T

$\pi(t,T) \equiv E_t[p(T) - p(t)]/T\text{-}t$ = expected inflation during [t,T]

$p(t) \equiv \ln P(t)$ = natural logarithm of the consumer price index (CPI)

$\varphi_{\pi}(t,T)$ = inflation risk premium

It is important to note that the real interest rate is here defined as the real yield guaranteed by a real bond and not as the nominal interest rate minus expected inflation. In other words, (2) should

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6 Relationship (1) applies irrespective of how long a period is.

7 There are a multitude of different definitions of term premium (apart from that implied by (1)). One definition is the expected yield on a long-term bond during a period minus the short-term (one-period) interest. Another definition is the difference between the forward interest rate and the expected future interest rate. All of these alternative definitions of forward premium have in common that they indicate some form of extra premium (possibly negative) for holding long-term bonds.

be seen as a hypothesis and not as a relationship that defines real interest rates.[8] However, given the lack of real bonds it is usually the case that real interest rates are defined on the basis of (2) and a theory about how inflation expectations are formed.

Finally, it can be noted that in a world with the free movement of capital, parity between domestic and foreign interest rates should apply according to:

$$r(t,T) = r^*(t,T) + \delta(t,T) + \varphi_S(t,T) \qquad (3)$$

where $r^*(t,T)$ = nominal foreign yield (or interest rate) at date t on a zero coupon bond that matures at date T

$\delta(t,T) = E_t[s(T) - s(t)]/T\text{-}t$ = expected depreciation during [t,T]

$s(t) \equiv \ln S(t)$ = natural logarithm of the exchange rate

$\varphi_S(t,T)$ = exchange rate risk premium

If the exchange rate risk premium is zero, the relationship above is referred to as uncovered interest rate parity. As we will see in Section III, there is also a real version of this relationship (3).[9]

Academic economists as well as practioners have paid substantial attention to the parity relationship described above, and it has been the subject of innumerable empirical tests. Despite all of this attention, parity relationships of this type provide an incomplete picture of the formation of interest rates and the form of the yield curve, and many questions are left unanswered. How should we interpret fluctuations in the yield curve, for example, in terms of nominal and real disturbances? Why do long-term and short-term interest rates sometimes move in opposite directions? What determines the magnitude of risk premia? In order to answer such questions, a more general, but at the same time structural, approach is required. Let us therefore investigate what modern financial pricing theory has to say.

2. Modern interest rate theories

Financial pricing theories developed at a furious pace during the 1970s and 1980s. This applies not least to the development of theories concerning the pricing of bonds, which in turn determines the formation of interest rates, and two types of models were worked out: arbitrage models and models based on general equilibrium. Before presenting these attempts, let us discuss the term factor, which is of fundamental importance in what follows.

A factor is an exogeneously stated quantity which follows a stochastic process and is believed to affect bond prices. A factor may sometimes be directly interpreted as an economic quantity, for example the short-term interest rate or the inflation rate, but in general accounts factors are often abstract state variables. A factor can be direct or latent. A direct factor is in principle possible to measure from price data, even though this may be difficult in practice. A latent factor is an

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8 When (2) is used as a definition of real interest rate, the inflation risk premium is set at zero. If (2) is seen as a hypothesis, it must be assumed that the inflation risk premium is negligible and/or constant. However, on purely theoretical grounds it may be concluded that (2) is not always correct as a hypothesis. If the real interest rate is low (or even negative) and if there are expectations of deflation, (2) implies negative nominal interest rates, which is absurd.

9 The corresponding real version of (3) can be derived in the following way: substitute relation (2) for the foreign interest rates into (3) and obtain $r(t,T) = R^*(t,T) + \pi^*(t,T) + \delta(t,T) + \varphi_{\pi^*}(t,T) + \varphi_S(t,T)$, where R^* and π^* denote foreign real interest rate and expected foreign inflation respectively. Then combine this expression with (2) and solve for the domestic real rate. We find that $R(t,T) = R^*(t,T) + \delta_r(t,T) + \varphi_h(t,T)$, where $\delta_r(t,T) = \delta(t,T) + \pi^*(t,T) - \pi(t,T)$ is expected real depreciation and where $\varphi_h(t,T) = \varphi_S(t,T) + \varphi_{\pi^*}(t,T) - \varphi_\pi(t,T)$ is the real exchange rate risk premium.

exogene factor which cannot be directly measured from price data. A latent factor is almost always related to some form of probability assessment or expectation. A typical latent factor is the expected rate of devaluation measured as the probability of devaluation multiplied by the expected magnitude of the devaluation. Latent factors are therefore difficult to quantify. When defining a latent factor it is thus important to stress that it should be *exogenous*. A latent factor can often be estimated on the basis of price data, given a theoretical hypothesis, if it is treated *endogenously*. One example of this, which we will consider in the next section, is whether the expected rate of devaluation mentioned above is estimated by means of the difference in the interest rate in relation to the rest of the world. A factor may also have both a direct and a latent component. As we will see, it is probable that expectations concerning inflation have this dual nature.

Arbitrage models are essentially built on the arbitrage argument which lies behind Black-Schole's famous formula for pricing options. The basic idea is that if different bonds are all affected by a common stochastic factor, albeit to different degrees, the price per unit factor risk must be the same for all bonds regardless of the maturity. This so-called factor risk premium is treated exogenously and is determined by actual data. If several factors are assumed to affect bond prices, it is a case of each factor being associated with its own factor risk premium. The arbitrage theory in general gives no guidance on which factor or factors should be included, but in specific models there are proposals that are justified to varying degrees. In single-factor models, the short-term interest rate is almost always the only explanatory factor, as in the early model of Vasicek (1977). Among two-factor models we find that of Brennan and Schwartz (1979), which also includes a long-term interest rate, and that of Richards (1979), which uses short-term real interest rates and the inflation rate as constituent factors. In recent years, a fairly general model has been developed by Heath, Jarrow and Morton (1991), in which the constituent factors are related to the dynamic of the forward rate curve.

General equilibrium models are based on intertemporal optimisation where households in each period decide how much of the given resources shall be consumed and how much shall be invested in different production processes.[10] Here the factors are technological in nature and describe the investment opportunities for different production processes. These abstract factors, however, can often be transformed to observable quantities. A well-known example is the interest rate model of Cox, Ingersoll and Ross (1985b), in which the short-term real interest rate is the only relevant factor. In addition, Cox, Ingersoll and Ross (1985b) expand this model into a model for nominal interest rates and add the inflation rate as an explanatory factor. Another two-factor variant is proposed by Longstaff and Schwartz (1992), in which the volatility of the short-term (real) interest rate is also included. An advantage of these general equilibrium models is that they can be interpreted in terms of investment behaviour which reflects technological shocks, whilst the interpretation possibilities in the arbitrage models are much more limited. Another advantage is that the factor risk premia are determined endogenously The disadvantage is that these models tend to become complicated and difficult to handle.

What both these modelling strategies have in common is that they provide complete expression for interest rates, where expressions for various risk premia can be obtained explicitly. Moreover, the stochastic characteristics of the yield curve are given completely by the models, which means that they are directly testable empirically. The stochastic characteristics are, of course, determined by how the constituent factors are specified dynamically. The models are almost always described in continuous time, and the constituent factors are assumed to be driven by diffusion processes, which in discrete time is normally analogous with simple autoregressive processes, possibly with state-dependent variance, i.e. the dynamics of the factors follow GARCH processes.[11]

10 The economies studied in these models are generally closed one-commodity economies where the production can be directly reinvested in some production process, which in the next period generates a new production.

11 GARCH stands for General Autoregressive Conditional Heteroscedacity. In the Vasicek model the short term interest rate, r, follows an Ornstein-Uhlenbeck process according to $dr = \kappa[r_0 - r]dt + \sigma dZ$, where Z is a standard Wiener process. In discrete time it corresponds to an AR(1) process: $\Delta r = \kappa[r_0 - r_{t-1}] + \varepsilon_t$, $\varepsilon_t \sim N(0,\sigma^2\Delta t)$. In the model of

Finally it is notable that the above-mentioned interest rate models are normally compatible with the expectations hypothesis with a small term premium.

3. Implications and evaluation of modern term structure models

We will now discuss and evaluate those characteristics of the yield curve which the interest rate theories in Sections II.1 and II.2 imply. We will pay particular attention to how different factors affect the shape and the dynamics of the yield curve. What is important for the shape of the yield curve appears to be how the constituent factors are expected to change during the course of time. The typical relationship between the factors and the yield curve is shown in Figure 1.

In Figure 1, factor 1 is assumed to be above its long-run equilibrium level (the dotted line), which it is expected to revert to during the course of time, implying that the effect on the yield curve becomes less as the term increases.[12] Correspondingly, we see that factor 2 deviates negatively from its long run equilibrium level. Note that the effect of the two constituent factors affects the yield curve in an additive way. This is not a universal characteristic, although in most modern term structure models interest rates of different durations are a linear function of the constituent factors.[13]

Furthermore we see from Figure 1 that the interest rate is simply the sum of the factor effects, but in general a constant term plus a premium term can occur, which for the sake of simplicity we have put at zero. Factor decomposition of the above type often expresses some type of parity relationship whereby the constant terms above equal zero. Algebraically the above discussion means that the term structure can be expressed as

$$r(t,T) = \alpha + \sum_{k=1}^{K}\left[q_k(t,T)(x_k(t) - x_{k0}) + x_{k0}\right] + \varphi(t,T) \tag{4}$$

where $x_k(t)$ is the k:th factor, x_{k0} its long-run equilibrium level, α is a constant, and where $\varphi(t,T)$ is a risk premium. $\theta_k(t,T)$ is a function showing the effect on the yield curve when the k:th factor ($x_k(t)$) deviates from its long run equilibrium level (x_{k0}). We will sometimes call $\theta_k(t,T)$ the *factor sensitivity* (associated with the k:th factor). The factor sensitivity can be positive as well as negative depending on how the factor is defined. Often we have that $\theta_k(t,t) = \pm 1$ and it is always true that $\lim_{T\to\infty}\theta_k(t,T) = 0$. Normally the factor sensitivity declines monotonically towards zero (in absolute value).[14] Generally the factor sensitivity $\theta_k(t,T)$ may be stochastic, but in many cases $\theta_k(t,T)$ is a deterministic (but often complicated) function of time to maturity (T-t).[15]

Cox, Ingersoll and Ross (1985b) the dynamic of the short-term interest rate is given by $dr = \kappa[r_0 - r]dt + \sigma\sqrt{r}\,dZ$, i.e, a heteroscedastic AR(1) process ($\Delta r = \kappa[r_0 - r_{t-1}] + \varepsilon_t$, where the variance of ε_t depends on the interest rate according to $\varepsilon_t \sim N(0,\sigma^2 r\Delta t)$). In Longstaff and Schwartz (1992) an additional volatility factor of GARCH type is included in the the expression for the interest rate volatility.

12 Note that it is the effects of factor deviation on the yield curve that are illustrated in Figure 1 and not the factor itself.

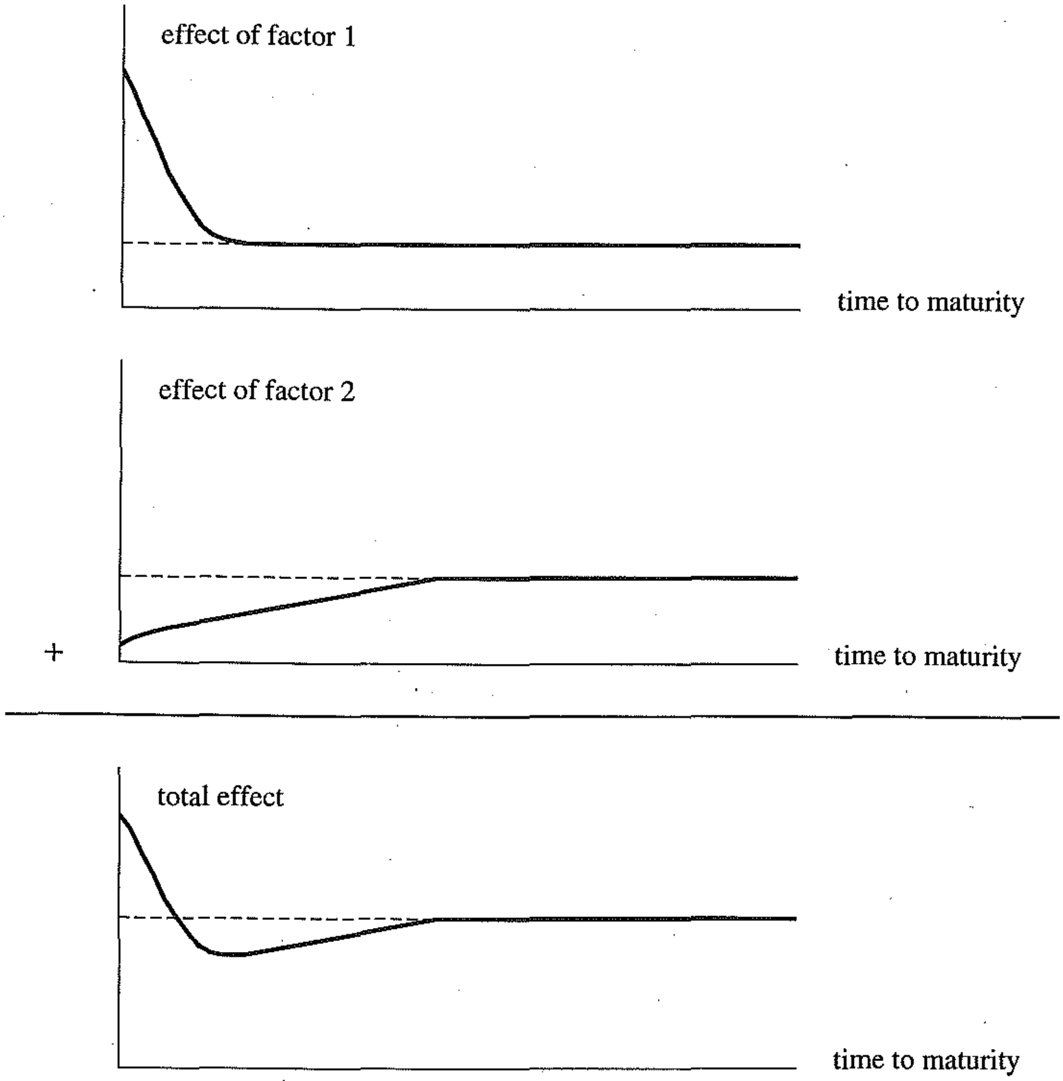
13 Interest rate models which display this linear characteristic are said to belong to the affine class of interest rate models. See Duffie (1992) or Duffie and Kan (1993) for a general presentation of this popular class, which amongst others includes the well-known models of Vasicek (1997), Cox, Ingersoll and Ross (1985b), and Longstaff and Schwartz (1992).

14 The factors (the short-term real interest rate and its volatility) in the model of Longstaff and Schwartz (1992) do not always exhibit the properties mentioned above. For instance it is possible that the factor sensitivities in this model can be non-monotonic and change sign when time to maturity changes. These factors are, however, linear combinations of the genuine technological factors of the models (factors describing investment opportunities in physical capital). If the expressions for the interest rates are rewritten in terms of these genuine factors then the factor sensitivities become positive and monotonically declining towards zero.

15 Interest models exhibiting this property is said to be affine. See footnote 13.

Figure 1

The term structure of interest rate in a two-factor economy



What are the implications, then, of the interest rate models discussed above? An interesting observation is that two-factor models can give rise to non-monotonous yield curves, which is exemplified by Figure 1 above. The reason for this is that the one factor (factor 1) is volatile, but not so persistent, and consequently mainly affects short-term interest rates. The second factor (factor 2), on the other hand, fluctuates less but is more persistent in nature, and consequently also affects long-term interest rates to a certain extent. If the constituent factors deviate in different directions from their respective equilibrium levels, we can obtain yield curves which are positively sloped in some intervals and negatively sloped in other intervals. In general, we have the following rule of thumb:

(i) If the yield curve consists of k number of monotonous segments where two consecutive segments have different slopes, this is an indication that at least k factors are affecting the yield curve.

As indicated by Figure 1, we have the following closely-related rule of thumb for the dynamics in the yield curve:

(ii) The yield curve exhibits mean reversion in that interest rates under (over) their equilibrium levels tend to rise (fall).[16]

Finally we have a third implication:

(iii) The variability of interest rates declines when the remaining duration increases.

This is more or less a direct consequence of the expectations hypothesis, as the average structure which exists there mathematically reduces the interest rate variance.

How well, then, do modern interest rate models describe actual interest rate movements? One problem is that many modern interest rate models are driven by only one factor, which according to (i) implies monotonous yield curves. The Swedish interest curve has often appeared to be non-monotonous, which suggests that at least two factors are present. Dahlquist and Svensson (1994) have shown that the two-factor model of Longstaff and Schwartz (1992) can well be adapted to the Swedish yield curve. On the other hand, they report deficient parameter stability, which is an indication of faulty specification, e.g. a missing factor. The lack of stability of the parameters in the models is fairly usual in the empirical evaluations of explicit interest rate models.

I am not aware of any direct examination of (ii). The reason for this is probably that (ii) largely says that interest rates that are comparatively low tend to rise and vice versa, which is a highly natural hypothesis which is perhaps seen as far too self-evident to test. In particular (ii) implies that a negatively (positively) sloped yield curve tends to move downwards (upwards). This implication is not entirely trivial, however, since the effects of a factor sometimes seem to move in the opposite direction than what the theory prescribes. One example of this is that exchange rates and interest rate differentials (the difference between rates of interest at home and abroad) are sometimes positively correlated even though one expects the opposite in accordance with the parity relationship (3). The occurrence of this unexpected positive correlation in the case of empirical tests of the so-called target-zone model for exchange rate movements led to considerable scepticism against this model.[17] Bertola and Svensson (1993), however, were able to explain this by introducing a latent factor which reflects devaluation expectations. If the devaluation expectations increase in a regime with exchange rate bands, we will most likely observe both a falling yield curve and rising interest rates, even though this conflicts with (ii). We will return later to the question of whether the problem of positive correlation between interest differentials and the exchange rate can be explained by fluctuations in a latent factor.

The relationship between maturity and the variability of interest rates has been the subject of considerable attention. It is not the qualitative message in (iii) that has been questioned but rather the quantitative implications of the expectations hypothesis, which is also indirectly a criticism of modern financial interest rate models, as they largely confirm the expectations hypothesis. The problem is that if the expectations hypothesis is true, we would probably expect much lower variability in long-term interest rates than we actually see. This criticism of the expectations hypothesis has come from Shiller (1979), Singleton (1980) and others. Such criticism, however, is built on some type of notion as to what a reasonable development of the future short-term interest rates is. If there are expectations that the short-term interest rates will follow a random walk in the

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16 In Figure 1, the long-run equilibrium level is constant for interest rates of all maturities. However, the long-run equilibrium level may depend on time to maturity if the risk premium (which we ignore in Figure 1) depends on time to maturity.

17 See, for example, Lindberg and Söderlind (1991).

future, the expectations hypothesis implies that long-term interest rates will have the same variability as the short-term rates.[18] Even if a random walk assumption appears unreasonable, perhaps the investors still expect a more volatile and less predictable development in the short-term interest rate compared with historical interest series, which implies a relatively high variability in the long-term interest rates in accordance with the expectations hypothesis. The trend from regulated credit markets to more deregulated credit markets which are characterised by free movement of capital in an increasingly internationalised economy gives certain support to this idea. Hamilton (1988) argues that the expectations hypothesis is compatible with historical data if the occurrence (and expectations) of regime shifts in monetary policy is taken into consideration.

The discussion above indicates that the existing interest rate models are probably in some respects misspecified. One deficiency is that it is assumed that the interest rates are only affected by factors that are driven by diffusion processes. More intuitively, this means that interest rates are assumed only to react to frequent but not so dramatic information, i.e. the daily stream of information, but not to infrequent but dramatic events such as devaluation, war, oil price shocks, devaluations, etc. From a purely empirical point of view it would thus be a step towards increased realism if we permitted the term structure to be affected by infrequent but dramatic shocks, as we sometimes observe large movements in interest rates which reflect something other than the daily stream of information. This restricted modelling procedure is partly due to the fact that existing financial interest rate models lack an economic structure in which the above-mentioned shocks have some interpretation. This in turn is due to the fact that many interest rate models, developed by financial economists, are adapted to be used for evaluation of so-called interest rate derivatives such as bond options. In these contexts it is more important that the models statistically describe the short-run interest rate dynamic in an adequate way than that they have any structural content. In those cases where the interest rate models have any financial structure, they often describe closed one-commodity economies, where neither exchange rates (real or nominal) nor monetary policy exists.[19]

In summary, it can be said that modern financial pricing theory offers good opportunities for analysing the formation of interest rates under different assumptions concerning what factors are to be included and the dynamics of the factors. The problem is that existing applications of this theory often lack an interesting economic structure. We will show in the next section, however, that it is possible to give more structure to the financial interest rate models and retain the tractability of the models at the same time.

III. A THREE-FACTOR MODEL OF THE TERM STRUCTURE

In this section and the next we will present the main outline of an interest rate model proposed by Dillén (1994), to which the interested reader is referred for details. In the appendix, however, there is a more formal presentation of the model and an analysis of the size of various risk premia. In this model, the formation of interest rates is affected by three economic factors: the global real interest rate, the real exchange rate and the inflation rate. In this section we will present the constituent factors under the assumption that the factors are driven by (well-known) diffusion processes. One consequence of this is that the interest rate dynamic which arises in this case is of the same type as found in the above-mentioned financial interest rate models. A model of this type naturally constitutes an important, but probably incomplete, part of a more complete model.

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18 If the short-term rate follows an random walk (without drift) then we have that $E_t[r(s)] = r(t)$, implying that (1) simplifies to $r(t,T) = r(t)$ + risk premium.

19 An interesting exception is Nielsen and Saà-Requejo (1993), who study a two-commodity economy where the relative price between the two commodities can be interpreted as a real exchange rate if we associate each commodity with a country. There are models in the more macro-oriented literature (e.g. Lucas (1982)), which pay regard to monetary and international aspects. The disadvantage is that they are more analytically unwieldy and the possibility of paying regard to a somewhat more complicated dynamic course of events is therefore limited.

1. The global real interest rate

The global economy is, in contrast to the economies of individual countries, closed. This means that it is possible to permit the equilibrium on the financial markets to be determined by an optimisation problem which a representative investor meets. Thereby we can also make use of general pricing principles and apply these in order to price bonds, and in this way determine equilibrium interest rates. From several standard models now at hand, we will, for the sake of simplicity, choose that of Vasicek (1997), in which the short-term interest rate follows a so-called Ornstein-Uhlenbeck process, which means that the short-term interest rate during a short time interval (Δt) changes according to

$$\Delta R_G(t) \equiv R_G(t+\Delta t) - R_G(t) = \kappa_G[R_{G0} - R_G(t)]\Delta t + \varepsilon_G(t), \tag{5}$$

where $R_G(t)$ is the short-term global interest rate, R_{G0} is the long-run equilibrium level for the short-term real interest rate, and where $\varepsilon_G(t)$ is a normally distributed random term with the mathematical expectation zero and variance $\sigma_G^2\Delta t$ and where the parameter κ_G measures the degree of mean reversion. The higher the value of κ_G, the faster the short-term global interest rate tends to return to its long-run equilibrium level. In discrete time this process is analogous with an AR(1)-process. The factor dynamic above is certainly simple, but many of the more sophisticated interest rate models within financial economy have a factor dynamic of a similar type, and often it is only the specification of the random term that constitutes the difference (see footnote 11). It can be shown (see Dillén (1994)) that long global real interest rates relate to the short-term rate according to

$$R_G(t,T) = \theta_G(t,T)[R_G(t) - R_{G0}] + R_{G0} + \varphi_{Gl}(t,T) \tag{6}$$

where $\theta_G(t,T) = (1 - e^{-\kappa_G(T-t)})/(\kappa_G(T-t))$

and where $\varphi_{Gl}(t,T)$ is real term premium. Note that the short-term global interest rate has been considered as an exogeneously given factor and that the term structure for global real interest rates has the form stated in (4).[20] The function $\theta_G(t,T)$ is the factor sensitivity with regard to the short-term global real interest rate and states how deviations in the short-term real interest rate affect global long real interest rates. This effect is less the larger the mean reversion parameter κ_G is.

Global real interest rates are not observable since there are no bonds, so far as I know, that are index-linked to any representative global consumer price index. On the other hand, there are empirical work where researchers have tried to estimate and characterise a global interest rate, see for example Barro and Sala-i-Martin (1990). The short-term real interest rate should be seen as an international economic indicator which is a common factor in all financial asset prices in the world economy. With a sufficiently representative set of asset prices, it would in principle be possible to identify this common factor.

2. The real exchange rate

What does the formation of real interest rates look like when we move on to the study of open economies? The point of departure is that the global economy consists of open economies which differ between themselves in that different economies are exposed to different types of shock and that they have different orientations regarding production and consumption. These differences in turn lead to variations in the real exchange rate, H, which is defined as

$$H(t) = S(t)P^*(t)/P(t) \tag{7}$$

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20 It is reasonable from a Swedish perspective to treat the global real interest rate as exogenously given.

or in logarithms

$$h(t) = s(t) + p^*(t) - p(t) \qquad (7')$$

where S denotes the nominal exchange rate (the number of units of domestic currency per unit of foreign currency) and where P and P* denote the domestic and foreign price level respectively measured as consumer price indexes. In particular we can let S and P* be weighted indexes so that they represent a global exchange rate index relative to the domestic currency and a global price level respectively. With the latter interpretation of the real interest rate, the following important result is shown in the appendix: *the domestic real interest rate is determined only by the global real interest rate and the real exchange rate.* The force in this result is that the real exchange rate contains all relevant information for determination of how the domestic real interest rate deviates from the global. For the purpose of obtaining a little quantitative feeling for the effect of the real exchange rate, let us assume that it follows a geometric Ornstein-Uhlenbeck process, i.e. the logarithm for the real exchange rate has a dynamic during short time intervals according to

$$\Delta h(t) = \kappa_h[h_0 - h(t)]\Delta t + \varepsilon_h(t) \qquad (8)$$

where h_0 is the long-run equilibrium level for the real exchange rate, κ_h is a mean reversion parameter and where $\varepsilon_h(t)$ is a normally distributed random term with variance $\sigma_h^2\Delta t$. If the real exchange rate lies below (above) its long-run equilibrium level, it is said to be overvalued (undervalued). It can now be shown that (5) and (8) imply the following expression for domestic real interest rates

$$R(t,T) = R_G(t,T) + \delta_r(t,T) + \varphi_h(t,T) \qquad (9)$$

$$\delta_r(t,T) = E_t[h(T) - h(t)]/T\text{-}t = \theta_h(t,T)(h_0 - h(t))$$

$$\theta_h(t,T) = (1 - e^{-\kappa_h(T-t)})/(T-t)$$

where $R_G(t,T)$ is given by (6), $\delta_r(t,T)$ is the expected real depreciation rate and where $\varphi_h(t,T)$ is a real exchange rate risk premium. The factor sensitivity $\theta_h(t,T)$ measures how sensitive the real interest rate is to fluctuations in the real exchange rate, and it has a similar interpretation as $\theta_G(t,T)$ in equation (6).[21]

If $\varphi_h(t,T) = 0$, (9) corresponds to a real version of the uncovered interest rate parity. We can moreover show that a similar relation also applies if the global real interest rate is replaced by the real interest rate in an arbitrary foreign economy.[22] Abuaf and Jorion (1990) have estimated the factor $\rho_h = e^{-\kappa_h(T-t)}$ to be around 0.8 on annual data (T-t = 1) for the real value of the dollar against various foreign currencies. The value of 0.8 for ρ_h implies an overvaluation of the domestic currency by 10% ($h(t) - h_0 = -0.1$) gives rise to a real interest rate differential of about 2% on one-year bonds. This simple calculation example suggests that fluctuations in the real exchange rate can have a significant effect on the formation of the real interest rate. Baxter (1994) has shown that the real exchange rate is related to long-term real interest rate differential in accordance with the pattern above, whilst a similar relationship is difficult to verify for the short-term real rate. One explanation for this can be that the degree of reversion to long-term equilibrium is weak and in the short term the real exchange rate appears almost as a random walk.

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21 Note that $\theta_G(t,T)$ and $\theta_h(t,T)$ differ in that the latter function lacks the mean reversion parameter in the denominator.

22 This is most easily perceived if we combine the relationship (9) for the domestic and foreign economy and thereby eliminate the global real interest rate assuming that the difference in expected real depreciation (in relation to the world economy) between the home country and the foreign is identical to the expected real depreciation of the domestic currency relative to the foreign. Moreover, the difference in the currency risk premium in relation to the world economy determines the currency risk premium between the home country and abroad.

In contrast with the global real interest rate, the real exchange rate is to a certain degree possible to affect for a small open economy. Thus, the exchange rate channel of the transmission mechanism also works via an effect on real interest rates. The dynamic for the real exchange rate depends also on what type of exchange rate regime (at least in the short run) and the above analysis is misleading if the nominal exchange rates are fixed and the risk of devaluation exists. This case is discussed in Section IV.1.

3. The inflation rate

The third economic factor which affects the formation of interest rates is the inflation rate, which here is defined as the expected relative rate of price increases in a short period of time. The inflation rate can formally be defined according to

$$\pi(t) = E_t[\ln P(t+\Delta t) - \ln P(t)]/\Delta t \qquad (10)$$

where P(t) is the price level and where Δt is a short period of time. The inflation rate is a measure of the rate of price increase that is expected during the immediate future, whilst with inflation we refer to the actual rate of price increase.[23] Experience shows that periods of high inflation tend to be followed by periods of high inflation and again we let a so-called Ornstein-Uhlenbeck process represent the inflation rate too, i.e.

$$\Delta\pi(t) = \kappa_\pi[\pi_0 - \pi(t)]\Delta t + \varepsilon_\pi(t) \qquad (11)$$

where π_0 is the long-run equilibrium level for the inflation rate and where $\varepsilon_\pi(t)$ is a normally distributed random term with the variance $\sigma_\pi^2\Delta t$. The inflation rate can, of course, be influenced by monetary policy. The inflation rate is even controllable to a large degree, and it is possible to interpret the parameter values (π_0, κ_π and σ_π^2) in terms of price stability. The Riksbank's inflation target of 2% means that $\pi_0 = 0.02$, and its tolerance interval of $\pm$ 1 % requires that the degree of mean reversion, κ_π, must be sufficiently large.[24] Note that the inflation rate is not directly observable since what we can observe is the actual inflation, which apart from the inflation rate depends on a random component. However, it is possible to obtain a good estimate of the inflation rate with the help of historical values of price level and regression analysis (if (11) is a correct specification). The specifications above now imply the following expression for nominal interest rates

$$r(t,T) = R(t,T) + \pi(t,T) + \varphi_\pi(t,T) \qquad (12)$$

$$\pi(t,T) = \theta_\pi(t,T)[\pi(t) - \pi_0] + \pi_0$$

$$\theta_\pi(t,T) = (1-e^{-k_\pi(T-t)})/(k_\pi(T-t))$$

where $\pi(t,T)$ is the expected inflation during the period [t,T], R(t,T) is given by (9) and where $\varphi_\pi(t,T)$ is an inflation risk premium. In addition it is straightforward to make sure that nominal interest rates according to (12) really have a linear structure in accordance with (4). This is easily seen by rewriting (12) as

$$r(t,T) = R_G(t,T) + \delta_r(t,T) + \pi(t,T) + \varphi(t,T) \qquad (12')$$

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23 The terms inflation and inflation rate are not particularly well-defined concepts and are often used as synonyms. Inflation rate is often used to signify the quantity defined in (10).

24 This is one of many different ways of modelling an inflation target. Other alternatives are discussed by Gerlach (1993).

where $\varphi(t,T) = \varphi_{\pi}(t,T) + \varphi_{h}(t,T)$. In (12) it is also the case that the long-term global real interest rate, $R_G(t,T)$, relates to the short-term global interest rate, $R_G(t)$, in accordance with the expectations hypothesis (i). An analogue relationship prevails between expected inflation, $\pi(t,T)$, and the inflation rate, $\pi(t)$. Finally, the expected real depreciation depends on the expected future real exchange rate. We can say that it is the expected future evolution for the three factors $R_G(t)$, $h(t)$ and $\pi(t)$ which determines the yield curve. The description of how these factors are expected to change during the period is, however, primitively described as Ornstein-Uhlenbeck processes, equivalent to AR(1) processes in discrete time. Let us therefore consider somewhat more sophisticated models of how the constituent factors develop over time.

IV. REGIME SHIFTS

In the discussion and analysis of the three-factor model above, we have assumed that the constituent factors $R_G(t)$, $h(t)$ and $\pi(t)$ are of the diffusion type, i.e. the factors are affected only by frequent information which constantly induces small stochastic changes of the factor values. It is probable, however, that other types of information of an infrequent but drastic nature also affect interest rates. An obvious example of this is the drastic shift in the yield curve that occurs when information on a devaluation reaches the financial markets. When the exchange rate is flexible we can also conceive that information on a fundamental change in monetary policy (e.g. the abandoning of price stability as an overall goal of monetary policy) can give rise to dramatic movements in interest rates. A suitable designation of events of this type is regime shift if this term is interpreted in a broad sense and other dramatic and infrequent events, such as wars, are also included. A characteristic of factors that describe regime shifts is that they are latent in nature, which makes them more difficult to analyse. We will below, using two examples, analyse in a little more detail what consequences the occurrence of regime shifts of the above-mentioned type can have for the dynamic and shape of the yield curve.

1. The formation of interest rates in a devaluation economy

In our first example we will study a small open economy which is planning to maintain a fixed value for its currency against a currency index. The exchange rate (relative to the currency index) is permitted to deviate a few percent around this so-called target value. In other words, the exchange rate moves within a exchange rate band. This type of exchange rate system has existed in different forms during recent decades in Europe, including Sweden, and research into how exchange rates and interest rates fluctuate in such band regimes has been extensive over recent years.[25] Research and practical experience shows that these exchange rate bands have not always been completely reliable, and a number of adjustments have been made to them (so-called realignments). In our example, an adjustment will mean a devaluation, which is an upwards adjustment of the target value. We do not rule out, however, that this adjustment can be downwards, and the devaluation in this case is negative, i.e. a revaluation. The width of the exchange rate band is assumed to be unchanged in relative terms during the entire period. Formally (the logarithm of) the exchange rate can be written as

$$s(t) = x(t) + c(t) \tag{13}$$

where $x(t)$ is the logarithmic deviation from the logarithm of the target value, $c(t)$. This target value is normally constant but is sometimes adjusted upwards in the event of a devaluation. It is important to note that with the exchange rate we are no longer referring to a global currency index but a narrower index, e.g. Deutsche Mark or ECU. One consequence of this is that the global real interest rate, R_G, is replaced with R^* which we can simply call the foreign real interest rate.

25 An overview of this research is given by Svensson (1992).

In Section III.2, the importance of the real exchange rate for the formation of interest rates was stressed. An important aspect in this relationship is in what way the real exchange rate adapts in relation to its long-run equilibrium level. As the adjustment of the real exchange rate by means of the nominal exchange rate is limited by the band, it is natural to study adaptation mechanisms entailed by adjustments in the target value. Let us define the process *g* as

$$g(t) \equiv c(t) + p^*(t) - p(t) \tag{14}$$

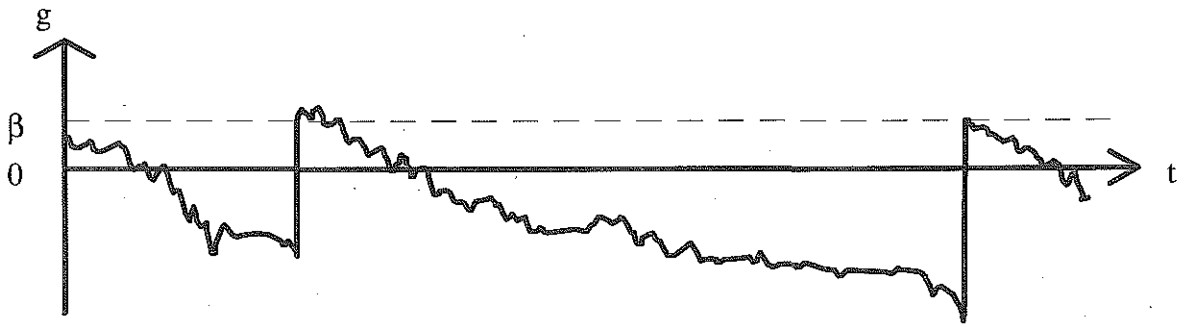
The process *g* can be interpreted as the long-term component in the real exchange rate. We can see this more clearly by combining (7'), (13) and (14) so as to obtain the following expression for the real exchange rate (in logarithm form)

$$h(t) = x(t) + g(t) \tag{15}$$

Note firstly that fluctuations in *g* between devaluations reflect the difference in the rate of increase between foreign and domestic price levels. In the short run exchange rate fluctuations within the band dominate over relative price changes, as prices are considered as sticky in the short run. The opposite applies in the long run, as the difference in domestic and foreign price levels is not restricted to varying within a narrow band. If the domestic inflation systematically tends to exceed the foreign, the real exchange rate will thus appreciate and the domestic currency becomes overvalued, which in turn can lead to external imbalance. In this situation, a devaluation can be the only way to restore external balance. A devaluation which only aims to restore external balance can be said to be *passive*, although there can also be *offensive* reasons for devaluing in order to provide the domestic export industry with competitive advantages. A typical development of the long-term component in the real exchange rate, *g*, is shown in Figure 2 below.[26]

Figure 2

Example of how the long-term real exchange rate, g(t), evolves over time



We see in Figure 2 that in the long term the real exchange rate tends to appreciate between devaluations when the real exchange rate takes an upwards jump, which happens on two occasions in our example. In this example there is also an offensive element in the devaluations in that the new target value is set at a level where the domestic currency becomes undervalued.[27] β in Figure 2 can thus be seen as a measure of the offensiveness in a devaluation. Moreover, we assume that the exchange rate's deviation from the current target value, x, follows an Ornstein-Uhlenbeck process according to

26 It is also of interest to think what a reasonable specification of the long-term exchange rate can look like if the band regime is entirely credible. In this case, the adaptation in the real exchange rate does not take place by means of devaluations but by adaptations in the trend of inflation. A conceivable specification of the long-term exchange rate would perhaps again be an Ornstein-Uhlenbeck process.

27 In the example, it is assumed that g = 0 corresponds to the long-run equilibrium level, but that there is a real "overshooting" in the domestic currency, which means that g is set at β after a devaluation.

$$\Delta x(t) = -\kappa_x x(t)\Delta t + \varepsilon_x(t) \tag{16}$$

where κ_x is a mean reversion parameter and where $\varepsilon_h(t)$ is a normally distributed random term with variance $\sigma_x^2\Delta t$. This specification relies on the assumption that the long-run equilibrium level for x equals zero, implying that the exchange rate behaves symmetrically within the band.[28]

Let us analyse what the formation of interest rates looks like in this devaluation economy. For that purpose we need to introduce some new quantities. One important quantity is the devaluation intensity λ, which is the expected number of devaluations per year.[29] Let us further assume that the domestic inflation tend to exceed the foreign inflation by μ ($E_t[(p(T) - p(t)) - (p^*(T) - p^*(t))]/(T-t) = \mu$). It can now be shown (see Dillén (1994)) that the assumptions above imply that the nominal short-term interest rate is of the form

$$r(t) = r_0(t) - \mu + \lambda[1 - e^{-\beta+g(t)}] + \varphi_g \tag{17}$$

$$r_0(t) = R^*(t) - \kappa_x x(t) + \pi(t) + \varphi_x \tag{18}$$

where φ_g and φ_x are insignificant premia.[30] Moreover, $r_0(t)$ can be interpreted as the interest rate that would prevail in an economy where long-term fluctuations in the real exchange rate do not exist, i.e. g is identical with zero. In other words, $r_0(t)$ is the interest rate that is established in a credible band regime where the foreign inflation rate coincides with the domestic, and all fluctuations in the real exchange rate stem from nominal exchange rate fluctuations within the band. The relationship (17) seems strange at first sight in that an increased inflation rate increases the difference between domestic and foreign inflation rates (μ), which according to (17) appears to reduce the short-term nominal interest rate! This effect is counteracted, however, by the fact that $r_0(t)$ increases to a corresponding degree. The remaining effect of an increased domestic inflation rate is that the long-term real exchange rate appreciates faster, which according to (17) leads to a higher nominal interest rate. In an economy with fixed exchange rates, an increase in the domestic inflation rate leads to higher interest rates in that the risk of devaluation increases. Furthermore, (17) implies that an increased intensity of devaluation, ceteris paribus, increases the short-term interest rate given that g(t) is less than β. Note also that the perception that there is an offensive motive to devaluate, i.e. $\beta > 0$, also leads to higher interest rates.

We have above only analysed the short-term interest rate in a devaluation economy. Variations in the long-term component in the real interest rate affect long-term interest rates in a similar way to how they affect the short-term interest rate, although the effect declines when time to maturity increases. It is possible to produce explicit expressions for long-term interest rates, but we will content ourselves with a graphic illustration. Figure 3 shows the shift in the yield curve which a devaluation gives rise to under the assumptions that the devaluation intensity, λ, is 0.2 devaluations per year, that the domestic inflation rate is 1.5% higher than the foreign ($\mu = 0.015$) and that $\beta = 0.05$. The upper curve shows the additional component in the yield curve that a devaluation regime gives rise to compared with that in a credible band regime when the real exchange rate is overvalued by 15% ($g = -0.15$). The lower curve shows a corresponding additional component when the real exchange rate is undervalued by 5% ($g = 0.05$). The distance between these curves thus shows the effect on the yield curve which a devaluation of 20% gives rise to.

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28 Mathematically, (16) means that the exchange rate can temporarily leave the band with a small probability. It has been shown, however, see e.g. Lindberg and Söderlind (1992), that the degree of mean reversion is so strong that an Ornstein-Uhlenbeck process constitutes a good approximation to more sophisticated processes that do not allow the exchange rate to leave the band.

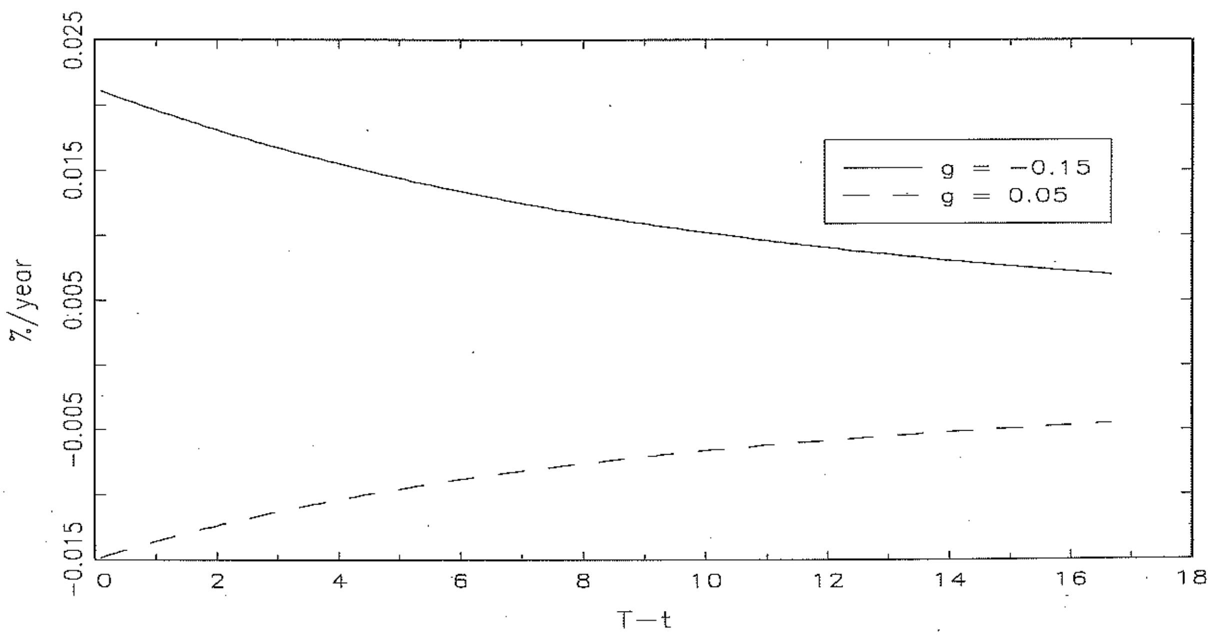
29 Formally we assume that the devaluations are the jumps in a Poisson process with jump intensity λ.

30 It can be shown that φ_g is equal to $-\frac{1}{2}\sigma_g^2$, where σ_g is the volatility of the long-run real exchange rate. φ_x is the sum of φ_h and φ_π, see (9) and (12).

. The shift in the yield curve is due to the fact that the expected real depreciation of the domestic currency subsides drastically in the event of a devaluation, which reduces real and thus also nominal interest rates. Amongst other things from Figure 3, we see that the real (and nominal) five-year interest rate falls by around 2.5%, which is a significant real shock.[31] As expected the effect on long-term interest rates is smaller than the effect on short-term rates. Note finally that Figure 3 indicates that the yield curve tends to be declining when the domestic currency is overvalued and the risk of devaluation exists. After a devaluation, the yield curve tends to have a positive slope. The presence of devaluation expectations is mainly reflected in fluctuations in the interest differential, i.e. the difference between domestic and foreign interest rates. Extensive research has been conducted over the last few years into the interest difference and its connection with devaluation expectations in band regimes.[32] Often the devaluation risk, defined as the product devaluation intensity (λ) multiplied by the expected size of a devaluation, is measured according to the so-called "drift adjustment method", which means that the risk of devaluation is given by the interest difference after the expected depreciation within the band has been subtracted. The devaluation risk in Sweden has been estimated in this way by Lindberg, Svensson and Söderlind (1991). The great variability in the devaluation risk found in this study suggests that the intensity of devaluation cannot be constant over time, but varies stochastically. We should remember, however, that it remains to be tested whether the drift adjustment method really gives a precise measure of devaluation expectations. Lindberg, Svensson and Söderlind (1991) found that a some devaluation risk was also present shortly after the offensive devaluation in 1982, which appears somewhat strange.

Figure 3

The effect of a devaluation of 20%



Note: The upper curve shows the impact (before a devaluation) that an overvalued domestic currency (g = -0.15) gives rise to and the lower curve shows the impact (after a devaluation) that an undervalued domestic currency (g = 0.05) gives rise to.

31 Actually the effect in Figure 3 is entirely real in nature. As we have implicitly assumed that the formation of the inflation rate (and thereby the inflation expectations) is not affected by a devaluation, Figure 3 also shows the effect on the nominal interest rates. This assumption is not entirely realistic, however, and the effect of devaluation on nominal interest rates can in reality differ from the effect of devaluation on real interest rates.

32 Examples of theoretical research are to be found, for example, in Bertola and Svensson (1993), who also discuss relevant empirical research.

2. The formation of interest rates in an economy with imperfect credibility in the inflation target

In the previous example, the formation of interest rates was analysed when the policy announced by the central bank of maintaining the exchange rate around a target level was not credible. In countries with flexible exchange rates, monetary policy is often expressed in more or less explicit inflation targets. We will analyse in what way imperfect credibility in meeting such inflation targets is reflected in the formation of interest rates.

There are several reasons why it is more difficult to analyse the effects of imperfect credibility in this case than when devaluation expectations exist. In the first place it is difficult to get a clear idea of the future inflation process if the inflation target is abandoned. Obtaining an idea of what a devaluation means is much easier even if there is some uncertainty on the size of the devaluation.[33] Secondly, it is unclear what regime shifts are possible after abandonment of the current inflation target. In a devaluation economy it is further devaluations that constitute the future regime shifts. Thirdly, it can be difficult to observe an abandonment of an inflation target, whilst it is easy to observe a devaluation. Another difference is that the motive behind the abandonment of an inflation target can be other than the motive behind a devaluation. A devaluation can be motivated by the fact that the value of the overvalued domestic currency needs to be adjusted. One interpretation of a change to a high inflation target can be that the government is trying to finance the national debt by printing money.

Of the many conceivable regime shifts in monetary policy which describe the abandonment of the current inflation target, we will now consider the following scenario. Let us imagine that at the start we are in the normal position where the inflation rate is low and varies moderately around the proclaimed inflation target. There is, however, a likelihood that the economy is put into a state where the inflation rate fluctuates at a considerably higher level. Given that the economy is in a high inflation state, there is also a likelihood that the economy shifts back to the normal position with low inflation. Formally this can be formulated so that the quantity π_0 in equation (11) can jump between two states: a low inflation state (π_{0l}) and a high inflation state (π_{0h}). Moreover we assume that the economy shifts from the low inflation state to the high inflation state with the intensity ν_l and that the economy shifts back with the intensity ν_h. The inverse of these intensities specifies for how long the prevailing state is expected to last. A value of 0.5 for ν_h, for example, implies that the expected duration in the high inflation state is two years. Thus, the inflation rate is decomposed in a direct component, representing fluctuations around the inflation target, and a latent component representing shifts in the inflation target. These shifts in inflation targets mean that the yield curve will also shift. We will have a high interest rate state and a low interest rate state. We will in what follows use subindices l and h for interest rates in the low and high inflation regime respectively.

It is possible within this model to produce explicit expressions for interest rates of different maturities, see Dillén (1994), although these expressions are somewhat complicated. We therefore choose to illustrate the formation of interest rates in graph and table form. Figure 4 below shows how large the shift in the yield curve is when the economy jumps from the low inflation state, where the inflation target is 2% (π_{0l} = 0.02), to the high inflation state, where inflation fluctuates around 7% (π_{0h} = 0.07) under different assumptions of the values of ν_l and ν_h. We see in Figure 4 that the change in the short-term interest rates corresponds to the shift in the inflation target, i.e. 5%, whilst the shift in the long-term interest rates is lower. Note that it is only the nominal interest rates that shift in this case. Figure 4 also indicates that the yield curve tends to have a positive slope when the low inflation state prevails, which reflects the fact that long-term interest rates to a large extent incorporate the possibility that the economy switches to a state of high inflation.

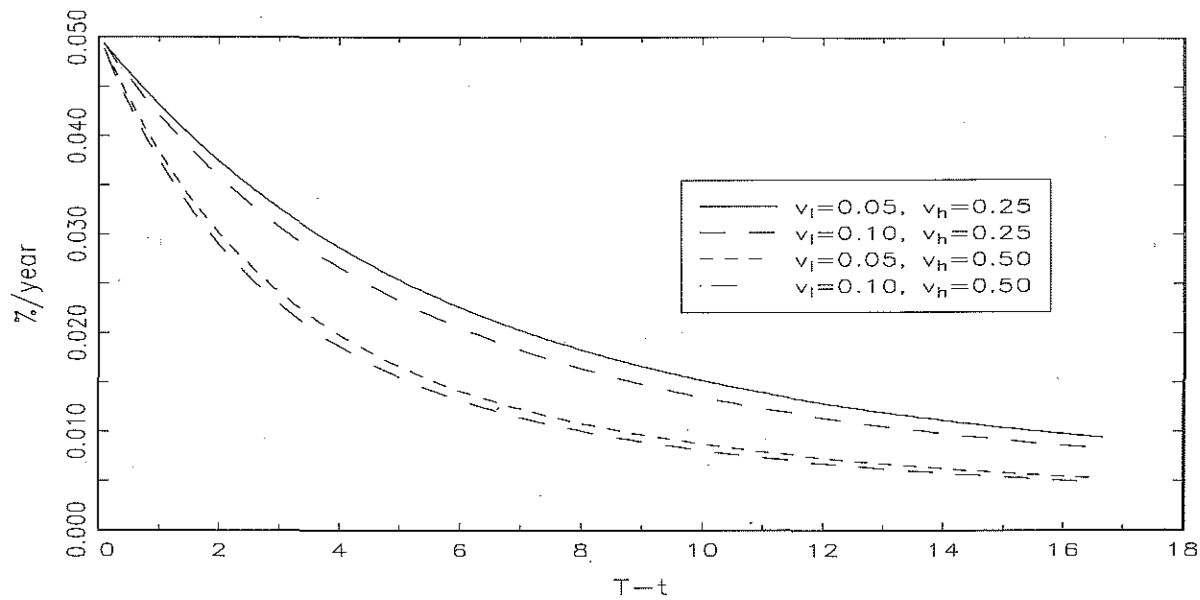
33 The size of devaluation should, however, be related to how overvalued the domestic currency is, which was the case in the above example.

In addition, forward interest rates tend to exceed future realised spot interest rates (positive *ex post* premia) if the economy remains in a state of low inflation, and vice versa in the high inflation state. Systematic patterns in *ex post* premia of this type are often interpreted to mean that the term premium varies over the course of time. What appears to be a time-varying term premium can in fact be a forecast error that this type of regime gives rise to. Forecast errors of this type are broadly consistent with the findings of Fama and Bliss (1987).

Figure 4

Shift in the yield curve as a result of a shift in the inflation target

$r_h(t,T) - r_l(t,T)$



We can also quantify how interest rates are affected if the credibility of the current inflation target is weakened. The point of departure is that an inflation target (π_{0l}) of 2% has been proclaimed but that it is not credible, which is expressed in a positive value in the parameter v_l. Table 1 shows for different values of the parameters v_l, v_h and π_{0h} the effect on short-term (six-month) and long-term (five-year) interest rates which imperfect credibility of an inflation target gives rise to.

The most striking observation is that long-term interest rates are more sensitive to changes in the credibility of the inflation targets than short-term rates. If the credibility is weakened, i.e. the intensity v_l increases, the rise in the five-year interest rate is four to five times larger than that in the six-month interest rate! Whilst imperfect credibility in a fixed exchange rate policy (devaluation expectations exist) mainly affects short-term interest rates, we find that imperfect credibility in the inflation target primarily affects the long-term interest rates.[34]

34 The intuition behind why long-term interest rates are affected more than short-term interest rates when the credibility of the inflation target is weakened can partly be obtained if we try to assess expected inflation in the short and long run. In the short run there is a small probability that the economy will change to a high inflation state, and the (expected) proportion of the time to maturity when the high inflation state prevails is therefore short. In the long run, the probability of a change to the high inflation state is higher, which raises the (expected) proportion of the time to maturity that is characterised by high inflation.

Table 1

Effect on interest rates when an inflation target is not credible

v_l	v_l	π_{0h}	**Effect on six-month interest rate**	**Effect on five-year interest rate**
0.10	0.50	0.10	0.18	0.85
0.20	0.50	0.10	0.35	1.56
0.10	0.50	0.15	0.29	1.32
0.20	0.50	0.15	0.57	2.44
0.10	0.25	0.10	0.19	1.11
0.20	0.25	0.10	0.37	2.01
0.10	0.25	0.15	0.30	1.70
0.20	0.25	0.15	0.59	3.13

Source: Dillén (1994). The current inflation target is 2% ($\pi_{0l} = 0.02$).

Naturally we should interpret the above analysis with caution. It is difficult to substantiate that regime shifts of this type actually take place, and it is more hazardous to form an opinion on the values of the parameters v_l, v_h and π_{0h}. Hamilton (1988) shows, however, in an empirical examination of a switching model that the US economy during the period from the end of 1979 to the end of 1982 was in a high interest rate state before then reverting to a more normal interest rate state. With some caution in interpretation, this study points to $v_l = 0.04$, $v_h = 0.38$ and that $r_h - r_l = 5.12\%$.[35] The last detail says that the high inflation state implies an increase in the short-term interest rate of fully 5%. In our model, this interest difference is equivalent to $\pi_{0h} - \pi_{0l}$. It would be highly misleading, however, to contend that the inflation target in the United States at the beginning of the 1980s was increased by 5%. Admittedly a high inflation rate (>10%) prevailed during a large part of the high interest period, but this inflation originated from other reasons, particularly the shock increase in oil prices in 1979. The high interest rate at the beginning of the 1980s more reflected the ambition of the Federal Reserve to squeeze inflation. The conclusion is that even if it is difficult to explicitly account what gets an economy to shift from low to high inflation and/or interest rate, the quantitative consequences of such changes are probably of great significance.

V. ANALYSIS OF THE FORMATION OF SWEDISH INTEREST RATES IN 1994

1. Introductory observations

On the basis of the theoretical argument in the previous sections, an analysis of the formation of interest rates during 1994 in Sweden will be made. The development of the six-month interest rate and the five-year interest rate during this period is shown in Diagram 1. We will also look at the trend of the interest rate differential relative Germany and how this trend follows the value of the krona, see Diagram 2. The diagrams give rise to the following questions:

I. Why have long-term interest rates increased so dramatically?
II. Why have long-term interest rates increased more in Sweden than in other countries?

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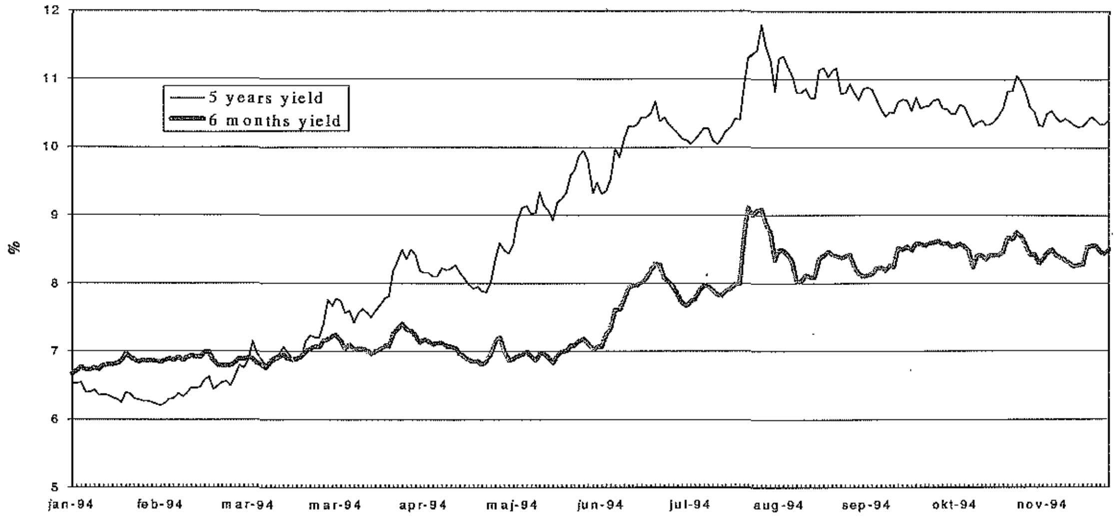
35 Hamilton (1988, Table 3) reports that the probability of staying in a low interest rate state until the next quarter is 0.9899. This probability corresponds to exp($-v_l$*0.25), implying $v_l = 0.04$. Similarly the reported probability of staying in a high interest state until the next quarter is 0.9087 implying $v_h = 0.38$. Furthermore, the quarterly short-term interest rate is on average 1.633%, i.e. an annual rate of 6.69%. Corresponding figures for the high interest state are 2.821% and 11.77%, respectively.

III. Why have long-term interest rates been so volatile?
IV. Why does the krona tend to become weaker at the same time as the interest rate differential (relative to other countries) increases?
V. Why are short-term interest rates also higher in Sweden than abroad?

Diagram 1

The formation of Swedish interest rates during 1994



Source: The Riksbank.

It can hardly have escaped anyone's attention that questions of this nature have been sharply in focus during 1994. Question II has been the subject of particular debate and has largely been linked to domestic political factors such as the size of the national debt and its growth rate, together with how the politicians have handled these problems. However, it should be noted that the national debt was not mentioned as an important factor to any great extent in previous theoretical discussions. On the other hand, we cannot discount the fact that the national debt has an indirect effect on the fundamental factors that in their turn influence the formation of interest rates. It is thus desirable to try to identify such links and to try to assess the plausibility of any links proposed.

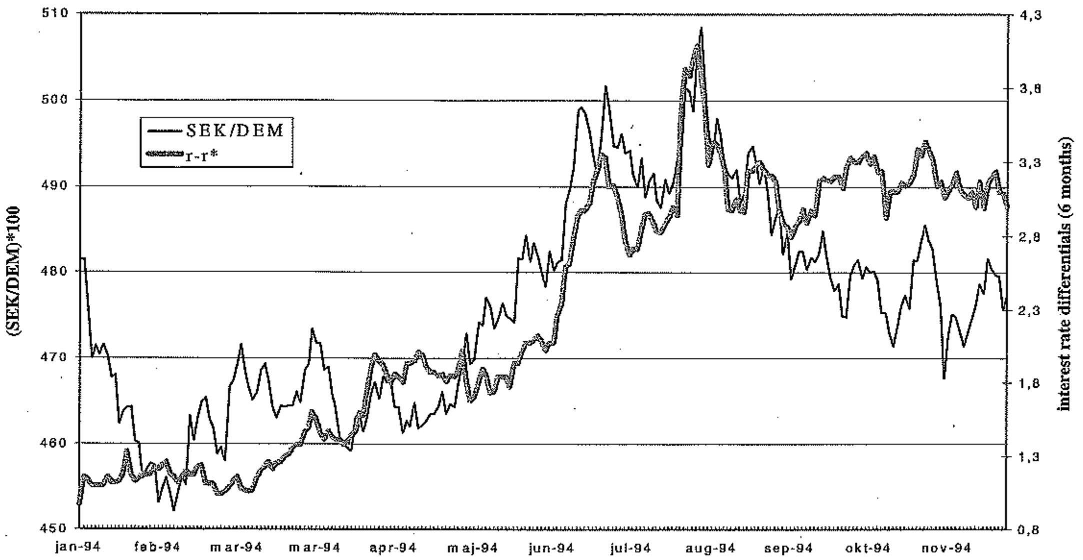
However, it is questions III and IV which at first glance seem to be most problematic from a purely theoretical point of view. Question III is difficult because both theory and (previous) empirical experience imply that long-term interest rates are relatively stable. The problem with question IV will be discussed soon in Section V.2. Finally, Question V has not been discussed to the same extent, but in my view it is perhaps the most difficult of all, since in this case we cannot refer to the "risks" concealed in an unforseeable future. However, it may be relevant here to remember that short-term interest rates reflect the operational part of monetary policy, which includes aspects that are not incorporated in the theoretical models presented in previous sections. Let us first take a look at the general question of why Swedish interest rates are higher than abroad.

2. Interest rate differentials and exchange rate expectations

One of the main reasons why nominal interest rates differ between countries is that interest rate differentials reflect expected nominal exchange rate expectations. This is the principal proposition of the parity relationship (3). It is therefore natural to ask whether the interest rate

Diagram 2

The exchange rate (SEK/DEM) and the interest rate differential (r-r*)



Source: The Riksbank.

between domestic and foreign interest rates reflects expectations that the Swedish krona will be nominally depreciated in the future. Expectations of a future depreciation could be due to the fact that the krona is overvalued. However, it is hard to imagine that the Swedish krona is overvalued given the dramatic depreciation that has taken place since the krona was allowed to float in November 1992. The fact that the Swedish export industry has been working at full speed during 1994, and that both the balance of trade and the current account are positive, also contradicts the view that the Swedish krona is overvalued. It may, however, be the case that the Swedish krona is undervalued rather than overvalued, but that expectations of a high inflation rate in the future give rise to expectations of a nominal depreciation of the krona.

There is an interesting observation, however, which points to the existence of a latent factor which in some way affects the demand for Swedish government securities. We normally expect a negative correlation between exchange rate and interest rate difference, as a weakening of the krona, i.e. increase of the exchange rate, should dampen future depreciation expectations (or increase future appreciation expectations), which in turn, *ceteris paribus,* should reduce the interest rate differential. What is interesting now is that we actually often observe the opposite, i.e. the interest rate difference tends to increase at the same time as the krona is weakened and vice versa, as seen in Diagram 2. The explanation for this can be that there is an underlying fluctuating factor which affects the demand for Swedish government securities. When the demand for these securities falls, this results in the price of Swedish bonds falling, which leads to higher Swedish interest rates and/or a weakened krona. If both these price changes occur at the same time in the event of a fall in the demand for Swedish bonds, this results in a positive correlation between the exchange rate and the interest rate differential. But the questions remain: What is this demand factor? Why has the demand for Swedish bonds fallen? It is these questions that we will now try to analyse.

3. The national debt

Judging from recent debate, the size of the national debt would appear to be the principal candidate for the demand factor sought for above. One argument supporting this could be that when the national debt, and thus the need for government borrowing, increases, investors demand a higher interest rate in order to hold the larger stock of bonds. This line of reasoning is correct in a closed economy, for example the world economy, and it is probable that the increase in public debt all over the world has tended to increase the international interest rate. If this is the case, we have an answer to Question I.

On the other hand, the above argument does not hold in a small economy like the Swedish economy, since the magnitude of the Swedish national debt has an entirely negligible effect on the international interest rate. Expressed in another way, the size of the national debt cannot in itself provide an answer to Question II. It is only if an increased national debt involves a greater risk of some type that the yield demand on Swedish bonds rises compared to the world around. The next step in the analysis is therefore to try to identify what this risk consists of.

4. Credit risk

Credit risk is one example of a risk that should be positively related to the size of the national debt and which should be able to explain the high yield requirement of investors on kronor assets. The credit risk should also be able to explain why Swedish interest rates overreact to international fluctuations in interest. An international upswing in interest rates is accompanied by the increased credit risk which results from the fact that the government debt and its financing then becomes a greater burden, and Swedish interest rates rise relative to more creditworthy countries. The opposite applies in the event of an international downswing in interest rates, when a reduction of the credit risk means that Swedish interest rates decrease more (from a high level) than abroad. It should be noted that other factors may also affect the credit risk, for example the ability of politicians to come to terms with the national debt. If the credit risk is considered to be higher for long-term government securities than for short-term securities a situation of this type could perhaps be an answer to Question II. It would appear to be possible to explain many of the phenomena that have been observed in recent months by the fact that the Swedish Government's credit rating has been significantly worsened. Is this a reasonable explanation?

The answer to this question is that the credit risk can only be a partial explanation. The justification for this answer is that an increased credit risk would also be able to force up the interest levels to a corresponding extent on the loans that the Swedish Government has taken in foreign currencies. This has only taken place to a relatively limited extent. We must try to find other risks that are associated with Swedish government securities.

5. Regime shift in monetary policy and inflation shocks

It remains to be seen whether the difference in interest rates compared with surrounding countries reflects the depreciation of the krona which should follow from a severe increase in future inflation rates. An expected increase in the inflation rate may, however, be of different types. One type of inflation increase is the one that prevails if investors believe that the long-term inflation rate, π_0, in equation (11) is considerably higher than that of other countries. This would mean that the inflation rate during recent years would have deviated negatively from this level but that the investors now expect a relatively rapid adjustment upwards towards the equilibrium level. The presence of this kind of expectation would naturally mean an element of distrust against the ability of the Riksbank to achieve its inflation target. On the other hand, there are several objections to believing this to be a likely description of the expected inflation. In the first place, an explanation like this would mean a long-term inflation rate of approximately 7%, which is a relatively high value that is not reflected in other indicators of inflation expectations.[36] In the second place, an inflation process of this type cannot generate the major fluctuations in the long-term interest rates and especially not the strong upswing. In the third place, this kind of adaptation does not give rise to the positive correlation between the difference in interest rates and exchange rates that has been observed. These objections

36 See "Inflation and inflation expectations in Sweden, October 1994," published by the Riksbank.

are a result of the fact that the expectations with regard to inflation that follow the above pattern are of a direct type, i.e. we would be at present experiencing a substantial inflation pressure if the above scenario were the true explanation for the increase in interest rates.

Expectations of an increased inflation rate may, however, be latent. Let us assume that there is faith in the ability of the Riksbank to meet the current inflation target but that the investors assign a certain probability that the development of the Swedish national debt will lead a situation characterised by high inflation rates, i.e. a high inflation regime.[37] With the aim of quantifying the kind of effects that the above concerns among investors would give rise to, use is made of the switching model that was presented in Section IV.2.

The hypothesis that there is growing apprehension of a future inflation shock (of the kind mentioned above) can explain much of the fluctuations in the long-term interest rates in Sweden during the recent period. It can be seen clearly from the table in Section IV.2 that intensifying fears of a future inflation shock can lead to a substantial increase in the long-term interest rates at the same time as the short-term rates show a more modest increase. The rising long-term interest rates would in this case indicate that the investors on the bond markets judge that the probability of a development of the government finances that leads to a high inflation regime has increased during 1994. Furthermore, the variability in the long-term interest rates indicates that these assessments vary over time. The model in Section IV.2 is capable of explaining both why the long-term interest rates have risen and exhibited a high variability - a phenomenon that is otherwise difficult to explain. Like the credit risk, the risk of an inflation shock is a latent demand factor that may explain why the difference in interest rates compared to other countries tends to increase when the krona is weakened. The important difference is that an inflation shock of this kind only affects assets denominated in Swedish kronor, whereas the credit risk should also exist in debts dominated in foreign currencies. The objection that was raised against the credit risk as being the main causative factor behind the drastic rise in long-term interest rates thus disappears.

However, it is still necessary to make an assessment of whether it is apprehensions of the above category alone that lie behind the powerful upswing in the Swedish long-term interest rates. Let us return to Table 1 and judge the plausibility of the parameter values that are needed in order to create major long-term effects on interest rates. The most critical factor is the intensity v_I, which reflects the probability of a regime shift.[38] The assumption that $v_I = 0.2$ means a probability of 18% that the economy will shift towards a high inflation position within the coming year.[39] If the time horizon is extended to two years, the corresponding probability becomes 33%. These figures can be interpreted to mean that investors believe that Sweden will probably remain with a low inflation rate during the next few years. It is not unreasonable to believe that participants in surveys report the inflation rate that is most likely rather than the (mathematically) expected inflation. Therefore it may be difficult to detect apprehensions of inflation shocks in surveys. Thus, it is nevertheless the lack of explicit fears concerning a switch to a high inflation regime among observers which means that there may be an element of doubt associated with the above argument as being the only explanation for the

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37 Since Sweden has not ealier experienced a deterioration of the public finances that we observe today it is difficult to have a picture of how a switch to a high inflation regime will look like. There are commentators, e.g. Goldman-Sachs (1994), who fear that the budget problem of Sweden will be solved by printing money. A more detailed discussion of such a scenario can be found in Lachman (1994).

38 The other parameters are even more difficult to assess. In the bottom line of Table 1, where the effects on interest rates are most pronounced, we have assumed that the expected duration of the high interest rate regime is four years (4=1/0.25) and that a high inflation situation means an inflation rate of approximately 15%. If the high inflation situation is intended to describe a situation in which the national debt is financed by printing money, the parameter values are hardly on the high side. It is, on the other hand, a genuinely difficult problem to describe a situation like this in quantitative terms.

39 The reported probability is actually 1 - the probability that no shift occurs = 1 - $\exp\{-v_I\tau\}$, where τ is the time horizon considered.

increase in interest rates. Another reason is that this explanation cannot justify existing differences of 2-3% between Swedish and foreign short-term interest rates.

6. Risk premia

I have so far refrained from explaining observed differences in different interest rates in terms of risk premia. The use of the term risk premium is often confusing, since what different people mean by the term and what the risk comprises are not always entirely clear. Most people, however, seem to use risk premium as a term that explains why expected yields are different between different bond investments.[40]

I intend below both in qualitative and quantitative terms to discuss the premia that show up in the parity relations in Sections II and III. The size and characteristics of the risk premia are examined in a little more detail in an appendix, and here I will present the most important insights.[41] We will begin with an insight of a qualitative nature:

The risk premia can be positive as well as negative, and mathematically they to a large extent reflect statistical phenomena.

It is in other words hazardous to interpret premia which explain the yield differences between different bond investments in terms of risk. My use of the concept risk premium should be seen as a reluctant adaptation to a generally accepted usage. The riskiness of interpreting different premia as compensation for risk assumed is also illustrated by the following statement:

Increased uncertainty in the form of increased variability in exchange rate or inflation often tends to reduce the premia instead of increasing them. This is always the case if the variability is sufficiently large.

This goes against the intuition that is often conveyed. Intuitively or not, the question remains whether it is changes in the risk premia that can explain recent fluctuations in long-term Swedish interest rates. The answer is given in the following assertion:

The size of the risk premia for normal parameter values is a small fraction of 1%.

It is not possible to explain interest variations of several percent by fluctuations in a premium in the order of 0.2%. It is clear that the above assertion is based on a number of simplified assumptions such as concerning the dynamic for inflation and exchange rate. The fact remains that there is not, so far as I know, any fundamental bond pricing theory that generates risk premia of quantitative importance.

7. Shortsightedness and herd behaviour[42]

It may be the case that traditional financial theory, which the discussion above is based on, analyses risk in a limited perspective. Commentators who claim that Swedish bonds are risky perhaps refer to aspects, probably of a more psychological nature, which traditional financial theory disregards. It is highly possible that many commentators on the formation of Swedish interest rates

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40 Many users (including academics) of the term risk premium display a limited interest in actually explaining why some form of risk premium appears, and risk premium can often be replaced by the expression "unexplained difference in expected yield". However, it is often hinted that an increased uncertainty (increased variability) in a variable tends to increase the size of the risk premium.

41 A more detailed analysis of different risk premia is to be found in Svensson (1993b).

42 In this section we will briefly discuss effects of a market-psychological nature not captured by the presented model framework. There can naturally be other effects such as portfolio effects which can occur in the event of the issue of government securities. This effect is judged to be small according to Hörngren and Lindsjö (1994), who also conduct an interesting discussion of different effects which traditional pricing theory disregards.

have important insights into how investors on the Swedish bond market behave. The problem is that these commentators are usually very hazy on questions as to what type of risk is concerned. I have tried to interpret such assertions in terms of fundamental factors such as credit risk or the risk of future inflation shocks. We cannot rule out that there are other non-fundamental factors that investors take into consideration.[43]

One type of risk that I have not yet dealt with is the interest rate risk, i.e. the price rate risk of holding bonds when the rate of interest varies. If one buys a five-year government security and the five-year interest rate then rises from 9 to 10%, one incurs a capital loss of some 5%. This is of course a risk if one has a short-term investment view and intends to sell the paper in the near future. On the other hand, the nominal yield is still 9% if one holds the paper until maturity and one can reckon on a good real yield. It seems to me that the Swedish bond market is characterised by shortsightedness. Given that shortsightedness now exists and given the recent variability of interest rates, it is not unreasonable that investors require a certain risk premium for holding long-term Swedish bonds.

What is this shortsightedness due to? I do not have a good answer, but perhaps it has something to do with the increased focus over recent years on active portfolio management. The number of people buying and selling securities has increased, as too has the turnover on the financial markets. There seems to be a belief that a constant monitoring of the financial markets, combined with quick decisions to buy and sell based on the steady stream of information which reaches us daily, can generate an unusually good yield. Undoubtedly there are examples of investors who with luck and/or skill have, through well-timed decisions to buy and sell, utilised the short-term fluctuations and thereby obtained a very good yield. It is not unreasonable that such examples exercise a strong attraction to take part in the frequent trading. It is the case, however, that trading on the secondary market constitutes a zero sum game in the sense that what proves to be a good deal for one party is a bad deal for the opposite party.

There should be counterbalances to these shortsightedness investors. I am thinking mainly of insurance companies and managers of major funds, such as the Swedish Pension Insurance Fund, who reasonable should look to the yield possibilities in the long run and calmly disregard the short-term fluctuations. This counterbalance does not appear particularly clearly in Sweden. A long-term investor who observes an increase in the five-year interest rate from 9 to 10% should be pleased that the possibilities of obtaining a good real yield in the long term have in fact increased, and should not worry over the short-term price rate loss of 5% which the holding of five-year bonds entails. Judging by recent reactions to rising interest rates, this type of long-term thinking is not particularly prevalent in Sweden. Another sign of shortsightedness is the modest interest shown in the recently issued real bonds. These bonds, which have a term of 20 years, guarantee a real yield of more than 4% and should therefore be an attractive investment alternative.

Acting in a short-term manner can also be combined with herd behaviour. A long-term investment based on fundamental evaluation can in the short run develop negatively in a way that is experienced as frustrating, particularly if other investors are doing well. The fear of being a sole loser can mean that we follow the "herd" and do what the others are doing, even if this provides a lower yield in the long run. This behaviour is probably reinforced if the portfolio manager thinks that he is being evaluated in relation to other portfolio managers. Herd behaviour of this type can then lead to an extra premium being demanded for certain differing investment alternatives. Major, respectable currencies such as the dollar and Deutsche Mark have lower yield requirements than minor "anxious" currencies such as the Swedish krona. It hurts more to make a bad investment in Swedish bonds than in German bonds.[44]

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43 The term fundamental factors refers to factors which affect the real dividend that a financial security generates.

44 A variant of this argument can be the psychological explanation below for the so-called size effect on the stock market, i.e. the historical circumstance that shares in a small company have generated a much larger return than shares in large companies. If you invest in IBM (a large company) and it goes badly, people ask what is wrong with IBM,

It is difficult to express an opinion on the importance and extent of possible herd behaviour on the financial markets.[45] I have difficulty in finding any fundamental explanations as to why the short-term Swedish interest rates exceed those abroad by around 2%, which confirms my belief that effects of a market-psychological nature influence the formation of interest rates. There is increasing interest from academics in herd behaviour on the financial markets. Research is still in its infancy, and it is difficult on the basis of this research to make any quantitative assessments of the importance of herd behaviour.

VI. SUMMARY

In this report I have presented a framework within which the formation of Swedish interest rates can be studied. Several different interest rate models have been analysed, but they all have in common that the formation of interest rates depends on three factors: the global real interest rate, the real exchange rate and the (domestic) inflation rate. The global real interest rate can be seen as an international economic indicator which reflects global investment opportunities and return requirements. Furthermore, it is evident that the real exchange rate is an important factor in the explanation of why real interest rates in individual countries can deviate significantly from the global real interest rate level. The inflation rate, finally, is a purely nominal factor which arises when nominal interest rates are taken into consideration. The framework is flexible enough to allow the study of the formation of interest rates under different monetary regimes, and two types of interest rate model which are appropriate for Sweden have been specially analysed.

One of these models is designed to analyse the formation of interest rates when the exchange rate moves within an exchange rate band including the effects of devaluations and devaluation expectations. The implications of this model are well in line with the theories that have developed in recent years in the so-called target zone literature. One difference is that the link between the real exchange rate and devaluations is given more emphasis in the model presented here.

The other model describes the formation of interest rates when the exchange rate is variable and an explicit inflation target has been proclaimed. This model also takes into account the possibility that there are expectations that the inflation target will be abandoned and that inflation in that case will be allowed to rise (or will be forced up) to a high level. Such a model may be relevant in the current situation if one believes that there are fears that the deterioration of the public finances will lead to a high inflation regime. It was established that this model is able to explain several of the complex phenomena that recently have been observed. Among other things, this model implies that a weakening of the credibility of the current inflation target leads to a significant increase in long-term interest rates, while the increase in short-term rates is more limited, which has indeed been the case. The fears mentioned above also represent a latent demand factor, which may explain why the international interest rate differential increases at the same time as the krona becomes weaker.

On the basis of the discussion above, the following scenario could be used to describe the development of interest rates during 1994. During the spring there was an international increase in interest rates (even in real terms), which in our framework can be described as a positive shock in terms of the global real interest rate. This increase in interest rates may reflect the increase in yield requirements demanded by international investors for maintaining the steadily growing stock of debts generated by national deficits all around the world. However, irrespective of the cause, this international increase in interest rates means that countries with a large national debt, such as Sweden,

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whilst a bad investment in the shares of a small company leads people to ask what is wrong with you because you make such poor investments. Perhaps there is a similar size effect on the currency market.

45 Personally I am fairly convinced that herd behaviour has existed in periods at least. Perhaps the clearest example is the granting of credits that took place in Sweden in the latter half of the 1980s, when loans were issued as never before. The lenders refrained from level-headed credit assessment since such a procedure would lead to fewer credits being granted, and thus a poorer result in the short term (relative to the herd willing to lend).

experience even greater problems in managing their national debt. A direct problem is that the financing costs for the national debt increase as interest rates increase. An indirect problem may be that a higher interest rate reduces the level of activity (fewer investments), which in turn reduces government income and increases the budget deficit and the national debt. These problems then increase investors' fears that the politicians will allow inflation to rise to a high level in order to reduce the real burden of the national debt (or, in an extreme case, will financing the debt by printing money). Fears of this type lead to investors demanding even higher interest rates in countries which have problems with a large national debt. The long-term interest rates in particular increase dramatically, as they are more sensitive to increased expectations of inflation shock of this kind. Moreover, the fear of a future inflation shock reduces the demand for Swedish bonds, which in turn may weaken the Swedish krona. This may explain why we often note a depreciation of the krona at the same time as Swedish interest rates increase in relation to the rest of the world.

Two of the basic factors, namely the global real interest rate and the inflation rate, played an active part in the scenario above. The third factor, the real exchange rate, is also important for a quantitative elucidation of the plausibility of the analysis above. If the krona is overvalued, a part of the interest rate differential in relation to other countries could be explained in terms of depreciation expectations. It follows from this that the extent of (or probability of) a future shock increase in inflation does not need to be especially large. If, on the other hand, the krona is undervalued, which is more probable, the model indicates that a considerably higher probability and/or magnitude of future inflation shocks is required to explain the high interest rate. Even though an increasing number of commentators see an increased risk of a rapid price rise in Sweden, it is difficult to find fears which concur with the scenario above. Neither do other indicators of future inflation trends point to drastic increases in inflation in the future which would justify the high Swedish interest rates. Another weakness of the argument above is that it cannot explain why the short-term interest rates are two percentage points higher in Sweden than abroad. My conclusion is therefore that the argument above represents an interesting partial explanation of interest rate trends during 1994, but that other aspects must also be taken into account.

Amongst the other explanations of the dramatic trend in interest rates in 1994 is the assessment that Swedish government securities now carry an increased credit risk, together with the occurrence of increased risk premia. An increased credit risk gives rise to similar effects as increased fears of future inflation shocks. However, an increased credit risk should increase the Swedish Government's interest costs for loans denominated in foreign currencies to the same extent, which is something we have noted only to a limited extent. It is therefore not probable that an increased credit risk lies behind the increase in interest rates in 1994. The problem with risk premia is that traditional economic theory cannot plausibly explain risk premia of a magnitude corresponding to Sweden's current high level of interest rates compared to the rest of the world.

It is perhaps the case that traditional economic theory alone cannot explain interest rate movements in Sweden, but that we must also try to find explanations of a psychological nature. One important element seems to be that investors in the Swedish bond market have a very short investment horizon. Investors care little about the real yield to maturity and are more concerned with the bond yield over the next few months. Given a short-term perspective and the sharp fluctuations in interest rates prevailing at present, Swedish long bonds are a risky investment. Another contributory element may be herd behaviour, i.e. that investors tend to behave in the same way as other investors, and demand premia for deviating from the herd. Taking the risk of being the only one to show poor yield figures in the short-term may be very frustrating. It is more painful to belong to a minority that makes a bad investment in Swedish bonds in the short run than to make an equivalent loss in a major, respectable currency. This type of argument could also possibly explain the relatively high short-term interest rates in Sweden. I cannot rule out the fact that non-fundamental explanations of this nature may have a considerable quantitative effect on the formation of Swedish interest rates.

APPENDIX

Theoretical motivation of the three factor model. According to modern pricing theory there exists (on frictionless markets) a real stochastic discount factor, m(t,T), such that the real price at time t, q(t,T,x), of a claim promising a random real payoff at time T, x(T), can be written as

$$q(t,T,x) = E_t[m(t,T)x(T)] \tag{A1}$$

In equilibrium models of closed economies, e.g. Lucas (1978), the real discount factor is often obtained as the marginal rate of substitution according to

$$m(t,T) = e^{-\rho(T-t)}\frac{U'(C(T))}{U'(C(t))} \tag{A2}$$

where ρ is the time preference parameter and U'(C) is the marginal utility of consumption C for a representative investor. The real payoff of a nominal zero coupon bond promising $1 at time T is 1/P(T), where P denotes the price level, implying that its real price at time t is $E_t[m(t,T)/P(T)]$. It follows that the nominal price, B(t,T), of such bond is given by

$$B(t,T) = E_t[m(t,T)P(t)/P(T))] \equiv E_t[M(t,T)] \tag{A3}$$

where M(t,T) is the nominal discount factor. It remains, however, to characterise a real discount factor in an open economy. For that purpose we remind that the real exchange rate, H(t), is defined as

$$H(t) = S(t)\frac{P^*(t)}{P(t)} \tag{A4}$$

where S(t) is the nominal exchange rate (or more precisely a global currency index) and P*(t) is the global price level. Let us consider a nominal domestic asset promising a nominal payoff X at T. Then we have the following identity

$$E_t[m(t,T)X\frac{P(t)}{P(T)}]/S(t) \equiv E_t[m_G(t,T)X\frac{P^*(t)}{P^*(T)S(T)}] \tag{A5}$$

The left hand side of (A5) is the nominal price in the foreign (i.e. global) currency of a security giving its owner a *nominal* payoff *X* in the domestic currency. Since the payoff of this security equals X/S(T) in the global currency index, the price of the security from a global perspective can also be written as in the right-hand side of (A5) by means of a global real discount factor, $m_G(t,T)$. Since (A5) holds for all well-defined payoffs X it must be true that

$$m(t,T)P(t)/[P(T)S(t)] = m_G(t,T)P^*(t)/[P^*(T)S(T)]$$

which together with (A4) implies

$$m(t,T) = m_G(t,T)H(t)/H(T) \tag{A6}$$

Notice that when the global economy is closed it is possible to interpret the global real discount factor, $m_G(t,T)$, as the marginal rate of substitution of a representative investor. Moreover, (A6) indicates that it is potentially misleading to interpret the domestic real discount factor this way, since we also have to take the effect of fluctuations in the real exchange rate into account. As indicated earlier, $m_G(t,T)$ can in principle be derived as the marginal rate of substitution of a representative investor according to (A2). However, according to modern pricing theory the discount factor $m_G(t,T)$ also can be represented as

$$m_G(t,T) = e^{-\int_t^T r_G(u)du} \tag{A7}$$

where r_G can be interpreted as the short term world real interest rate.[46] By substituting (A6) and (A7) into (A3) we obtain

$$B(t,T) = E_t\left[e^{-\int_t^T r_G(s)ds}\frac{H(t)}{H(T)}\frac{P(t)}{P(T)}\right] = E_t\left[e^{-\left\{\int_t^T r_G(s)ds + h(T) - h(t) + p(T) - p(t)\right\}}\right] \tag{A8}$$

where h = lnH and p = lnP. Notice that the price of a zero coupon bond depends on the expected future evolution of the three factors: the global real interest rate, the real exchange rate and the domestic inflation rate.

Risk premia.[47] We will now use the pricing model above to analyse the size of various risk premia defined as deviations from the parity relationships, which were introduced in Section II. Notice first that the future real exchange rate as well as the future price level appears in a convex manner in (A8). Consequently we expect that an increased variability of these quantities normally tends to increase the bond price, i.e. to decrease interest rates. This observation suggests that intuitive arguments like "an increased uncertainty of the future price level (increased variability) tends to increase the (inflation) risk premium" are not supported by general financial pricing theory. In order to quantify the risk premia we make the simplifying assumption that the terms that constitute the exponent in (A8) are normally distributed. This implies the real price of a real bond can be written as

$$b(t,T) = E_t[e^{-L(t,T)}] = e^{-E_t[L(t,T)] + \frac{1}{2}Var_t[L(t,T)]} \tag{A9}$$

$$L(t,T) = \int_t^T r_G(s)ds + h(T) - h(t)$$

where we have used the rule: X normal implies $E[e^X] = e^{E[X] + \frac{1}{2}Var[X]}$. It follows that domestic real interest rates are of the form

$$R(t,T) = -\ln[b(t,T)]/(T-t) = E_t[L(t,T)]/(T-t) - \tfrac{1}{2}Var_t[L(t,T)]/(T-t) \tag{A10}$$

Similar arguments for nominal bonds produce the following expression for nominal interest rates

$$r(t,T) = R(t,T) + \pi(t,T) + \varphi_\pi(t,T) \tag{A11}$$

where $\pi(t,T) = E_t[p(T) - p(t)]/(T-t)$ is expected inflation

$$\varphi_\pi(t,T) = -\tfrac{1}{2}Var_t[p(T) - p(t)]/(T-t) - Cov_t[p(T) - p(t), L(t,T)]/(T-t) \tag{A12}$$

is the inflation risk premia. If we ignore the covariance term in (A12) and assume that the annual standard deviation of the price level is about 4%, which is quite a high number, then the inflation risk premium is -0.08% ($-\frac{1}{2}\times 0.04^2$). Because the real exchange rate should tend to depreciate when the price level goes up the covariance term in (A11) should be positive, which in turn should reduce the inflation risk premium (in absolute value). I conclude that the inflation risk premium probably is negative and that one has to assume unreasonable values of the parameters to produce a premium outside the interval [-0.002, 0.002]. The inflation risk premium is negligible according to pricing theory.

46 It is implicitly assumed in (A7) that the so called market price of risk is zero. If the market price of risk is non-zero then we have to add some terms to the exponent on the right-hand side of (A7). For an analysis of how discount factors of the type (A7) are related to equilibrium analysis, see Cox, Ingersoll and Ross (1985a).

47 A similar and more detailed analysis can be found in Svensson (1993b).

By using an expression for the foreign interest rate that corresponds to (A11) we obtain[48]

$$r(t,T) - r^*(t,T) = \delta(t,T) + \varphi_s(t,T) \tag{A13}$$

where $\delta(t,T) = E_t[s(T) - s(t)]/(T-t)$ is expected depreciation of the domestic currency

$$\varphi_s(t,T) = \varphi_\pi(t,T) - \varphi_{\pi*}(t,T) + \varphi_h(t,T) - \varphi_{h*}(t,T) \tag{A14}$$

is the nominal exchange rate risk premium and where $\varphi_h(t,T)$ and $\varphi_{h*}(t,T)$ denote domestic and foreign real exchange rate risk premium relative the global economy, respectively. We see from (A14) that the nominal exchange rate risk premium is the difference in the inflation risk premium plus the difference in the real exchange rate risk premium. The difference in the inflation risk premia is small since the inflation risk premium in a single country is small according to the analysis above. The real exchange rate risk premium can roughly be approximated by ½ times the annual variance of the real exchange rate (relative the global economy).[49] A volatility of the real exchange rate of 10%/year then implies a real exchange rate risk premium of -0.5% ($-½\times0.1^2$). The difference in the real exchange rate risk premium between the countries should be a small fraction of 1%. Accordingly the nominal exchange rate risk premium is of the same size.

48 When calclulating the interest rate differential one finds that all price level terms vanish.

49 I disregard a covariance term that tends to reduce the real exchange rate risk premium.

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Simulation analysis of the transmission of monetary policy in Switzerland

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I. INTRODUCTION

This paper presents and comments on the results for Switzerland of a macroeconometric simulation exercise concerning the process of monetary policy transmission. The exercise was conducted in response to a 1994 project initiative by the Bank for International Settlements (BIS), which aimed at an overview and comparative analysis of transmission patterns in different countries. Participating central banks were to conduct macroeconometric simulation experiments of a temporary increase in the policy-controlled (or controllable) interest rate of 100 basis points during two years, after which that rate was to be immediately returned to its baseline scenario. The results of the temporary policy shock were to be recorded over an interval of at least five years. The shock was to be imposed on a baseline model solution starting in January 1994.

The Swiss National Bank was one of the few participating central banks which could not conduct such a simulation exercise with a readily applicable official macroeconometric model. The exercise was instead carried out with a model developed by this author. The task was manageable in the time available only because the author had already previously, partly in collaboration with another staff economist, investigated and modelled most of the crucial parts of the transmission process in the financial and non financial markets of the Swiss economy. Various results from that research have already been presented[1] and other papers, including one on the details of the full model, will become available in 1995.[2] A major part of the proposed simulation experiment could thus be usefully carried out for Switzerland as well. It was not feasible in due time to adjust the model for disaggregating the total effects on real GDP into all the five transmission channels proposed by the BIS. In fact, at present the model allocates all such separate effects of monetary policy either to the aggregate exchange rate channel or to the aggregate interest rate channel. The secondary effects on aggregate economic activity induced by the primary interest rate and exchange rate impulses can be considered as the response not only of households, but also of business and government entities mainly to income and cash-flow changes. In the compact modelling of the GDP process for Switzerland, to be described below, secondary effects are included jointly with the primary effects in the respective interest rate and exchange rate channels.

The next part of the paper outlines some general and specific features as well as some limitations of the current version of the macroeconomic model for Switzerland used for the simulation exercise.

II. SOME FEATURES AND LIMITATIONS OF THE MODEL

The simulation exercise for Switzerland is based on a relatively small quarterly macroeconometric model with 21 estimated equations. These determine six nominal interest rates, the two components of the monetary base, a bilateral and a multilateral exchange rate, three price indices,

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1 Bernegger and Ettlin (1991), Ettlin (1989, 1994), Ettlin and Bernegger (1992, 1994).

2 Ettlin (1995a, 1995b).

actual real GDP and five main components thereof, the unemployment rate and potential GDP. The remaining endogenous variables completing the system are generated by a priori definitional equations.

Each of the estimated equations explains the path of a time series which by itself alone was classified, on the basis of (augmented) Dickey-Fuller tests, as a non-stationary I (1) variable. These non-stationary variables form, however, cointegrated stationary relationships with the other variables in the respective equations. Although error-correction equations for the first differences of these I (1) variables were also estimated by the two-step OLS-procedure of Engle and Granger (1987), they will be incorporated in a more complete version of the model only. The present simulation exercise was carried out on the basis of the cointegration equations alone. As the latter were developed as structural-type rather than vector-autoregressive relationships, their short-run response does not differ much from that indicated by the corresponding error-correction equations. This applies in particular when according to the BIS project guidelines the quarterly results are averaged on a calendar year basis.

In the simulation model, not only the official discount rate but also the day-to-day (or overnight) rate of interest is taken, in agreement with the BIS guidelines, as exogenously determined by the Swiss National Bank. In this connection, the recent and current strategy of the Bank of targeting the monetary base over a medium-term period of several years by means of short-run operational reserve targeting can be reinterpreted as a form of indirect targeting of the day-to-day rate of interest. That controlled rate, in turn, acts directly or indirectly as the major domestic determinant of the six money and capital market rates represented in the model. The impact of this domestic monetary force on the market rates is strongest near the short end of the maturity spectrum and weakest near the long end.

Switzerland has a small open economy with a relatively large financial sector and a fully flexible exchange rate regime. Money and capital market rates are therefore codetermined also by the corresponding foreign, i.e. primarily German rates.[3] This foreign influence is strongest where the domestic influence is weakest, namely near the long end of the maturity spectrum, whereas near the short end the relative impact of foreign and domestic determinants is reversed. This type of approach to nominal interest rate determination has proved to be much more successful in tracing cyclical interest rate developments in Switzerland than the traditional Fisher approach based on mostly not directly observed inflation expectations and real rates of interest. The Fisher approach, made operational only by recourse to specific assumptions regarding the formation of price expectations, seems to be more useful for explaining cyclical interest rate developments in the very large economy of the United States or the steady-state nominal interest rate differentials between countries with very unequal long-run inflation rates.

To keep the current version of the Swiss simulation exercise relatively simple, and tractable, second-order effects on money and capital market rates are neglected. The interest rates which are specified to be directly affected by the temporary increase in the policy-controlled interest rates are the flexible market rates for three-month Swiss franc deposits in the Euro-market and the yield on long-term bonds of the Federal Government. Changes in these two key market rates are, mostly with some time delay, transmitted to the administered variable rates which the banks charge for mortgage credit as well as other lending and pay on three-month time deposits and on savings accounts.

According to the simulation model, an increase in the official discount rate and the three-month Euro-Swiss franc deposit rate, while the corresponding German interest rates remain unchanged, leads to an appreciation of the key bilateral Swiss franc exchange rate for the Deutsche Mark. As long as consumer prices do not react to the temporary rise in the policy-controlled interest rates, the nominal and real appreciation are equal. The real appreciation of the Swiss franc in relation to the Deutsche Mark implies an equally large proportional appreciation of the multilateral real

3 See Ettlin and Bernegger (1994).

effective exchange rate of the Swiss franc. When the delayed reactions of the Swiss consumer price index to the temporary interest rate shock start to set in, the bilateral and multilateral nominal exchange rates will be affected further. But since according to the model the nominal exchange rates respond to the consumer price index without lag and with an elasticity of unity, there will be no further real exchange rate effects on that account.[4]

Real GDP in the Swiss model is estimated as a single-equation reduced form which allows a direct accounting of the total real activity effects of monetary policy through the interest and exchange rate channels.[5] This approach of compressing the specifications of the individually modelled GDP components into a directly estimated aggregate equation seems to provide both a simpler and better approximation to the data-generating process of GDP than the traditional indirect approach of modelling and adding up the individual components. The reason for this seems to be that crucial cross-equation constraints are neglected in the disaggregated approach but implicitly enforced in the direct aggregate approach. For example, the significance of certain specified effects in one component of the aggregate can be matched by unspecified opposite effects in other components, thus leaving the actual aggregate unaffected. Up to now, the performance of the direct aggregate GDP approach for Switzerland appears to be stable and accurate within as well as out-of-sample.

In this compact model two variables are chosen to represent the interest rate channel of monetary policy transmission on aggregate economic activity. One is the rate charged by banks on pre-existing primary mortgage-backed loans. In Switzerland most bank loans to the public, even those not related to real estate transactions, are mortgage-backed. As there is no repayment requirement for primary mortgages, the public is on that account allowed to borrow for any purpose up to some two-thirds of the estimated value of a commercial or residential real estate property. Amounts that were previously repaid can be drawn upon anew at the discretion of the borrower. Although the share of fixed rate mortgages (usually for terms of up to five years) has increased substantially since the early 1980s, some three-quarters or more of mortgage-backed lending is still tied to administered variable rates. These rates are changed by the lenders in discrete steps mainly in response to movements in long-term market rates. For new mortgage credits the rates can be adjusted at any time, but for pre-existing mortgage loans the lenders have to give advance notice of rate changes. In the simulation model, the mean of the variable rates on pre-existing primary mortgage loans serves as the key indicator of the cost of capital. The four-quarter moving average of this representative borrowing rate starts to affect aggregate GDP after a time delay of five calendar quarters. The surprising length of this initial lag was confirmed by separate empirical studies of investment. The other variable represented in the interest rate channel is the interest rate spread between the rate paid on three-month time deposits and the variable rate charged on new mortgage-backed loans. This rate differential between marginal bank borrowing and lending rates can be interpreted as a proxy variable for bank credit rationing of new credit lines, which mostly will be drawn upon only later. The spread starts to affect aggregate activity after a time delay of three calendar quarters.

The primary impulses on real GDP via the exchange rate channel are determined by the consumer-price-deflated real effective exchange rate of the Swiss franc. Changes in the latter start affecting real GDP already within the same calendar quarter, but the total impact of primary and secondary reactions is estimated to be distributed over a period of almost four years. The mean value of these time lags is six calendar quarters.

In the Swiss model the real GDP effects of a temporary increase of the policy-controlled interest rates can be estimated without explicit information on the various components of real GDP. Nevertheless, since for the simulation exercise the composition of the GDP effect is of interest also, the reaction pattern with regard to a subdivision into five major expenditure components of GDP is modelled as well. Reaction functions with regard to some or all of the explanatory variables in the compact GDP model were estimated not only for private consumption, total fixed and inventory

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4 See Ettlin (1995a).

5 For the latest presentation of that model, see Ettlin (1994).

investment, exports and imports of goods and services, but also for government consumption. Any model inaccuracies with regard to these components will not affect the remaining parts of the simulation.

The most relevant single price level variable in the context of the simulation exercise is the consumer price index (CPI). Among its determinants the first one to start reacting to the temporary interest rate shock is the domestic price of imports, and in particular that of imported energy, which is lowered on account of the nominal appreciation of the Swiss franc. Rents, which currently have a very substantial 22% weight in the CPI, also respond relatively quickly. The increases in the variable rates charged by the cantonal banks on their existing old mortgage loans give the owners of rental properties the legal right to raise the rents of some 75% of the country's residents who are tenants. For a one percentage point increase in this mortgage rate rents may on average be raised by more than 10%. It is this constellation regarding the rent component of the CPI which is responsible for the "perverse" early reaction of the Swiss CPI to a monetary tightening. The activity effects of higher interest rates will, however, reduce the gap between actual and potential GDP. At least in the case of Switzerland that gap is a more reliable indicator of excess demand also in the labour market than the available statistics on unemployment, which do not provide an approximately uniform time series of sufficient length. The diminishing gap will, in particular, result in comparatively lower collective wage agreements and thus in reduced unit labour costs in the following year. The resulting downward pressure on prices will ultimately become dominant. An important special feature of the (wage and) price determination model for Switzerland, which contrasts with the standard Phillipe curve approach, presumes that it is basically the level and not the change of (wages and) prices which, ceteris paribus, depends on the level of the GDP gap.[6] This feature, which has very considerable repercussions on model behaviour and major implications for economic policy, is justified by test results regarding the stationarity of these time series. Univariate augmented Dickey Fuller tests indicate non-stationary I (1) properties for the level of those variables and stationary I (0) properties for their first differences. Moreover, the non-stationary level variables for prices and the lagged GDP gap form, together with some other I (1) variables, a cointegrated vector with stationary I (0) residuals. In this respect it seems important also to recognise the institutional set up of, mainly annual, collective wage agreements, which normally also include compensation for actual past rather than expected future price changes during the term of an agreement.

The simulation model for Switzerland also accounts for the development of the bank reserves held at the Swiss National Bank and the total circulation of Swiss banknotes, which together constitute the monetary base. Banknote circulation, which in recent years has come to account for more than 90% of the base, is unquestionably an endogenous variable determined in the short run by demand responses mainly to predetermined movements of the current price level, current and past consumption, lagged interest rates on short-term bank deposits as well as on savings accounts, and seemingly important but difficult to specify changes in payments technology and hoarding behaviour.[7] In the intermediate run the Swiss National Bank is able to influence the circulation of banknotes through its ability to directly or indirectly control the day-to-day rate of interest by means of the supply of bank reserves held at the central bank. The transmission process from the day-to-day rate to the variables determining banknote circulation was sketched above.

6 For a recent contribution of the relevant partial relationship between the levels of lagged unemployment and wages (rather than wage changes), see Blanchflower and Oswald (1994). Possibly the earliest treatment and empirical validation of this topic was discussed in Ettlin (1979) and formed an integral part of the macroeconomic system described in Ettlin et al. (1979).

7 For an earlier version of the model of Swiss banknote demand, see Ettlin (1989). For a theoretical survey and an international empirical perspective on banknote circulation, see Boeschoten (1992).

III. QUANTITATIVE EFFECTS OF THE MONETARY POLICY SIMULATION EXPERIMENT

The Swiss simulation results for the temporary increase in domestic policy-controlled interest rates are summarised in Tables I-IV. The rise in the official discount rate and the day-to-day call rate of 100 basis points each from January 1994 to December 1995 was superimposed on the baseline solution of the previously outlined model for the period of the first quarter of 1994 to the fourth quarter of the year 2000. In this exercise the Swiss franc exchange rates are determined endogenously, in agreement with the actual fully flexible exchange rate regime in force since 1973. The numbers in Table I-IV refer to the calendar year averages of the quarterly results.

Table I shows the transmission effects of the two-year increase in the policy-controlled interest rates on the market and administered interest rates represented in the model. The short-term money market rates react relatively strongly with only a short time delay. This is illustrated by the rate on three-month Swiss franc deposits in the Euro-market, which is raised on average by 0.57 percentage points in the first and 0.62 percentage points in the second year. The small increase between the first and the second year as well as the 0.05 percentage point effect in the third year, when the policy-controlled rates have already been returned to their baseline values, is due to a minor time delay in the response to the day-to-day rate. The domestic time deposit rates are usually adjusted daily to changes in the corresponding Euro-market rates but, as the published data on the former are collected for the end of the month only, an artificial time-lag behind the monthly averages of the Euro-rates is introduced into the estimated reaction pattern. Euro-market as well as domestic money market rates adjust only by about two-thirds of the policy-controlled rate increase, because in the case of Switzerland their second important determinant, namely the corresponding German interest rates, are assumed to remain unchanged at their baseline values.

The response of the long-term rates of interest is much smaller than that of the short rates. The yield in the secondary market on federal government bonds increases on average by about 1/6 of a percentage point during the first two years, when the higher domestic controlled rates apply. The Swiss bond yield would react relatively more strongly if a concurrent rise in the German bond yield also occurred, which is here, however, not the case. In the course of the third year, 1996, the Swiss federal government bond yield returns quickly towards its baseline values.

The bank-administrated variable rates on new mortgage credits rise by about 1/8 and 1/6 of a percentage point respectively in 1994 and 1995. These increases apply with some time-lag, due to the required preannouncement, also for the already existing old mortgage-backed credits. The rate adjustment on savings accounts corresponds to a weighted average of the rate increases on new and old mortgage loans. All three of these rates return to their baseline values in the course of the third year.

Central-bank-held bank reserves are first reduced concurrently with the temporary increase in the policy-controlled day-to-day call money rate, since that increase is accomplished by means of a reduced supply of reserve balances to the banks. When real activity and consumer prices are reduced below their baseline values, some further reduction in the supply of reserves is needed to keep the day-to-day rate in 1994 and 1995 one percentage point above and from 1996 on at the baseline level. Because reserves account nowadays only for about 9% of the total monetary base, the direct effects of these changes in reserves on the monetary base remain small, except in the first two years. The base is affected mainly indirectly through the reaction of the demand for banknotes to the temporary rise in interest rates on three-month deposits as well as on savings accounts, to the decline in real activity and to the induced changes in the CPI. The monetary base response to the initial two-year increase in the controlled interest rates is relatively strong and long. The decline reaches a maximum of 1.37% in the second year and an average of 0.75% during the entire seven-year period over which the simulation results are traced.

The simulated effects of the temporary increase in the policy-controlled domestic interest rates on exchange rates, real activity, prices, and real interest rates in Switzerland are summarised in

Table II. The exogenous rise in the official discount rate and the induced increase in the three-month Swiss franc interest rate in the Euro-market lead to an appreciation of the bilateral Swiss franc exchange rate for the Deutsche Mark (not shown) and by definition an equal appreciation of the multilateral effective exchange rate. The simulated real appreciation reaches close to 1.5% on average in the first year and 1.7% in the second year. After the policy-controlled interest rates return to baseline at the beginning of the third year, the real appreciation starts to disappear. Moreover, the nominal, but not the real exchange rate fully reflects also the induced changes in the Swiss CPI. The nominal exchange rate appreciation amounts to about 0.7% on average during the seven-year period covered in the table. The restrictive effect of the temporary rise in the domestic policy-controlled interest rates on real GDP amounts to only -1/9 of a percentage point in the first year, but the decline relative to the baseline then becomes larger in each of the three following years to reach -1 1/9 of a percentage point in 1997. After that real GDP starts to return towards the baseline, which it reaches again in the year 2000. Over the years 1994-2000 Swiss real GDP is reduced by 0.5% on average.

The unemployment rate increases from 1994 to 1997, when the rate lies more than 0.5 of a percentage point above baseline. The latter is reached again in the year 2000. During the entire seven-year period the unemployment rate is raised by 0.25 of a percentage point on average. The less than full response of the unemployment rate to the reduction of GDP is due to variations in the work week, productivity changes and labour force reactions.

The negative effect on import prices reflects the nominal appreciation of the Swiss franc, which is most pronounced in 1994 and 1995. The perverse positive response of the GDP deflator during the first three years is mainly tied to the temporary phase of higher domestic interest rate costs which generate higher residential and commercial rents and a higher mark-up on other prices. But ultimately the GDP deflator falls temporarily below its baseline as the reduction of economic activity results in lower wage and unit labour costs. The CPI also shows some perverse positive reaction to the temporary tightening of monetary policy. But as during the first three years the price changes of imports and of domestic value added diverge, the perverse phase is more subdued than in the case of the domestic GDP deflator. Normal negative CPI reactions to the phase of higher interest rates are shown only from 1997 on, when they correspond for three years to around 0.3%. In the course of the year 2000 the CPI returns close to the baseline.

Finally, Table II lists the changes of some real interest rates calculated simply as the ex post difference between the respective nominal rate changes and the changes of the year-on-year inflation rate, which are implied in the simulation results for the level of the CPI.

IV. REAL GDP CHANGES BY CHANNEL OF TRANSMISSION AND BY EXPENDITURE COMPONENTS

The contributions to GDP changes by channel of transmission are listed in Table III. For reasons mentioned in the introduction, only two channels, one for exchange rate and one for interest rate effects, are distinguished. They include all the primary and secondary effects of the exchange rate and interest rate impulses generated by the temporary increase in the domestic policy-controlled interest rates. A small exchange rate effect of -0.1% is practically the only effect on GDP registered in 1994. In 1995 the exchange rate channel still dominates, as it accounts for three-fifths of the total GDP effect of almost -0.6%. The total exchange rate effects get even more negative in 1996, but in 1997 they start to shrink until they reach zero in the year 2000.

The interest rate channel becomes relevant for the changes in real GDP from 1995 on and dominates them from 1996 to 1999. Of the total GDP effect of 1% in 1996 the interest rate channel accounts for almost three-fifths. Its share of the total effect of -1.1% in 1997 and of -0.7% in 1998 corresponds to two-thirds. When in 1999 both the exchange rate and interest rate effects dwindle, the latter makes up three-quarters of the remaining total effect of -0.16%. In the year 2000 also the interest rate effects on GDP fade away. On average, the exchange rate channel accounts for two-fifths and the interest rate channel for three-fifths of the total changes in real GDP from 1994 to the year 2000.

In Table IV the expenditure composition of the real GDP changes is summarised. These simulation results only disaggregate the total changes based on the directly estimated GDP model, which was referred to above in the second part of the paper. All the numbers for component changes in this table are weighted by the ratio of the respective component to total GDP in the baseline scenario. This means that the numbers add up directly to the GDP percentage changes. The major change regarding exports of goods and services occurs mainly in 1995 and 1996, when it corresponds to about -0.5% of GDP. During the seven-year period it reaches on average -0.2% of GDP. The negative reaction of total (fixed and inventory) investment in the years 1995-98 is rather strong, as it also contains a considerable negative distributed-lag response to the appreciation of the real effective exchange rate. From 1994 to the year 2000 total investment declines an average by 0.8% of GDP. The corresponding average reduction in private consumption corresponds to only 0.3% of GDP. Government consumption at the federal, cantonal and municipal levels, which is treated as an endogenous reaction variable just like the other expenditure components, is on average cut back by 1/6 of a percentage point of GDP. The largest contributions, 0.9% of GDP on average, are recorded with regard to the decline of imports. This strong response in the simulation derives from high marginal import shares in the large negative changes in fixed (equipment) and inventory investment, as well as in the more moderate changes in exports and private consumption. These negative forces on imports by far exceed the direct substitution effects on the change in imports from the temporary real appreciation of the Swiss franc.

V. REMARKS ON AN ALTERNATIVE SIMULATION EXERCISE WITH EXOGENOUS EXCHANGE RATES

The BIS project guidelines also suggested an alternative simulation of the temporary increase in domestic policy-controlled interest rates with exogenous instead of endogenous exchange rates. Given the fully flexible exchange rate system of Switzerland, this implies, as a rough first approximation, that the other countries choose a concurrent temporary increase in their policy-controlled interest rates of the same magnitude. Such a coordinated global, or at least wide-ranging multilateral policy shock would lead to increases in both short and long-run interest rates also in those other countries, which in the previously discussed simulation were assumed to remain at their respective baseline scenarios. The rise in foreign interest rates would have immediate repercussions on the relevant Swiss interest rates, which would increase more than indicated in Table I. According to the Swiss model specification, it would be foremost the changes in the three-month Deutsche Mark deposit rate in the Euro-market and in the yield on long-term bonds of the Federal Government in Germany which would help to drive up the equivalent Swiss rates. Taking the according numbers from the respective simulation carried out by the representatives of the Bundesbank[8] in the BIS-led project as an added shock into the Swiss model results in a total rise of the endogenous Swiss rates which is approximately 1½ times as large as in Table I. The interest rate effects on the real GDP of Switzerland are therefore also 1½ times as large as the ones indicated in Table III. Since the exchange rate effects are presumed to be nil, at least approximately, this suggests that the total effects on Swiss GDP reach about 9/10 of the magnitudes registered in Table III. This result is interesting as far as it goes, but it does not go far enough. The transmission effects on GDP via the trade channel can be neglected as insignificant in the case where only the domestic policy-controlled interest rates are raised. But they are an essential aspect of the transmission process in the case of a multilateral or global increase of the policy-controlled interest rates. Inclusion of these feedback effects would substantially modify the simulation results. In particular, the reduction in Swiss GDP would turn out to be considerably larger than suggested above. A valid simulation procedure in that case can no

8 See Jahnke and Reimers (1994).

longer be based on a model of the domestic country alone, but requires the latter to be tied into a multi-country system. This type of simulation procedure would, of course, give significantly different results also with regard to the other endogenous variables than a simulation based on the model of the domestic country only. For that reason no further one-country model results for Switzerland are presented for the alternative monetary policy simulation with "exogenous" exchange rates.

VI. CONCLUDING OBSERVATIONS

The simulation results presented in this paper of a temporary, two-year phase of higher policy-controlled interest rates in Switzerland alone show relatively strong and, on average, quite delayed negative effects on the country's real GDP. The lag distribution of these effects is approximately symmetric and forms an inverted peak a little over two years after the mid-point of the monetary policy shock. Because the Swiss economy was modelled in a rather compact manner, it was not possible to split off some further channels from the real exchange rate channel and the interest rate channel of transmission. Therefore all the primary and secondary reactions to the exchange rate and interest rate impulses are jointly included either in the first or in the second channel.

The negative effects manifested via the exchange rate channel dominate the total GDP effects during the first two years and account for 2/5 of the average response during the entire seven-year period covered by the simulation study. The more delayed but stronger reactions through the interest rate channel manifest themselves mainly in the third, fourth, and fifth years. The mean lags are approximately 2½ years for the interest rate effects and 1½ years for the exchange rate effects on real GDP. These results, according to which monetary policy has strong effects on real economic activity in Switzerland, can be considered as robust. They contrast sharply with earlier findings of studies which tried to model the monetary influence on Swiss GDP around the behaviour of monetary aggregates[9] instead of using a structured interest rate transmission approach as was done in this paper.

The relatively large GDP response for Switzerland derives in part from the inclusion of a proxy variable for the degree of rationing of new bank credit lines. The proxy variable consists of the difference between the cost of raising additional funds in the money market and the interest rate to be received on additional loans. It accounts for three-fifths of the total interest rate effect shown. Moreover, it seems to help also in the identification of the conventional level effects of interest rate changes, which account for the remaining two-fifths of the total effects. Credit-rationing effects do not seem to be included in the specifications of the transmission mechanism underlying the simulation results for the other countries in the BIS sample.

The relatively large GDP response for Switzerland as compared to most other countries is also related to the fact that Switzerland has a very low day-to-day rate of interest in the baseline solution for 1994 and 1995. The temporary rise of that rate by 1 percentage point for those years implies therefore a larger proportional increase than in the case of most other countries. The exchange rate effects, too, will be relatively large for Switzerland because of the openness of the country and a more flexible exchange rate regime than in the countries directly or indirectly tied into the Exchange Rate Mechanism of the European Monetary System. The country that is most similar with regard to these criteria is Japan. Interestingly, the simulated GDP effects for Japan resemble the ones for Switzerland both in regard to their magnitude and their timing pattern.[10]

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9 See Wasserfallen (1985), Genberg and Swoboda (1985) and Koellreuter and Kugler (1985).

10 See Momma and Shimizu (1994).

Table I

Simulation results for nominal interest rates and the monetary base

Policy experiment: A temporary increase in policy-controlled Swiss interest rates in 1994 and 1995 (with endogenous nominal exchange rates)							
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Policy-controlled interest rates (%)							
Day-to-day rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Discount rate	1.00	1.00	0.00	0.00	0.00	0.00	0.00
2. Three-month market interest rates (%)							
Euro-Swiss franc deposits	0.57	0.62	0.05	0.00	0.00	0.00	0.00
Domestic time deposits	0.54	0.62	0.08	0.00	0.00	0.00	0.00
3. Long-term market interest rates (%)							
Federal government bond yield	0.15	0.17	0.02	0.00	0.00	0.00	0.00
Variable rate on new mortgages	0.12	0.19	0.07	0.00	0.00	0.00	0.00
Variable rate on existing mortgages	0.07	0.19	0.07	0.00	0.00	0.00	0.00
Rate on ordinary savings deposits	0.10	0.19	0.06	0.00	0.00	0.00	0.00
4. Monetary base	- 0.78	- 1.37	- 0.83	- 0.67	- 0.81	- 0.57	- 0.24

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II

Simulation results for exchange rates, economic activity, prices and real interest rates

Policy experiment: A temporary increase in policy-controlled Swiss interest rates in 1994 and 1995 (with endogenous nominal exchange rates)							
Deviation from baseline[1]	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Effective nominal exchange rate[2]	1.50	1.50	0.08	0.25	0.31	0.27	0.04
2. Effective real exchange rate[2]	1.47	1.68	0.13	0.00	0.00	0.00	0.00
3. Real GDP	- 0.11	- 0.57	- 1.01	- 1.11	- 0.67	- 0.16	- 0.01
4. Unemployment rate	0.03	0.21	0.43	0.55	0.41	0.14	0.01
5. Import prices	- 1.25	- 1.32	- 0.16	- 0.13	- 0.16	- 0.09	- 0.04
6. GDP deflator	0.14	0.53	0.24	- 0.35	-0.33	- 0.15	- 0.02
7. Consumer prices	- 0.03	0.18	0.05	- 0.25	- 0.31	- 0.27	- 0.04
8. Real day-to-day interest rate	1.03	0.79	0.13	0.30	0.06	- 0.04	- 0.23
9. Real Euro-Swiss franc deposit rate	0.60	0.43	0.07	0.30	0.06	- 0.04	- 0.23
10. Real federal government bond yield	0.52	0.43	0.10	0.30	0.06	- 0.04	- 0.23

[1] Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%). [2] A positive number indicates appreciation of the domestic currency. The real exchange rate is deflated by relative consumer prices.

Table III

Contributions to GDP changes by channel of transmission

Policy experiment: A temporary increase in policy-controlled Swiss interest rates in 1994 and 1995 (with endogenous nominal exchange rates)			
	Total	**Exchange rate channel***	**Interest rate channel***
1994 – 1st year	- 0.11	- 0.10	- 0.01
1995 – 2nd year	- 0.57	- 0.34	- 0.23
1996 – 3rd year	- 1.01	- 0.44	- 0.57
1997 – 4th year	- 1.11	- 0.35	- 0.76
1998 – 5th year	- 0.67	- 0.22	- 0.45
1999 – 6th year	- 0.16	- 0.04	- 0.12
2000 – 7th year	- 0.01	0.00	- 0.01

* Includes direct effects as well as (mainly income-related) indirect effects regarding all components of GDP.

Table IV

Contributions to GDP changes by expenditure components

Policy experiment: A temporary increase in policy-controlled Swiss interest rates in 1994 and 1995 (with endogenous nominal exchange rates)							
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1. Real GDP	- 0.11	- 0.57	- 1.01	- 1.11	- 0.67	- 0.16	- 0.01
2. Contribution by private consumption	- 0.04	- 0.24	- 0.50	- 0.66	- 0.48	- 0.15	- 0.01
3. Contribution by government consumption	- 0.02	- 0.11	- 0.18	- 0.24	- 0.25	- 0.20	- 0.15
4. Contribution by total investment	- 0.10	- 0.71	- 1.56	- 1.72	- 0.96	- 0.23	- 0.01
5. Contribution by exports	- 0.11	- 0.42	- 0.51	- 0.28	- 0.09	- 0.01	0.00
6. Contribution by imports (minus)	0.17	0.90	1.73	1.79	1.11	0.44	0.16

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Interest rate effects in the Bank of England's medium-term forecasting model[1]

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I. INTRODUCTION

The Bank of England's medium-term forecasting (MTF) model is the most recent of a series of macroeconomic models used in the Bank dating back to 1973. The current model was specified and estimated in early 1994 and is still subject to revision. The model was designed with the specific aim of providing a quantitative basis for the Bank's medium-term inflation projections published in the quarterly Inflation Report. It should be stressed that the Bank's inflation judgement is based on a wider range of evidence than the model-based forecast[2] and the forecast itself draws on more information than the model-based conditional extrapolation. Econometric models are not capable of accurately capturing every macroeconomic influence on price inflation. The model is best seen as a framework around which an inflation forecast can be constructed.

The marginal simulation properties of the model were originally designed and tested over the two-year forecasting horizon of the medium-term inflation projections. The exercise reported in this paper has thrown up some interesting longer-term issues which may warrant further model development. These results should therefore be treated as provisional.

The paper is laid out as follows. In the introduction we briefly outline the structure and key features of the model. In Section II we give a more explicit list of which equations feature interest rates as an explanatory variable. Section III discusses the simulation results and draws out the most interesting features. Section IV offers a short summary. There are two annexes describing model features in more detail.

1. Economic structure

The provisional MTF model differs significantly from the tradition of UK macroeconomic models. Although the underlying behavioural relationships are basically the same, we have de-emphasised the importance of the income and expenditure accounts. This has been done in order to pay equal attention to the modelling of supply and demand (i.e. the same attention to both quantity and prices). It also helps to focus on the key macroeconomic concepts. In order to explain this further we briefly outline how the MTF model compares with its predecessors.

Conventionally, macroeconomic models of the UK have been built around the National Accounts. The focus is on explaining the components of the expenditure measure of GDP, for which the income accounts are necessary, with the output measure obtained by residual identity. Labour markets, pricing behaviour and a monetary/financial sector are then added on, usually as inter-linked but separate sectors.

A model built along these lines has a strong real-side bias with aggregate demand as the key variable and inflation something of an additional extra. It is generally consistent with the way that macroeconomics has been taught at undergraduate level in the United Kingdom: we start with an

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1 The views expressed in this paper are those of the authors and not necessarily those of the Bank of England. The authors would like to thank Neil George for assistance in preparing the charts and tables.

2 E.g. other expectations of inflation.

IS/LM analysis, then add a labour market (conditioned on a production function) to determine aggregate supply; the price level is determined by the interaction between supply and demand. Since the LM curve is usually set to be horizontal, by assuming exogenous interest rates, the concentration is on components of the IS curve - hence the focus on the National Accounts and the expenditure components.

Macroeconomic models are used for a variety of purposes but a driving force has often been the need to produce forecasts of the short to medium term. In the past this has usually meant priority was given to models which "fit" the recent past well rather than those which have sensible economic properties.[3]

Recent developments in macroeconomic modelling have started to change the emphasis within the traditional model structure. The development of econometric procedures[4] has allowed model-builders much greater control over long-run model properties and forecasting failures have created a demand for greater theoretical coherency.[5] At the same time there have been numerous, albeit partially successful, attempts to build consistent supply-side models, with cross-equation restrictions between equations explaining the behaviour of employment, prices and investment.[6] One consequence of these developments is a trend towards smaller models whose properties are better understood.[7]

With the Bank's focus on forecasting inflation, the MTF model has concentrated on redressing the balance between the modelling of activity and prices. Rather than build up demand via the expenditure components we specify a single equation in which aggregate private sector demand is a function of wealth, tax rates and interest rates. This avoids the need to model either the income or expenditure accounts in the central core of the model (as much of the detail is constructed in a non-simultaneous sub-block).

In the simultaneous heart of the MTF model, demand and supply, quantity and prices, carry equal weight and equal attention. The inflation (and growth) projections can be obtained by concentrating on the fundamental macroeconomic issues, with points of detail added using our judgement of the context.

Annex 1 outlines a schematic model. Annex 2 describes the theory behind its long-run properties. A full equation listing is also available from the authors.

The model has a well-defined real equilibrium, and in the long run behaves like a neo-classical Solow-Swan growth model. The underlying technology is Cobb-Douglas with constant returns to scale, and the price, employment and output equations are all consistent with this technology. The classical dichotomy holds in the long run, but monetary policy has short-run real effects because of sluggish wage and price adjustment. Output is conditioned on demand in the short run and private sector aggregate demand is a function of outside wealth,[8] tax rates and interest rates. Consequently, the monetary transmission mechanism is of the "traditional" sort, with causation running from monetary policy through output and onto prices in the short to medium run. In other words, ours is not a real business cycle model in which money is a veil, although by imposing a vertical Phillips curve and relatively rapid wage and price response the model dichotomises faster than many others.

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3 Many examples of "rogue" simulation properties have been explored by the Macroeconomic Modelling Bureau at the University of Warwick; see Turner (1991) for an example study.

4 In particular cointegration analysis; see Bannerjee et al. (1993).

5 See the numerous articles in Hargreaves (ed.) (1992).

6 See Wren-Lewis (1988) for one of the more comprehensive supply-side treatments, based on a vintage model of the capital stock.

7 An example is the new COMPACT model developed by the team at Strathclyde University.

8 Outside wealth consists of the physical capital stock, real Divisia money balances and net external assets.

Monetary policy can be characterised in three ways in the model. The standard form has an interest rate reaction function which targets (expected) inflation. The form of the reaction function is constrained so that the real interest rate equals the growth rate in the long run, but, while this reaction function is relatively efficient at stabilising inflation in the fact of nominal shocks, it does not tie down the price level. The second formulation of policy - money targeting - does tie down the price level but, given the instability of the money demand equation, tends to generate implausibly large swings in interest rates. The third formulation, exchange rate targeting, also ties down the domestic price level by linking it to the price level overseas.

2. Estimation methods

The preliminary version of the model has been estimated using the MICROFIT package. Most of the equations are based on OLS, a few on Instrumental Variables. In further developments we expect to use a variety of simultaneous estimation techniques. The equations are all specified in error-correction format, allowing for the non-stationarity of data as necessary. Many of the long-run elasticities are imposed (being identification conditions); the rest are estimated, using either one-step or two-step estimation methods as appears to be appropriate. The equations are routinely required to pass the standard diagnostics for serial correlation, heteroskedasticity, normality and functional form. Full details are given in the equation listing.[9]

II. INTEREST RATE EFFECTS IN THE MODEL

Interest rates affect the model in the following equations (precise interest rate variable in brackets: short rate is London three-month interbank unless indicated).

Core equations:

- mortgage interest payments, which form part of the Retail Price Index [average mortgage interest rate];
- private sector domestic demand function [real short rate];.
- balance of payments: interest, profits and dividends [world short rate];
- sterling effective exchange rate: UIP [world short rate, UK short rate];
- divisia money demand function [user cost of Divisia money].

Non-core equations:

- consumption function [real short rate];
- stock levels check variable [real short rate];
- persons' income from rent, dividends and interest [nominal short rate];
- M0 [nominal short rate and cumulated short rate].

Interest rate linkages:

- mortgage interest rates [nominal short rate];
- real cost of capital [real long rate]. Feeds into investment;

9 See Dhar and Fisher (1994).

- user cost of Divisia money [nominal short rate];
- long rates [nominal short-rate].

The direct effect on aggregate demand in the core combines expenditure effects on consumption (income and substitution), stockbuilding and investment. There are also indirect effects via the three wealth terms (net external assets, including an exchange rate valuation effect; Divisia money and the capital stock). Supply-side effects come solely through the cost of capital for investment.

A key parameter is the direct effect of real short rates on aggregate demand and this starts to act with a lag of one quarter. A sustained 1 percentage point rise in real interest rates would reduce long-run real aggregate demand by around 3%.[10] This sort of partial derivative calculation is useful for comparative purposes but in the full model the real interest rate is determined endogenously and in the long run will equal the equilibrium rate of growth (ultimately determined by technical progress and population growth).

III. SIMULATION RESULTS

The simulations reported here are of the standard design agreed for the study of the transmission mechanism being undertaken by the Bank for International Settlements.

They are:

(a) a temporary (two-year) shock to nominal interest rates of +1 percentage point, with the exchange rate endogenous;

(b) the same shock but with the exchange rate fixed via a simultaneous rise in world interest rates.

In addition, a decomposition of the interest rate channels is provided by separately shocking the different interest rate terms in the model.

1. Overview

The clearest result relates to the dynamic response of the model. A temporary interest rate shock sets off a cyclical response in all endogenous variables (Chart 1). The cycles are damped and of a wavelength of approximately 9-10 years. The results are consistent with the characteristic roots being complex but stable. The last three UK cycles, starting in the early seventies, have an average wavelength about 8-9 years. But only the last of these looks purely like a demand-generated cycle and seems to be taking somewhat longer.

Viewing these cycles in Phillips curve space (Chart 2) suggests that they are not unreasonable as a reflection of the UK economy. The first part of the cycle has a classic clockwise loop but after 10 years the loop switches to be anti-clockwise. The cycle length is reasonable. In the absence of an active monetary or fiscal policy, it is not surprising that the cycles are self-propagating.

A temporary rise in interest rates, which is not offset by a subsequent reduction relative to base, will not be neutral on nominal variables. We would expect the money stock and price level to be permanently lower and the exchange rate higher. When the cycles eventually die down we would observe that the economy had returned to the same inflation rate.

It is not clear *a priori* whether we would expect a temporary rise in interest rates to be neutral on real variables. Investment is temporarily reduced and then returns to base - but the capital

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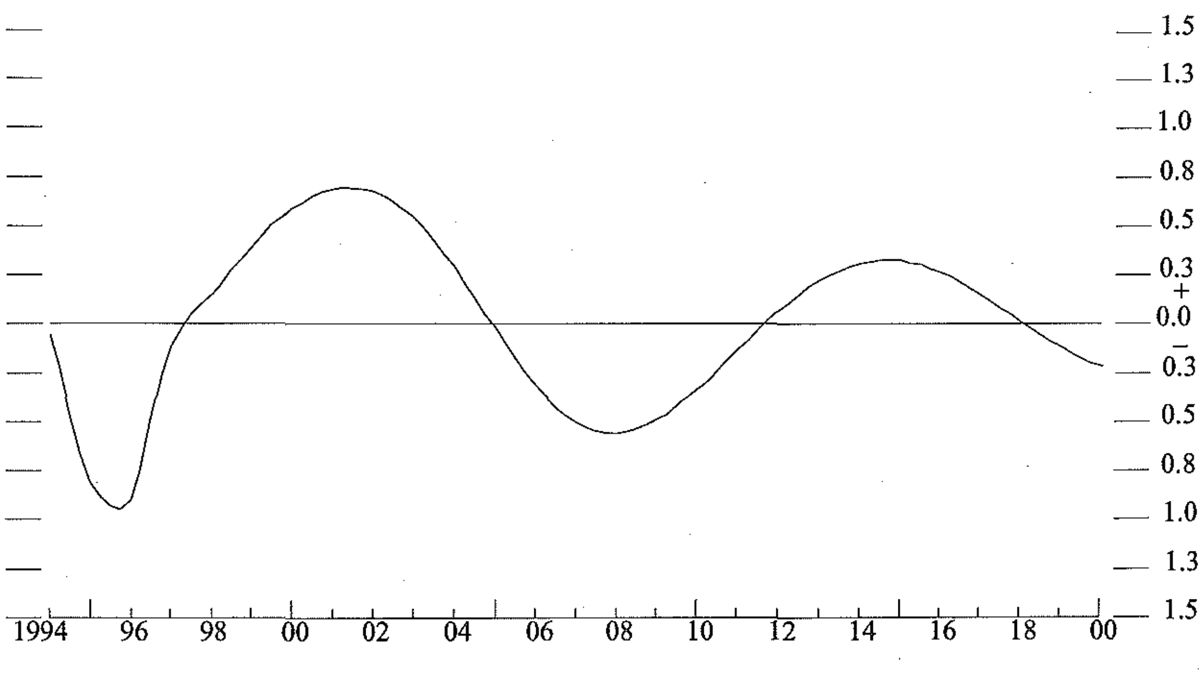
10 For constant inflation this is also the elasticity on nominal interest rates.

stock can be permanently affected. This hysteresis effect is evident in our model with the capital stock playing a role in demand, supply and pricing behaviour. If the model were completely specified then there would probably be other forces - such as direct inward investment - which would counteract the loss of the capital stock. The MTF model has not yet been designed to allow for all such long-run factors but these may be added in due course.

Chart 1

GDP response

(% difference from base)



The result of the interest rate shock in our model is therefore to shift the Phillips curve slightly. However, the effect on the natural rate of unemployment is minimal since there is an offsetting real wage reduction which shifts equilibrium factor demand from capital to labour. Despite these effects it is the sloping short-run Phillips curve which is most easily observed in Chart 2.

2. Exchange rate and expectations formation

The exchange rate is known to play a key role in the transmission mechanism in macroeconomic models.[11] Within the MTF model, the exchange rate could follow any one of a variety of paths depending on the precise assumptions made about expectations formation and whether any risk premium term is allowed to affect the UIP condition. In the simulations discussed here we have chosen to maximise clarity by allowing no risk premium to enter and have set expectations as follows:

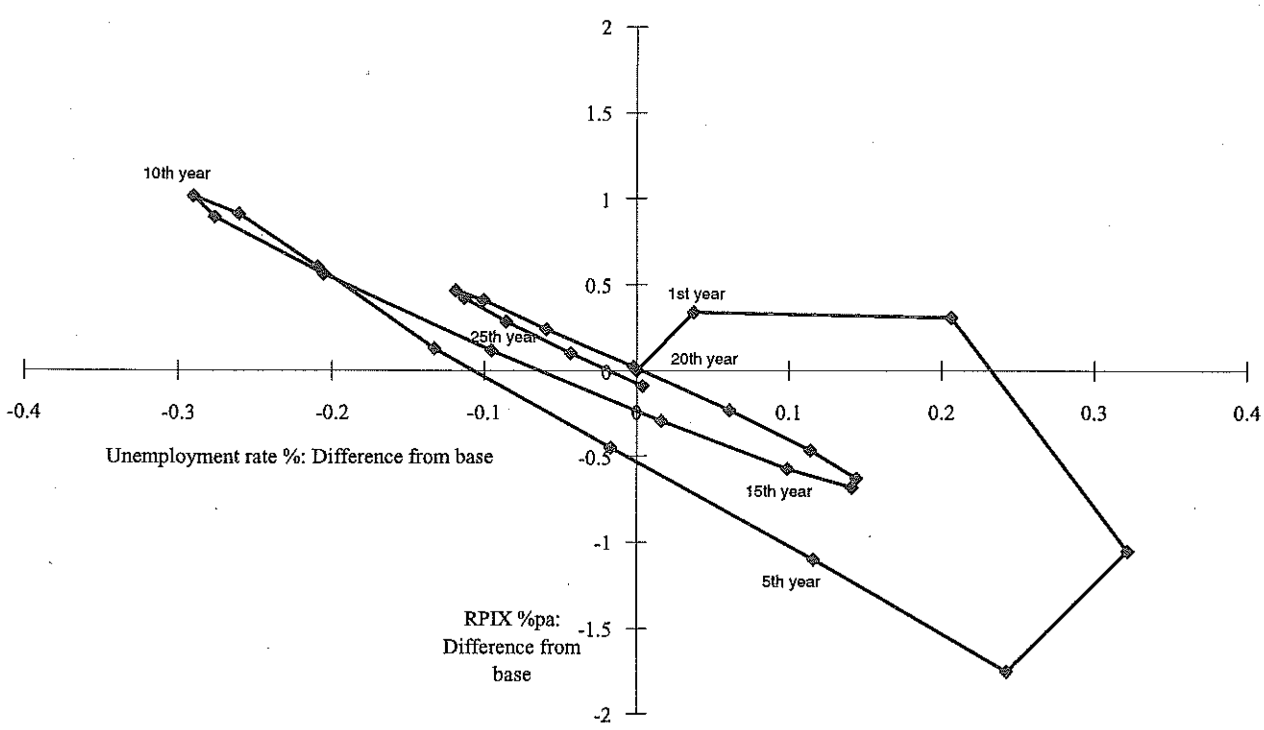
11 See Fisher et al. (1990, 1992).

(a) The base case, reported in the tables, assumes that the expectation, formed at the beginning of period t, of the exchange rate in period t+1 is equal to the observed value in period t-1. This gives a solution in which any shock to the interest rate differential is both unexpected and is not expected to continue.

(b) A forward-looking variant in which the future interest rate differential is assumed to be known with certainty. Conventional UIP then applies.

Chart 2

Unemployment and inflation responses



Simulation (a), starting in 1994 Q1 and ending in 2020 Q4, requires an initial condition for the exchange rate which is simply the known value of the exchange rate in 1993 Q4. Simulation (b) requires a terminal condition for the exchange rate in 2021 Q1 which is given by the value in 2020 Q4 in simulation (a). The resulting paths for the exchange rate are shown in Chart 3.

3. Real interest rates

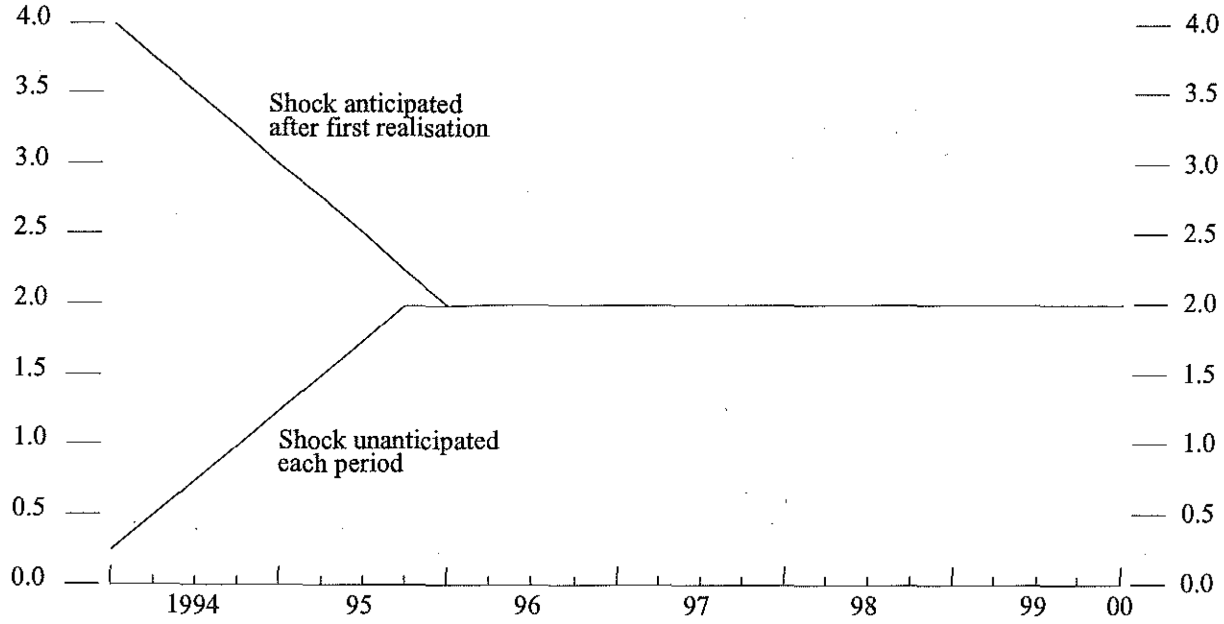
An interesting and timely question is the effect of a nominal short-term interest rate shock on real short-term and long-term rates. In general, the effect of interest rates on inflationary expectations is ambiguous. During the course of 1994 we have seen increases in interest rates precede higher inflationary expectations in some countries and lower expectations in others. In the long-run we would not expect real interest rates to be significantly affected by a temporary shock to nominal interest rates.[12] In the tables reported here real interest rates are defined using current rather than expected inflation. Nevertheless, assuming rational expectations we can calculate forward-looking real

12 Unless there are hysteresis effects - but these should be small, as observed above.

Chart 3

Exchange rate response

(% difference from base)



rates. The simulation suggests that real rates, both long and short, do rise temporarily in response to a nominal increase and the maximum impact occurs after two years (for a two-year shock to short rates). This *real* rate change will be partly responsible for the cycle in real activity (Chart 4a). Although the direct real interest rate effect is one of the main transmission channels, it is not the only factor affecting activity and not the most immediate.

4. Activity

As discussed in Section II, interest rates act on aggregate demand directly via income, substitution and cost of capital effects and indirectly via wealth. Chart 4b shows the response of domestic demand compared with the shocks to the wealth terms and real interest rates (scaled and weighted by their long-run elasticities in the demand equation). This clearly shows that the wealth terms have an effect equal to the real interest rate term but is a *quicker* part of the transmission. Hence, in our model, interest rates act faster via the wealth terms than by direct effects. However, there is some question over exactly what behaviour is being reflected in the wealth terms - this is discussed in the next sub-section. Also, real interest rate effects become more important than wealth effects over time.

The net interest rate effect on domestic demand is split into short-run responses in real domestic output and imports. Since the nominal exchange rate responds faster than prices, the real exchange rate appreciates, thus putting downward pressure on exports as well as output supplied to the domestic market. The fall in output has consequences for employment, investment and stockbuilding. Reflecting the temporary nature of the shock, the growth in output is eventually recovered.

Chart 4a

Real interest rate and output cycles

(percentage points, percentage difference from base)

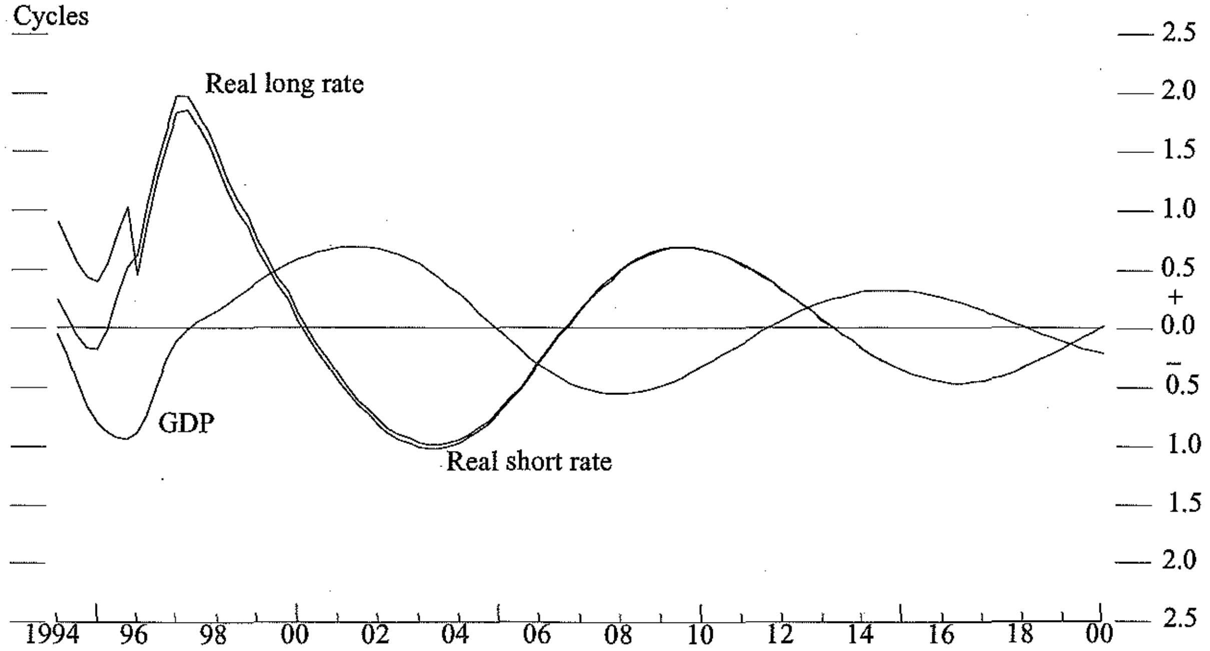
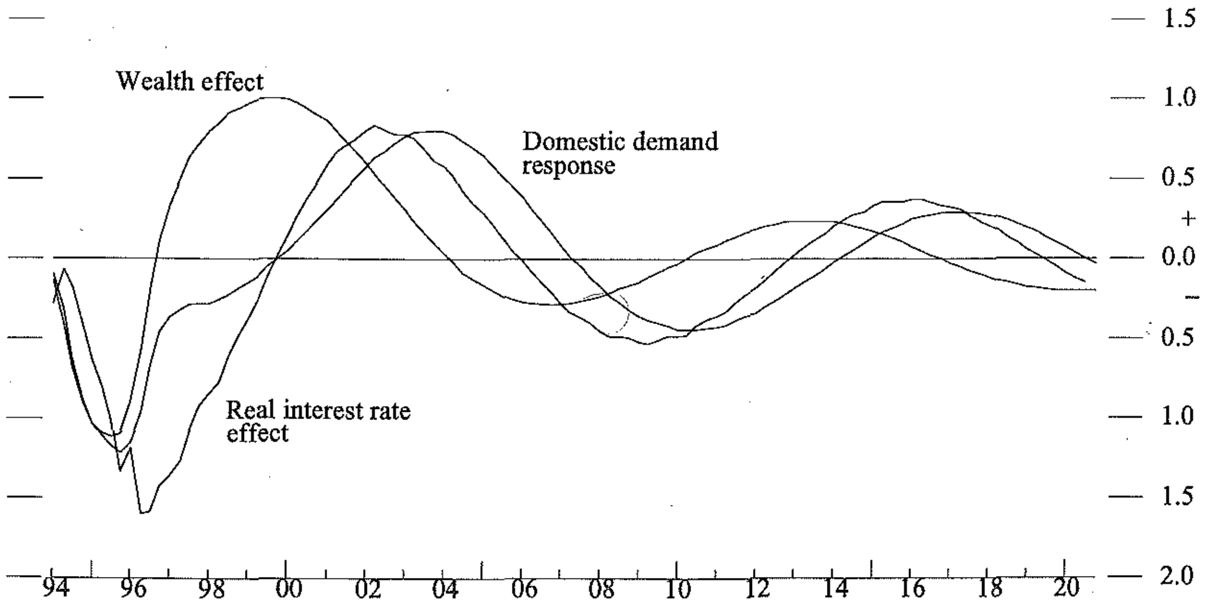


Chart 4b

Demand: wealth and real interest rate effects

(% difference from base)



Note: Wealth and real interest rates weighted and scaled by long-run elasticity in demand function.

5. Contributions to GDP by channel and by variable

Tables III.1 and III.2 give a decomposition of the GDP response by interest rate channel and by the expenditure components. The latter has no real significance for the MTF model since the expenditure components are used only as a check on the aggregate demand system.

The tables show the importance of the wealth channels. Chart 5 shows the total wealth effect and its components (scaled and weighted by their long-run elasticities in the demand equation). Real Divisia money balances are the largest item, followed by net external assets. The capital stock makes only a minor contribution. This gives a significant role to the money stock in the transmission mechanism. Raising interest rates reduces the demand for real money balances held for transactions purposes - this can be seen as a substitution effect since it implies that more money is held in savings accounts or other assets instead.

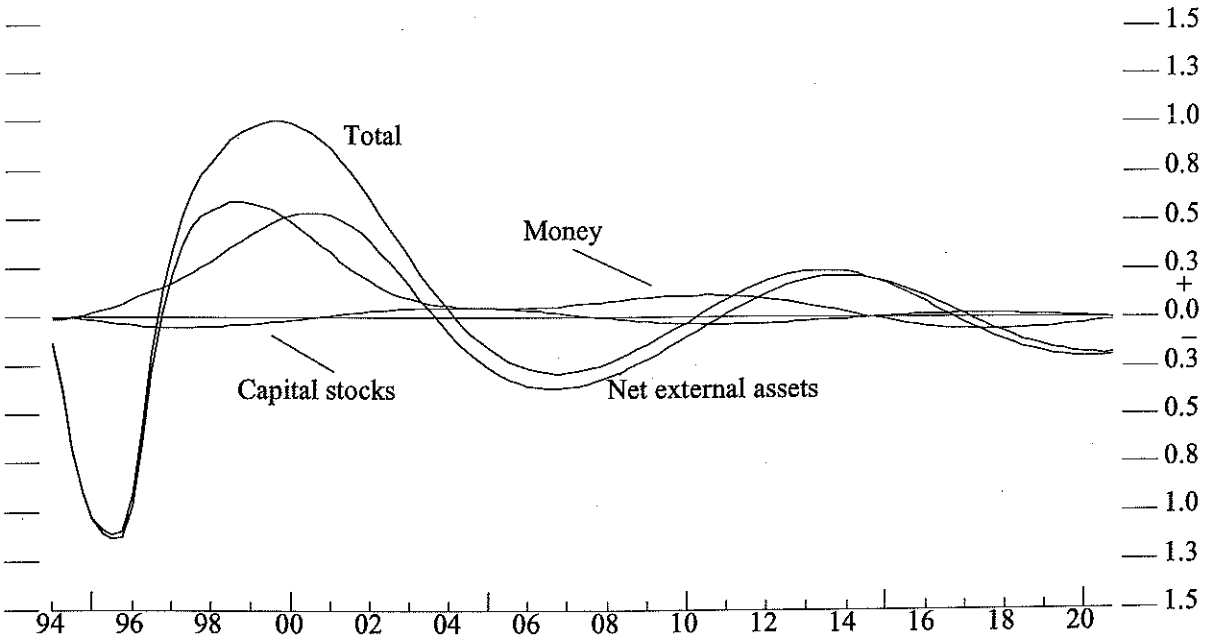
It is not uncommon in econometric models to find that interest rate terms do not have the expected size and sometimes even the expected sign across a variety of equations (consumption function, money demand, exchange rates, etc.). This is almost certainly due to an identification problem given that the interest rate is a key policy variable which is adjusted to exploit perceived relationships. It would not be surprising therefore if the Divisia money term is a better proxy for interest rate effects than the interest rate itself. This interaction clearly warrants further research.

In a study of M_4 behaviour (Fisher and Vega, 1993) we concluded that higher real money balances caused higher consumption but higher consumption reduced real money balances; hence the reduced form correlation between activity and broad money depends on the nature of the shock. That conclusion is also reflected here and is one of the reasons why we use a narrower money aggregate.

Chart 5

Wealth effects

(% difference from base)



Note: Wealth effects weighted and scaled by long-run elasticity in demand function.

Chart 6a

Price level response under alternative exchange rate assumptions

(RPIX, % difference from base)

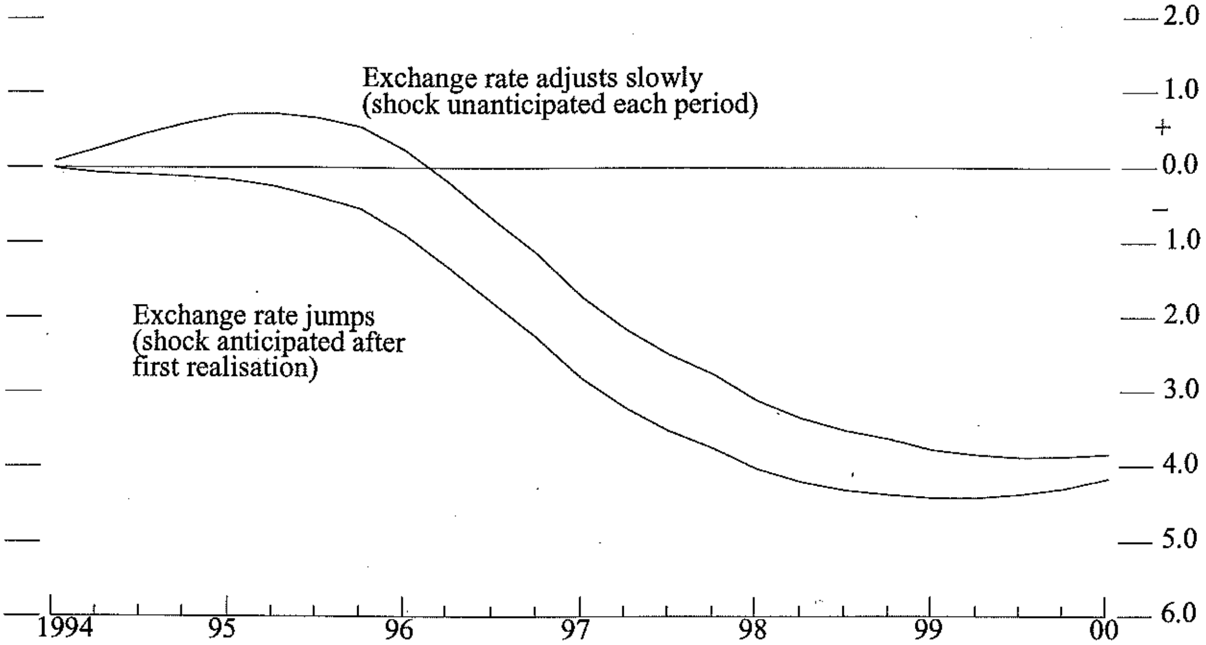
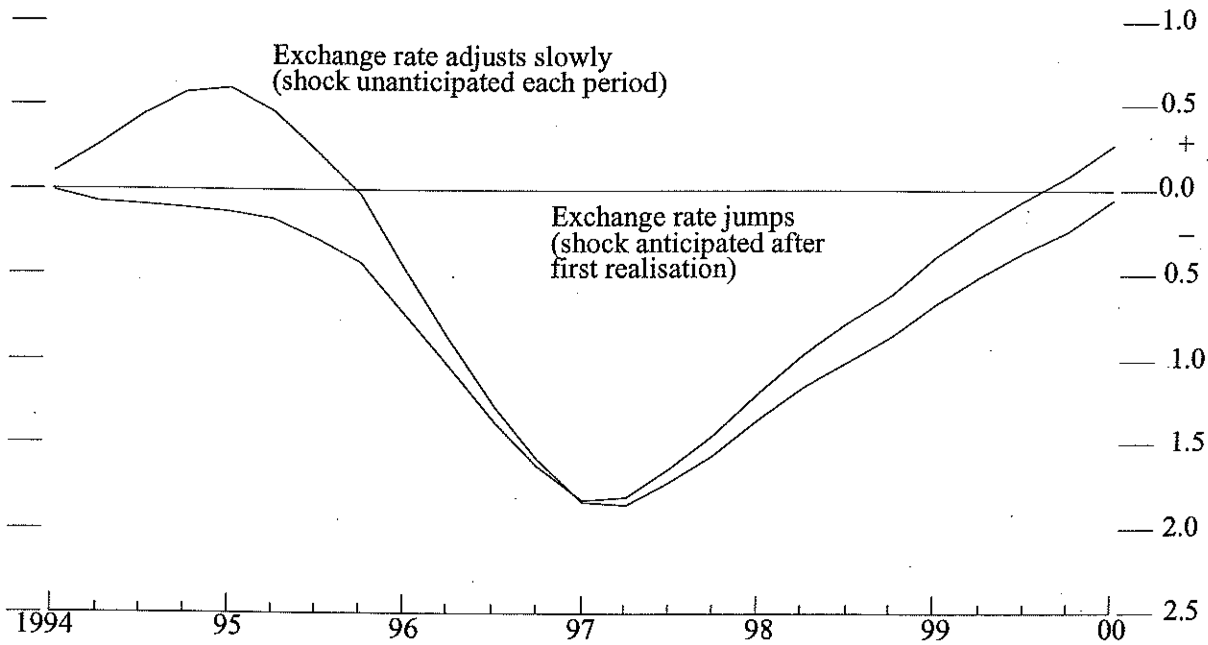


Chart 6b

Inflation response under alternative exchange rate assumptions

(RPIX, % difference from base)



Also, we effectively assume Ricardian equivalence and therefore have no role for government debt in net wealth. However, the lack of a comprehensively specified government budget constraint is a model weakness, and introducing this would potentially allow a role for government debt, possibly helping to separate wealth from substitution effects.

Over time, the direct interest rate effects kick in and eventually the two channels are out of phase - but this helps to stabilise the model and dampen the cycles.

6. Prices

The price response is where the expectations formation assumptions have most impact. In the first simulation, where the interest rate shock is unanticipated, the exchange rate adjusts slowly and so do prices. In fact, because the retail price index feeds into earnings in the short run, the increase in mortgage payments induces a positive response in prices and wages for the first two years of the simulation. This reduces the increase in real interest rates and softens the initial effects on output.

When the interest rate shock is assumed to be known, the exchange rate "jumps" in the first quarter and brings forward the process of price adjustment, starting with import prices. The net effect is to mitigate the initial "perverse" price response from all nominal variables bar the headline retail price index (see Chart 6).

The main reasons for these perverse price responses are that (i) wage determination is conditioned on the headline RPI in the short run; and (ii) the large initial output response, coupled with labour hoarding and some substitution away from capital towards labour, cause unit labour costs to rise in the short run. Neither of these impacts on prices are particularly well determined, and are straightforwardly eliminated from model properties required.

In the absence of explicit expectations effects in the labour market, the main driving forces for price change come through two real-side channels: labour market inactivity (population of working age less employment) affecting the real wage bargain and the output: capital ratio affecting the price: cost mark-up. Hence there is a clear transmission path from nominal interest rates to real interest rates and wealth to demand to output to prices and wages, with the exchange rate response acting to speed up or slow down the transmission depending on expectations formation.

Having imposed a stable exchange rate path, the model has a unique stable solution for the price level response given a temporary shock to interest rates. This is convenient for purposes of exposition but disguises the fact that the exchange rate profile is essentially an assumption. With exogenous interest rates, the UIP condition has a unit root in the exchange rate and the solution depends entirely on the assumed terminal condition. Endogenising interest rates[13] is a necessary but not sufficient condition to generate a unique solution. But endogenous interest rates in a forward-looking model raise the question of policy credibility - the modelling of which is beyond the scope of this exercise.

IV. SUMMARY AND CONCLUSIONS

In this note we have explored the transmission mechanism for interest rates in the Bank of England's medium-term forecasting model. The simulations reveal some interesting phenomena:

13 This could be through a reaction function or through a fixed money stock.

- in the absence of active policy the model has endogenous cycles generated by the lags between the response of demand, output and prices;
- the indirect effects of the wealth terms are as important for demand as other direct effects of an interest rate change - and can be quicker. But the wealth terms appear to be delivering the substitution effect, which is not picked up by the interest rate term;
- the model has some small hysteresis effects in the long term;
- the dynamics of the price response depend crucially on the exchange rate in general and on expectations in the foreign exchange market in particular.

The MTF model was designed for forecasting over a two-year horizon but the results are reasonably acceptable over a much longer horizon. However, we would end on a note of caution in interpreting these simulations, which have been designed for analysing the model. For model simulations to be realistic over a long time period we would need to endogenise interest rates. Only then could we hope to find a unique path for the exchange rate under all expectations assumptions.

ANNEX 1

An outline of the MTF model

The 19 equation model shown below is meant to be a comprehensive description of a one sector economy under Cobb-Douglas technology in equilibrium. Firms are assumed to set prices given output and the capital stock. They bargain with workers over wages and choose employment. Demand is aggregated, but is broadly consistent with modern theories of consumer spending in which state variables, like wealth and interest rates, play an important role. There are bound to be omissions from this simple structure, and the schematic model is intended to be illustrative.

There are also major gaps. The most important of these are: the lack of explicit forward-looking behaviour in wage and price determination; the absence of a government budget constraint and hence the role for government debt accumulation; and the less than satisfactory determination of demand, given theoretical advances in the analysis of consumption. We hope to rectify all of these as the model develops over the course of the next year.

1. The core of the MTF model

Goods market (lower case denotes variables in logs)

(a) Demand and output

(1) $$q=\alpha_1 n+(1-\alpha_1)k+\alpha_2 t=\alpha_1(n-k)+k+\alpha_2 t$$ (output)

(2) $$x=z-\beta_3(px-px^f+e)-\beta_4 t$$ (exports)

(3) $$d=-\gamma_1 r+\gamma_2(A-p)-\gamma_3\Delta p+g+\gamma_r t$$ (domestic demand)

(4) $$M=D-Q+X\equiv D-T$$ (imports)

(b) Prices and costs

(5) $$p=(\zeta/1-\zeta)+(w+q-n)+(1-\alpha_1/\alpha_1)(q-k)$$ (domestic prices/supply curve)

(6) $$pc=(\eta/1-\eta)+\alpha_3 p+(1-\alpha_3)pm$$ (retail price)

(7) $$px=(\theta/1-\theta)+(w+q-n)+\alpha_5(y-k)+(1-\alpha_5)(x-k)$$ (export price)

(8) $$pm\equiv p^f-e$$

Labour market

(9) $n = q - (w - p)$ (labour demand)

(10) $rw = q - n - \lambda_1 u - \lambda_2 (rw - rwc)$ (real wage)

(11) where $rw \equiv w\text{-}p\text{+}te$

(12) $rwc \equiv w\text{-}pc\text{-}td$

(13) $u = NAIRU + \delta_0 (q - q^*)$ (unemployment)

Money market/policy

(14) $e_t = e_{t+1} + (r_t - r_t^f) + risk$ (exchange rate arbitrage)

(15) $m^d = \mu_1 (k + p) - \mu_2 r - \mu_4 (p_{t+1} - p_t)$ (Divisia money demand)

(16) $i_t = \alpha \Delta p_{t+1}^e$ (interest rate reaction function)

(17) $A = K + (m^d - p) + (A^f - p + q)$ (real private wealth)

Overseas sector

(18) B=PX.X - PM.M (balance of payments)

(19) $A^f = (E_t / E_{t-1}) A_{t-1}^f + B$ (net overseas assets)

Glossary

q - Total output (GDP)
n - Employees in employment
k - Capital stock (exogenous)
y - Demand for domestic output
d - Domestic demand
p - GDP deflator
p^f - Overseas GDP deflator
e - Nominal exchange rate
z - World trade/world demand
px - Export prices (AVI)
px^f - World exports prices (AVI)
r - Real interest rate
g - Government spending (exogenous)
A - Outside wealth
A^f - Net foreign assets
w - Nominal wage
pc - Retail prices
pm - Import prices
ulcm - Manufacturing unit labour costs
u - Unemployment
rw - Real own product wage
rwc - Real consumption wage
NAIRU - Non-accelerating prices rate of unemployment
r^f - Foreign real interest rate
FEER - Fundamental equilibrium exchange rate
risk - Exchange market risk premium

ANNEX 2

Equilibrium unemployment and output in the new small forecasting model

I. INTRODUCTION

The small forecasting model has a coherent, if simple, supply side. It is coherent in the sense that firms' output, employment and pricing decisions are made consistently, based on a single production function and its cost function dual. It is simple because we have chosen an unsophisticated description of technology; namely, a Cobb-Douglas production function, with constant returns to scale and disembodied technical progress.

The section below describes how the model solves for equilibrium in the goods and labour markets, generating an equilibrium inactivity rate (akin to a NAIRU) and the level of potential output.

II. THE MODEL'S SUPPLY SIDE

The following equations describe the core of the model's supply side:

(1) $$(q-k)=\alpha(n-k)+\zeta t+\eta$$ (output)

(2) $$(p-w+q-n)=((1-\alpha)/\alpha)(q-k)+\lambda$$ (prices)

(3) $$(w-p-q+n)=\beta U+\theta$$ (wages)

(4) $$(n-k)=-(1/(1-\alpha))(w-p)+(1/(1-\alpha))(q-\alpha n-(1-\alpha)k)+\gamma$$ (employment)

or $$n=q-w+p$$

where q, n w and p denote output (GDP), employment, wages (average weekly earnings) and prices (GDP deflator) respectively - lower case letters denote logs; α is a production function parameter, here labour's share of GDP; β is the semi-elasticity of the real wage with respect to the inactivity rate, U; k is the capital stock, which is exogenous to this system; γ , λ, θ and η are estimated constants, which demean the series.

The price and employment equations are derived assuming firms minimise costs, taking output and the capital stock as given at the beginning of the decision period. The derivation is standard, as in Varian (1984),[14] and it implies cross equation restrictions between equations (1), (2) and (4). The wage equation assumes the firm's real wage (i.e. labour costs deflated by the firm's output price) is the important variable in the long run, implying that shocks which drive a wedge between the real product wage and real take-home pay, such as changes in labour taxes or the terms of trade, only affect firms' profitability in the short run. Firms eventually claw their losses back.

The system solves for a constant level of equilibrium inactivity and the output-capital ratio as follows.

14 Microeconomic Theory, Norton, 1984. Chapter 1 gives details.

Rewrite (4) as:

$$(5) \qquad (w - p - q + n) = \gamma(1 - \alpha)$$

i.e. real unit labour costs, or its inverse, the mark-up on labour costs is *constant* in the long run. For γ=0, or if the constant does nothing more than demean the variable, workers are paid their marginal product; γ>0 (or > the variable mean) suggests that workers are paid more than their marginal product, perhaps because of an efficiency wage premium (amongst other things). Variations in this mark-up, due perhaps to time-varying risk characteristics, could be a candidate for shifts in the NAIRU. Similarly, constants in the wage and price equations may be picking up the degree of product and labour market competition, which may not actually be constant in the long run, and changes in which may cause the NAIRU to change. The substantive point is that the micro reasons for changes in the NAIRU are not picked up well in this macro framework.

Chart 1

Unit labour costs

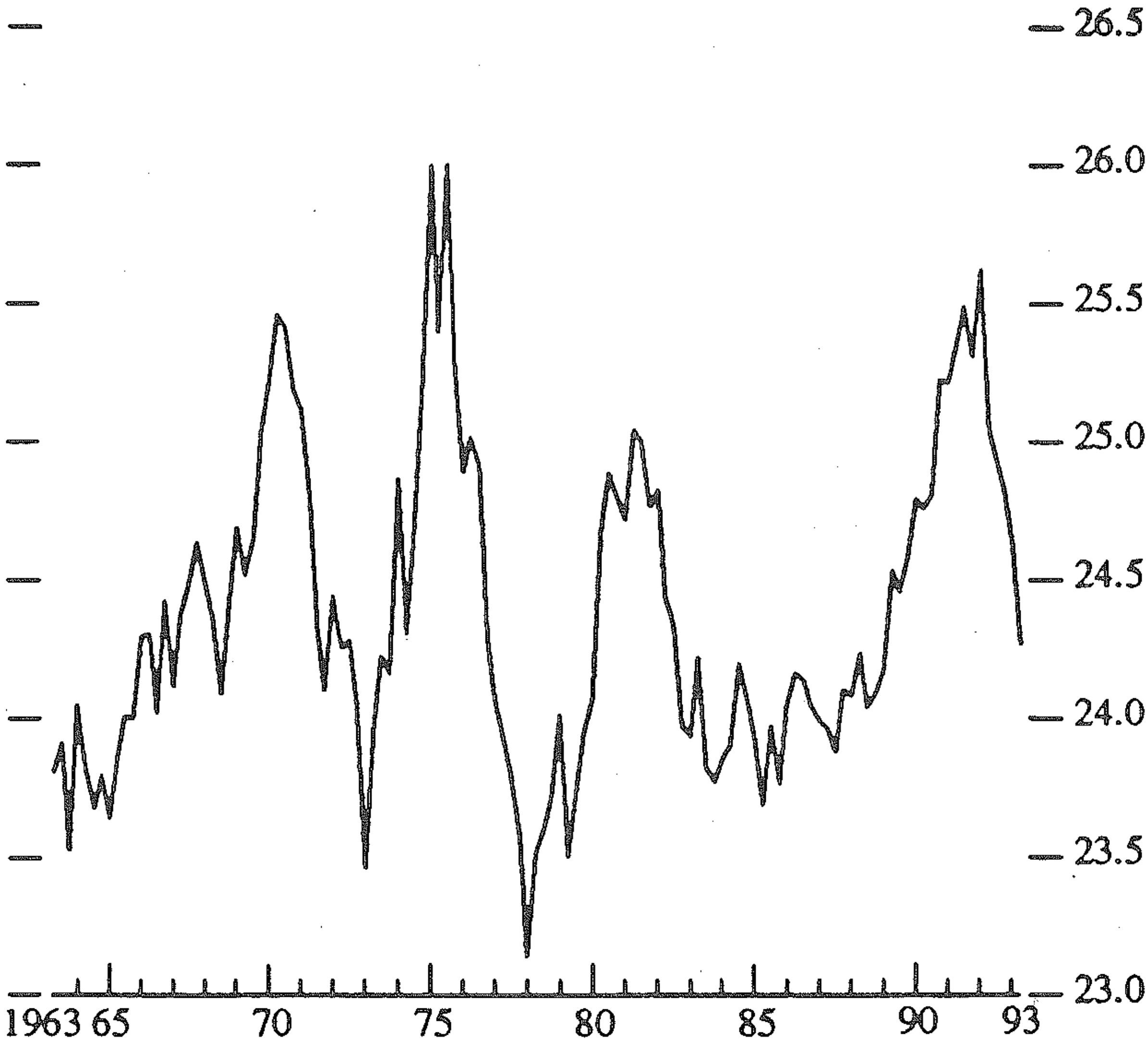


Chart 1 plots real unit labour costs (including employers' tax costs), and the series does appear to be stationary. Cointegration tests confirm this. However, close inspection suggests that there might be trends in sub-samples (an upward trend in the late 1960s to mid 1970s perhaps?), which could correlate with longer-term changes in equilibrium unemployment. Recursive estimation would reveal whether the constants are changing over sub-samples, though this would still be description rather than explanation.

Notwithstanding these concerns, the implication, from (2) and (3), is that in equilibrium the inactivity rate and the output-capital ratio are constant as well. Substituting (5) into (2) yields:

$$(6) \qquad u = \frac{\theta - \gamma(1-\alpha)}{\beta}$$

which gives the inactivity rate consistent with constant inflation as a function of product and labour market parameters. (6), (2) and (3) then solve for the equilibrium capital-output ratio.

$$(7) \qquad (q-k) = -\alpha\left[\frac{\lambda}{1-\alpha} + \gamma\right]$$

The estimated values of the parameters are tabulated below, along with the implied values of equilibrium inactivity, the capital-output ratio and the output gap.

Table

Key parameters

Parameter	**Description**	**Estimated value**
α	output-employment elasticity	0.7
β	real wage-unemployment semi-elasticity	0.3
γ	employment equation constant	10.64
λ	price equation constant	-1.92
θ	wage equation constant	3.27
$\{(\theta\text{- }(1\text{-}\alpha))/\beta\}$	equilibrium inactivity (nairu)	25% (latest actual = 28.4%)
$\exp(-\alpha\{\lambda/(1\text{-}\alpha)+\gamma\})$	equilibrium output-capital ratio	5.1% (latest actual=4.5%)
q-q*	output gap	-0.6%

The estimates are very sensitive to certain parameters. For instance, each 0.01(1%) rise in the employment constant γ leads to a 1% fall in the estimate of the NAIRU and a 0.7% fall in the equilibrium output-capital ratio. The standard error on the estimate of this constant is 2.8%. Similarly, a 1% higher wage equation constant would raise the NAIRU by 3%, while a 1% higher price equation constant would reduce equilibrium output by 2.3%.

More fundamentally, these "constants" may not be constant at all, but drifting parameters which capture supply shocks not evident in the other right-hand side variables. This might become clear in recursive estimation of these equations, where a rise in the NAIRU during the 1970s might, for instance, show up as a fall in the employment equation constant. Microeconomic labour market reforms, efficiency wage considerations and the degree of product market competition might still not be adequately captured. This becomes more apparent if we replace estimated constants with sample means, when all we do is reproduce the sample mean of inactivity and the output-capital ratio as our "long run" estimates.

Table A

Baseline values of selected exogenous variables

	1993	1994	1995	1996	1997	1998
1. Foreign interest rates (%)	6.53	5.17	5.51	5.51	5.51	5.51
2. Oil prices and other commodity prices	19.66	17.15	17.80	18.18	19.12	19.77
3. Foreign prices	99.14	100.14	102.36	104.58	107.23	110.13
4. Foreign output	103.26	105.23	107.76	110.71	113.70	115.97

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Temporary shock to interest rates (exchange rates endogenous)					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.37	0.45	0.15	0.12	0.09
3. Other interest rate (%)					
Mortgage rate	0.92	1.00	0.08	0.00	0.00
4. Real interest rates					
Real short-term interest rate (%)	0.70	0.70	1.05	1.75	1.10
Real long-term interest rate (%)	0.03	0.14	1.20	1.87	1.20
User cost of capital	- 0.10	0.02	1.83	2.97	1.98
5. Exchange rates					
Nominal effective exchange rate	0.62	1.62	2.00	2.00	2.00
Real effective exchange rate	1.06	2.53	1.75	- 0.31	- 1.62
6. Asset prices and wealth					
7. Money and credit					
Monetary aggregate (M4)	- 0.44	- 0.89	- 0.98	- 1.67	- 2.70
(M0)	- 0.34	- 0.91	- 1.47	- 2.29	- 3.15

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Temporary shock to interest rates (exchange rates fixed)					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.40	0.52	0.22	0.17	0.14
3. Other interest rate (%)					
Mortgage rate	0.92	1.00	0.08	0.00	0.00
4. Real interest rates					
Real short-term interest rate (%)	0.60	0.38	0.55	1.25	0.64
Real long-term interest rate (%)	- 0.01	- 0.10	0.77	1.43	0.77
User cost of capital	- 0.07	- 0.19	1.25	2.26	1.27
5. Exchange rates					
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	0.45	1.12	0.46	- 0.99	- 1.75
6. Asset prices and wealth					
7. Money and credit					
Monetary aggregate (M4)	- 0.42	- 0.71	- 0.43	- 0.65	- 1.17
(M0)	- 0.33	- 0.74	- 0.93	- 1.31	- 1.72

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary shock to interest rates (exchange rates endogenous)					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.35	- 0.89	- 0.59	0.01	0.24
Private consumption	- 0.36	- 0.88	- 0.67	- 0.22	- 0.05
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.54	- 4.20	- 3.30	- 1.80	- 2.70
Inventories	- 0.15	- 0.07	0.09	- 0.11	- 0.21
Exports	- 0.19	- 0.63	- 0.63	- 0.09	0.37
Imports	- 0.69	- 1.57	- 1.70	- 2.15	- 3.28
Factor cost adjustment	- 0.35	- 0.89	- 0.59	0.01	0.24
2. Unemployment rate (%)	0.15	0.83	1.29	0.97	0.46
3. Real disposable income	0.01	- 0.31	- 0.45	- 0.19	- 0.10
4. Inflation and wages					
GDP deflator	0.44	0.90	- 0.25	- 2.27	- 3.55
Consumer prices	0.89	1.27	- 0.46	- 2.36	- 3.48
Wages/earnings	0.49	0.79	- 0.46	- 2.28	- 3.46
Unit labour cost	0.67	1.14	- 0.42	- 2.53	- 3.70
Import prices	- 0.30	- 0.83	- 1.51	- 2.18	- 2.49
5. Government accounts (% of nominal GDP)					
Revenues	0.00	0.00	0.00	0.00	0.00
Primary expenditures	0.05	0.18	0.27	0.36	0.41
Government budget balance	0.05	0.17	0.26	0.36	0.41
6. Current account (% of nominal GDP)	0.31	0.52	0.31	0.30	0.46
Trade balance	0.31	0.51	0.29	0.27	0.41
Net interest payments abroad	0.00	0.01	0.03	0.06	0.09

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary shock to interest rates (exchange rates fixed)					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.33	- 0.79	- 0.40	0.20	0.37
Private consumption	- 0.36	- 0.88	- 0.63	- 0.13	0.08
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.61	- 4.21	- 2.86	- 0.74	- 0.97
Inventories	- 0.17	- 0.11	0.09	- 0.05	- 0.12
Exports	- 0.08	- 0.28	- 0.22	0.17	0.46
Imports	- 0.68	- 1.61	- 1.80	- 2.04	- 2.49
Factor cost adjustment	- 0.33	- 0.79	- 0.40	0.20	0.37
2. Unemployment rate (%)	0.04	0.21	0.30	0.20	0.06
3. Real disposable income	- 0.02	- 0.38	- 0.51	- 0.18	- 0.05
4. Inflation and wages					
GDP deflator	0.45	1.12	0.46	- 0.99	- 1.75
Consumer prices	0.96	1.67	0.43	- 0.96	- 1.62
Wages/earnings	0.53	1.10	0.34	- 0.95	- 1.62
Unit labour cost	0.70	1.37	0.26	- 1.28	- 1.89
Import prices	0.11	0.43	0.25	- 0.30	- 0.48
5. Government accounts (% of nominal GDP)					
Revenues	0.00	0.00	0.00	0.00	0.00
Primary expenditures	0.05	0.11	0.10	0.13	0.15
Government budget balance	0.07	0.10	0.09	0.14	0.14
6. Current account (% of nominal GDP)	0.30	0.57	0.44	0.42	0.47
Trade balance	0.30	0.53	0.38	0.33	0.36
Net interest payments abroad	0.01	0.03	0.06	0.09	0.12

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table III.1

Contributions to GDP by channel of transmission and by variable

Policy experiment: Temporary shock to interest rates (exchange rates endogenous)

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Direct interest rate effect on domestic demand**	**Cost of capital**	**Exchange rate**	**Discrepancy[2]**
Real GDP: first year after shock[1]	**- 0.35**	**- 0.11**	**- 0.17**	**0.00**	**- 0.04**	**0.00**	**- 0.02**	**0.00**
of which:								
Private consumption	- 0.27	- 0.05	- 0.14	- 0.06	- 0.01	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.29	- 0.06	- 0.23	0.06	- 0.08	0.00	0.01	0.00
Inventories	*- 0.14*	*- 0.03*	*- 0.15*	*0.06*	*- 0.07*	*0.02*	*0.02*	*0.00*
Exports	- 0.06	- 0.02	0.00	0.00	0.00	0.00	- 0.03	0.00
Imports	- 0.21	0.00	- 0.17	0.00	- 0.04	0.00	0.00	0.00
Factor cost adjustment	- 0.05	- 0.02	- 0.03	0.00	- 0.01	0.00	0.00	0.00
Real GDP: second year after shock[1]	**- 0.89**	**- 0.27**	**- 0.29**	**0.00**	**- 0.22**	**0.00**	**- 0.11**	**0.00**
of which:								
Private consumption	- 0.65	- 0.02	- 0.38	- 0.17	- 0.07	0.00	- 0.01	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.62	0.03	- 0.40	0.17	- 0.42	0.00	0.01	0.00
Inventories	*- 0.19*	*0.09*	*- 0.24*	*0.17*	*- 0.30*	*0.04*	*0.06*	*0.00*
Exports	- 0.19	- 0.10	0.01	0.00	0.00	0.00	- 0.11	0.00
Imports	- 0.42	0.22	- 0.42	0.00	- 0.23	0.00	0.02	0.00
Factor cost adjustment	- 0.14	- 0.04	- 0.05	0.00	- 0.03	0.00	- 0.02	0.00
Real GDP: third year after shock[1]	**- 0.60**	**- 0.26**	**0.05**	**0.00**	**- 0.18**	**- 0.01**	**- 0.20**	**0.00**
of which:								
Private consumption	- 0.47	0.07	- 0.25	- 0.13	- 0.14	0.00	- 0.02	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.38	0.22	- 0.19	0.13	- 0.50	0.00	- 0.05	0.00
Inventories	*- 0.06*	*0.33*	*- 0.21*	*0.13*	*- 0.40*	*0.02*	*0.07*	*0.00*
Exports	- 0.20	- 0.12	0.04	0.00	0.02	0.00	- 0.13	0.00
Imports	- 0.37	0.46	- 0.46	0.00	- 0.41	0.00	0.03	0.00
Factor cost adjustment	- 0.09	- 0.04	0.01	0.00	- 0.03	0.00	- 0.03	0.00

Table III.1 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary shock to interest rates (exchange rates endogenous)								
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Direct interest rate effect on domestic demand**	**Cost of capital**	**Exchange rate**	**Discrepancy[2]**
Real GDP: fourth year after shock[1]	**0.01**	**- 0.23**	**0.36**	**0.00**	**0.08**	**- 0.01**	**- 0.19**	**0.00**
of which:								
Private consumption	- 0.15	- 0.03	0.07	- 0.02	- 0.11	0.00	- 0.06	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.16	0.19	- 0.01	0.02	- 0.28	0.00	- 0.09	0.00
Inventories	*- 0.14*	*0.35*	*- 0.21*	*0.02*	*- 0.32*	*0.01*	*0.02*	*0.00*
Exports	- 0.03	- 0.04	0.05	0.00	0.04	0.00	- 0.08	0.00
Imports	- 0.35	0.39	- 0.29	0.00	- 0.43	0.00	- 0.01	0.00
Factor cost adjustment	0.00	- 0.04	0.06	0.00	0.01	0.00	- 0.03	0.00
Real GDP: fifth year after shock[1]	**0.24**	**- 0.18**	**0.35**	**0.00**	**0.20**	**- 0.01**	**- 0.12**	**0.00**
of which:								
Private consumption	- 0.03	- 0.17	0.25	0.00	- 0.02	0.00	- 0.09	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.19	0.06	0.05	0.00	- 0.17	0.00	- 0.12	0.00
Inventories	*- 0.33*	*0.17*	*- 0.15*	*0.00*	*- 0.29*	*0.00*	*- 0.07*	*0.00*
Exports	0.12	0.06	0.04	0.00	0.05	- 0.01	- 0.02	0.00
Imports	- 0.38	0.16	- 0.07	0.00	- 0.37	0.01	- 0.10	0.00
Factor cost adjustment	0.04	- 0.03	0.06	0.00	0.03	0.00	- 0.02	0.00
Real GDP: sixth year after shock[1]	**0.47**	**- 0.01**	**0.28**	**0.00**	**0.25**	**- 0.02**	**- 0.03**	**0.00**
of which:								
Private consumption	0.09	- 0.22	0.33	0.00	0.09	0.00	- 0.10	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.16	- 0.04	0.12	0.00	- 0.09	0.00	- 0.14	0.00
Inventories	*- 0.43*	*- 0.05*	*- 0.01*	*0.00*	*- 0.23*	*0.00*	*- 0.15*	*0.00*
Exports	0.20	0.13	0.00	0.00	0.04	- 0.01	0.02	0.00
Imports	- 0.42	- 0.12	0.14	0.00	- 0.25	0.01	- 0.18	0.00
Factor cost adjustment	0.07	0.00	0.04	0.00	0.04	0.00	- 0.01	0.00

[1] In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect. [2] Due to interaction between the different channels.

Table III.2

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary shock to interest rates (exchange rates fixed)

	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption	Direct interest rate effect on domestic demand	Cost of capital	Exchange rate	Discrepancy[2]
Real GDP: first year after shock[1]	**- 0.33**	**- 0.11**	**- 0.17**	**0.00**	**- 0.04**	**0.00**	**0.00**	**0.00**
of which:								
Private consumption	- 0.26	- 0.05	- 0.14	- 0.06	- 0.01	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.31	- 0.06	- 0.23	0.06	- 0.08	0.00	0.00	0.00
Inventories	*- 0.16*	*- 0.03*	*- 0.15*	*0.06*	*- 0.07*	*0.02*	*0.00*	*0.00*
Exports	- 0.02	- 0.02	0.00	0.00	0.00	0.00	0.00	0.00
Imports	- 0.21	0.00	- 0.17	0.00	- 0.04	0.00	0.00	0.00
Factor cost adjustment	- 0.05	- 0.02	- 0.03	0.00	- 0.01	0.00	0.00	0.00
Real GDP: second year after shock[1]	**- 0.79**	**- 0.27**	**- 0.29**	**0.00**	**- 0.22**	**0.00**	**0.00**	**0.00**
of which:								
Private consumption	- 0.64	- 0.02	- 0.38	- 0.17	- 0.07	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.62	0.03	- 0.40	0.17	- 0.42	0.00	0.00	0.00
Inventories	*- 0.26*	*0.09*	*- 0.24*	*0.17*	*- 0.30*	*0.04*	*0.00*	*0.00*
Exports	- 0.09	- 0.10	0.01	0.00	0.00	0.00	0.00	0.00
Imports	- 0.44	0.22	- 0.42	0.00	- 0.23	0.00	0.00	0.00
Factor cost adjustment	- 0.13	- 0.04	- 0.05	0.00	- 0.03	0.00	0.00	0.00
Real GDP: third year after shock[1]	**- 0.40**	**- 0.26**	**0.05**	**0.00**	**- 0.18**	**- 0.01**	**0.00**	**0.00**
of which:								
Private consumption	- 0.45	0.07	- 0.25	- 0.13	- 0.14	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.34	0.22	- 0.19	0.13	- 0.50	0.00	0.00	0.00
Inventories	*- 0.14*	*0.33*	*- 0.21*	*0.13*	*- 0.40*	*0.02*	*0.00*	*0.00*
Exports	- 0.07	- 0.12	0.04	0.00	0.02	0.00	0.00	0.00
Imports	- 0.40	0.46	- 0.46	0.00	- 0.41	0.00	0.00	0.00
Factor cost adjustment	- 0.06	- 0.04	0.01	0.00	- 0.03	0.00	0.00	0.00

Table III.2 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary shock to interest rates (exchange rates fixed)								
	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption**	**Direct interest rate effect on domestic demand**	**Cost of capital**	**Exchange rate**	**Discrepancy[2]**
Real GDP: fourth year after shock[1]	**0.20**	**- 0.23**	**0.36**	**0.00**	**0.08**	**- 0.01**	**0.00**	**0.00**
of which:								
Private consumption	- 0.09	- 0.03	0.07	- 0.02	- 0.11	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.07	0.19	- 0.01	0.02	- 0.28	0.00	0.00	0.00
Inventories	*- 0.16*	*0.35*	*- 0.21*	*0.02*	*- 0.32*	*0.01*	*0.00*	*0.00*
Exports	0.05	- 0.04	0.05	0.00	0.04	0.00	0.00	0.00
Imports	- 0.34	0.39	- 0.29	0.00	- 0.43	0.00	0.00	0.00
Factor cost adjustment	0.03	- 0.04	0.06	0.00	0.01	0.00	0.00	0.00
Real GDP: fifth year after shock[1]	**0.36**	**- 0.18**	**0.35**	**0.00**	**0.20**	**- 0.01**	**0.00**	**0.00**
of which:								
Private consumption	0.05	- 0.17	0.25	0.00	- 0.02	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.07	0.06	0.05	0.00	- 0.17	0.00	0.00	0.00
Inventories	*- 0.26*	*0.17*	*- 0.15*	*0.00*	*- 0.29*	*0.00*	*0.00*	*0.00*
Exports	0.14	0.06	0.04	0.00	0.05	- 0.01	0.00	0.00
Imports	- 0.28	0.16	- 0.07	0.00	- 0.37	0.01	0.00	0.00
Factor cost adjustment	0.06	- 0.03	0.06	0.00	0.03	0.00	0.00	0.00
Real GDP: sixth year after shock[1]	**0.50**	**- 0.01**	**0.28**	**0.00**	**0.25**	**- 0.02**	**0.00**	**0.00**
of which:								
Private consumption	0.19	- 0.22	0.33	0.00	0.09	0.00	0.00	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.01	- 0.04	0.12	0.00	- 0.09	0.00	0.00	0.00
Inventories	*- 0.29*	*- 0.05*	*- 0.01*	*0.00*	*- 0.23*	*0.00*	*0.00*	*0.00*
Exports	0.17	0.13	0.00	0.00	0.04	- 0.01	0.00	0.00
Imports	- 0.23	- 0.12	0.14	0.00	- 0.25	0.01	0.00	0.00
Factor cost adjustment	0.08	0.00	0.04	0.00	0.04	0.00	0.00	0.00

[1] In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect. [2] Due to interaction between the different channels.

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The monetary transmission mechanism in the United States: simulations using the Federal Reserve Board's MPS model

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I. INTRODUCTION

This paper analyzes the effects on the US economy of a temporary change to short-term rates of interest, as simulated by the Federal Reserve Board's MPS model. The experiment assumes that the monetary authority raises the federal funds rate by 1.0 percentage point above baseline, sustains the increase for two years, and returns the funds rate to baseline thereafter. The relative importance of the different monetary transmission channels and the relative responsiveness of the components of aggregate GDP are of particular concern in understanding the diffusion of this rate increase to the economy.

Although the MPS model has a clearly delineated path by which a change to short-term interest rates affects real output, in an important way the model structure is not well-suited to the exercise at hand. Pegging the nominal interest rate for an extended period results in an unstable simulated path for aggregate output and inflation; that is, an increase in the nominal interest rate causes the level of output and the rate of inflation to fall below their baseline paths by larger and larger amounts. This feature derives primarily from the interaction of two properties of the model: the first is that demand is a function of real, not nominal, interest rates, and the second is that the long-run Phillips curve is vertical. To return the economy to equilibrium, the nominal rate of interest must ultimately be brought below baseline for some period. But the design of this experiment - a rise in nominal rates, followed by a return to baseline - precludes this option.

Details of these critical features of the model specifications of the Phillips curve and the IS curve are presented later in this paper. However, warning is given at this point that - to the extent that the MPS model accurately characterizes the properties of the US economy - a monetary policy that attempts to peg nominal interest rates is not a viable policy for the United States. Consequently, the simulated path of output described in these exercises is unlikely to materialize, especially as the simulation horizon increases. In theory, output would follow a downward spiral were nominal rates constrained in the manner assumed in these simulations; in practice, the set of feasible monetary policies in the United States does not include pegging the nominal rate of interest for a sustained period of time.

II. USES OF THE MPS MODEL

For over twenty-five years, the MPS model has been used regularly in the forecasting cycle at the Federal Reserve Board. In preparation for the eight meetings each year of the Federal Open Market Committee (FOMC), the staff produces two forecasts of the US economy: a "judgmental" forecast and a model forecast. Differences between the two forecasts are debated at an early stage in the forecast cycle and final versions of the forecasts may or may not be influenced by the discussion. The model can be made to replicate the judgmental forecast; in doing so, the model calculates the adjustments to equation intercepts that are necessary in order to match the judgmental forecast. When these adjustments are large relative to an equation's error history, the final judgmental

1 The author acknowledges very helpful discussions with Flint Brayton and the excellent assistance of Tilda Horvath.

forecast is more likely to acknowledge the model point of view. In general, the influence of the model on the judgmental forecast is negligible in the very near term but increases with the forecast horizon. Similarly, the judgmental influence on the model forecast is strongest in the first forecast quarter, especially if much of the data or indicators for the quarter are already known. In such circumstances, the model's current quarter forecast is forced exactly to the judgmental forecast. The judgmental forecast becomes the "official" staff forecast and is presented to the members of the FOMC.

The model is used heavily for policy analysis, both around the times of the FOMC meetings - when the consequences of alternative monetary policy decisions are simulated - and for a wide range of other issues. The implications of changes to fiscal policy, as well as shocks to oil prices, exchange rates and foreign GDP growth, are commonly evaluated through model simulations. The model is also used in research undertaken by the staff on topics related to the design of monetary policy such as use of nominal GDP targets.

III. STRUCTURE OF THE MODEL

The long-run properties of the model conform to those of the neoclassical growth model. Thus, the growth rate of real output equals the rate of population growth plus the rate of technological progress, both of which are exogenous to the model. The long-run level of per capita output depends on the parameters of a three-factor production function, the ratios of energy to output and capital to output, as well as the level of technology embodied in the capital stock. The steady-state capital-output ratio is affected by a permanent change to fiscal policy but not by a permanent change to the amount of money. The latter causes only a proportionate change in the price level, leaving all real magnitudes unchanged. A long-run unemployment rate, consistent with a constant rate of inflation, exists. This natural unemployment rate is uniquely determined by the rate of productivity growth and the ratio of unemployment benefits to take-home pay. When the economy is at the natural rate, the inflation rate that prevails is determined strictly by the excess of the rate of money growth over that needed to support (the exogenously-determined) real output growth, taking into account any exogenous trend in the income velocity.

In the short run, adjustment costs and the assumption that expectations are formed autoregressively prevent wages and prices from instantaneously moving to clear the labor and goods market. As a result, the short-run behavior of the model is Keynesian so that output is driven by demand, and changes in the supply of money (as well as in fiscal policy) change demand. The transmission of changes in the supply of money to demand and output is effected entirely through changes to nominal and real interest rates, money having no effect on demand except through this channel. Changes to interest rates produce changes in aggregate demand by altering the present value of income flows, the user costs of producer and consumer goods, and the real exchange rate. In each of these channels, a rise in real interest rates depresses demand.[2] Similar to the absence of a direct role for money in affecting demand is the lack of a significant role for credit or cash-flow measures, with one exception. Because consumers are not Ricardian, an increase in interest payments on the government debt raises aggregate demand, holding constant the level of income originating in the private sector. Depending on the ratio of debt to GDP, the positive response of household spending to

2 Although the real exchange rate would be expected to appreciate with a rise in domestic real interest rates, one of the scenarios simulated below - that for an exogenous nominal exchange rate - will show a real depreciation of the US dollar. In this somewhat unrealistic scenario of raising the funds rate and pegging the nominal exchange rate, the resulting depreciation of the real exchange rate could conceivably be large enough at some point in time to offset the negative real interest elasticity of aggregate output.

higher government interest payments potentially could offset over some period the negative interest-elasticity of demand through other channels.[3]

In the short run, wage and price inflation are governed by deviations between aggregate supply and aggregate demand, as measured by the unemployment rate. A given level of the unemployment rate - sustained over time at any rate other than the natural rate - causes the rate of inflation to change monotonically. The inflation dynamics of the model can be illustrated through a simplified version of the model wage and price sector, with lags in the wage equation collapsed into one-period lags and lags in the price equation eliminated. Let w be the wage rate, p the price level, u the unemployment rate, and ρ the level of trend labor productivity. Other determinants of wages and prices are subsumed in the "constants" x and z. The MPS wage equation is

$$\Delta \log w = \alpha \, \Delta \log p_{-1} - \beta u + x \tag{1}$$

and the price equation, representing the mark-up of prices over unit labor costs (and incorporating the determinants of the mark-up into z) is

$$\log p = \log w - \log \rho + z. \tag{2}$$

Differencing the price equation and substituting for $\Delta \log w$ with equation (1) produces the following equation for the evolution of inflation rates:

$$\Delta \log p = \alpha \, \Delta \log p_{-1} - \beta u + (x - \Delta \log \rho). \tag{3}$$

Equations (1) and (3) highlight the importance of the coefficient on lagged inflation in the wage equation, α, for the inflation dynamics of the model. In the MPS model, α is 1.0 and changes in the rate of goods inflation pass through fully to wage inflation. As a result, any sustained displacement of the unemployment rate from baseline (assuming no offsetting changes in the natural unemployment rate) sets off a continuous sequence of price acceleration or deceleration.[4]

IV. SIMULATION RESULTS: THE FULL MODEL

Tables I and II present the results of simulating the full model for a temporary positive shock to the federal funds rate and under two different assumptions about the exchange rate. In Tables I.1-III.1 the nominal exchange rate is exogenous. In Tables I.2-III.2 the real exchange rate is determined endogenously under the assumption of open interest parity.

Common features of both simulations include a progressively larger shortfall in the inflation rate and, for most of the simulation horizon, a progressively larger contraction in real GDP and the unemployment rate, all measured relative to baseline. By the fifth year of the simulation, real

3 An increase in interest income received by households from the private business sector does not have the same impact on demand as an increase in government interest income. This is because, for a given level of production, an increase in private source interest income is viewed as being offset by a reduction in dividends and capital gains income. And marginal propensities to consume out of interest income and dividends and capital gains are all the same in the MPS model.

4 The term in parentheses in equation (3) equals β* natural unemployment rate. Thus, for α equal to 1.0, the inflation rate stabilizes only when the unemployment rate is at the natural rate.

GDP is down by 1.1% when the exchange rate is exogenous and by 2.1% when the exchange rate is endogenous. Both nominal and real long-term interest rates are above baseline through the simulation horizon, even though the short-term nominal rate is back at baseline in the third year. Nominal long rates exceed baseline for some time because they are modeled as long distributed lags on nominal short rates. Real long rates remain high, owing both to the elevated nominal rate and the depressed rate of inflation. With a fixed nominal exchange rate, the real exchange rate is down 1.0% by the end of the simulation, boosting net exports but not by enough to reverse the contraction of aggregate output. With the exchange rate determined by an open interest parity condition, a substantial real appreciation of the dollar occurs, augmenting the contraction in domestic absorption.

Several factors interrupt the monotonicity of these results, so that the path of output looks like it ultimately returns to baseline, at least when the exchange rate is exogenous. But the long-run properties of the model are such that output never returns to baseline and instead moves farther away over time. A major part of the explanation for this behavior is attributable to the vertical long-run Phillips curve, described in the preceding section. The other property of the model responsible for these dynamics is that aggregate demand responds to the real interest rate rather than to the nominal rate.

The dynamics behind the "explosive" behavior can be illustrated more easily by stripping out the complexity of the MPS model and preserving the essential properties in a simple vector autoregression (VAR). Two equations are necessary: one for the rate of inflation, and another for the output gap. The inflation equation can be interpreted as a reduced form of the wage and price sector, as in equation (3), where the deviation of the unemployment rate from the natural rate is proxied for by the output gap. The gap equation summarizes the model's IS curve.[5] Each equation is estimated including four lags of the output gap, the inflation rate, the nominal short-term interest rate and a constant.[6] The two equations are simulated assuming that the nominal rate of interest is increased by 1.0 percentage point for two years and returned to baseline thereafter.

Simulations based on two different versions of the VAR are shown in Figure 1, with the estimated equations reproduced in Table 1. In the first version, the inflation equation has an unrestricted sum of coefficients on lagged inflation of 0.88. The simulation shows that were the nominal interest rate to be returned to baseline, the output gap and the inflation rate ultimately would return to baseline.[7] In the second version, the sum of coefficients on lagged inflation in the inflation equation is constrained to 1.0, a restriction that cannot be rejected. In this case, despite a transitory movement of the output gap back to baseline, both the gap and the rate of inflation ultimately explode.

The intuition behind the two scenarios is as follows. An increase in the nominal interest rate raises the real interest rate initially by the same magnitude, causing output to decline and the unemployment rate to rise. With a coefficient of 1.0 on lagged inflation in the inflation equation, a rise in the unemployment rate (or output gap) *invariably* causes wages and prices to decelerate. By contrast, when the coefficient is less than 1.0, a rise in the unemployment rate may not be sufficient to continuously push the inflation rate lower. In the first case, the fall in the inflation rate pushes real interest rates up even further, setting off another contraction in both output and the rate of inflation.

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5 Unlike the MPS model's IS curve, the VAR equation for the output gap does not impose the restriction that the coefficient on the nominal interest rate equal the negative of the coefficient on the inflation rate. As long as aggregate demand responds negatively to the nominal rate of interest and positively to the rate of inflation, the unstable dynamic behavior described in the text will occur.

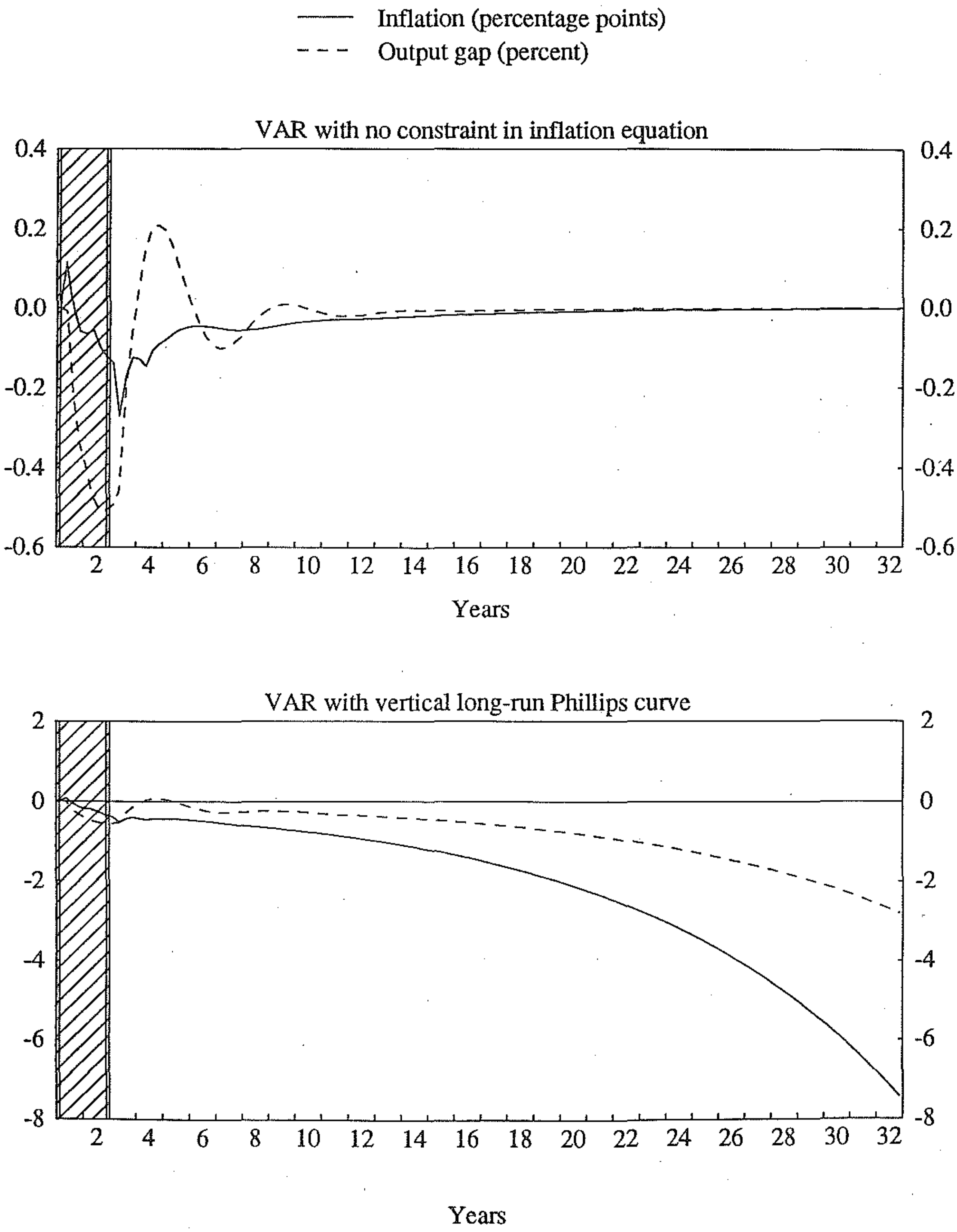
6 A third equation, for the nominal rate of interest, is irrelevant because the interest rate is exogenized for the simulation.

7 The speed with which the baseline is restored depends, among other things, on the coefficient of the lagged output gap in the equation for the output gap. Freely estimated, this coefficient indicates a high degree of persistence in the output gap. Purely for illustrative purposes, the coefficient on the lagged output gap was constrained in such a way as to reduce the implied persistence and the equation was re-estimated subject to this constraint.

Figure 1

Response of inflation and output gap to an increase in the nominal interest rate

(deviation from baseline)



Note: The shaded area marks the two-year period over which the nominal interest rate is 1.0 percentage point above baseline.

This cycle is repeated over and over.[8] In fact, as is clear by referring back to equation (3), in theory when the coefficient is 1.0, the *absolute change* in the inflation rate gets bigger over time because the unemployment rate is also growing.[9]

Table 1

VAR estimates

$$Z = \alpha + A(L)\pi + B(L)R + C(L)Y$$

(coefficients and T-statistics)

Dependent variable	A(L)	B(L)	C(L)	R^2	S.E.
Y	0.078 (1.46)	- 0.056 (- 1.67)	0.8 (constrained)	0.89	0.95
π	0.883 (12.53)	0.009 (0.22)	0.135 (3.00)	0.75	1.25
π	1.00 (constrained)	- 0.043 (- 1.46)	0.128 (2.83)	0.75	1.25

π = 100* annualized change in the log of the NIPA consumption deflator.
R = nominal effective rate on federal funds.
Y = log of per capita non-farm business output, detrended using a split time trend (with split occurring in 1973 Q1).

This description also suggests why a return of the nominal rate to baseline is insufficient to break the cycle. As long as the output gap is above baseline, the inflation rate will continue to fall. To break the free-fall in inflation and output, at a minimum the real interest rate must be brought back to baseline. But, because the inflation rate is below baseline, this requires a nominal rate below baseline. When the real rate is returned to baseline, inflation stabilizes at a rate below baseline. If the real rate, as well as the nominal rate, is brought below baseline, output and the rate of inflation start moving back toward baseline. At some point, holding the real rate below baseline will restore the inflation rate to its baseline.

Given the assumption that real, rather than nominal, rates determine demand, the issue of output and inflation stability under pegged nominal interest rates hangs entirely on the coefficient of lagged inflation in the inflation equation or, alternatively, the coefficient of lagged inflation in the

8 In the full model simulation with the exchange rate exogenous, the deviation of output relative to baseline appears to shrink a bit in the fifth year. This temporary reversal in the contraction of output can stem from several factors. First, when the nominal funds rate is returned to baseline after two years, deviations from baseline in the real short-term rate and the real long-term rate decline temporarily. For instance, in Table I.1, the real rate of return on equity (reported under the heading "Real long-term interest rate") stabilizes relative to baseline between years four and five, while the costs of capital for equipment, non-residential structures and housing temporarily move back toward baseline after the third year of the simulation. This pattern shows up in the VAR simulation also. As noted in the text, the output gap in the VAR with the vertical long-run Phillips curve temporarily reverts to baseline around year five. Another reason for the lull in the contraction of output in the model simulation is that not all of the model's exogenous output and price variables have been indexed to the endogenously-determined measures of output and prices. For instance, the dollar price per barrel of oil is held fixed at baseline values, not a realistic assumption over a long simulation horizon. As a result, these exogenous variables act as "automatic stabilizers".

9 The dynamics are more complicated when the price mark-up is a function of the unemployment rate, as it is in the MPS model. The change in the rate of inflation is then negatively correlated with the rate of growth of the unemployment rate. This "speed" effect can add substantially to the degree to which prices decelerate over some period.

wage equation.[10] Although the earliest version of the MPS model (in the late 1960s) did not impose this property on the wage equation, model specifications of the past twenty years have had a long-run vertical Phillips curve. The econometric evidence in favor of a vertical long-run curve for the United States is fairly strong. Freely estimated, wage equations generally show point estimates for the (sum of the) coefficients on lagged inflation rates that are slightly less than 1.0, but not statistically different from 1.0. When the MPS wage equation is re-estimated with no constraint on the lagged inflation terms, the point estimate is 1.048 (even greater than 1.0) with a standard error of 0.11. Similarly, in the VAR equation for the inflation rate, the point estimate on lagged inflation is 0.88 and the standard error is 0.073, suggesting that a coefficient of 1.0 cannot be rejected at standard significance levels.[11] Additional evidence consistent with a coefficient of 1.0 on lagged inflation is found in several papers which argue for the presence of a "unit root" in the inflation process in the United States.[12]

V. SIMULATION RESULTS: DECOMPOSITION BY TRANSMISSION CHANNEL

The MPS model identifies four separate channels through which changes to interest rates are transmitted to demand: wealth effects on consumption; cost of capital effects on investment; exchange rate effects on net exports; and interest payments by the government on consumption. Depending on the specification of monetary policy, a disturbance to any one of these channels produces a particular sequence of feedbacks to the rest of the economy. As indicated earlier, when monetary policy is assumed to target a nominal interest rate, the feedbacks to US inflation and real interest rates are very striking. And because all the transmission channels depend on real interest rates, a disturbance originating in one channel will have feedbacks to the other channels. Thus, the net effect on output of a disturbance in any one channel will reflect both the initial disturbance to that channel and the broader impacts as secondary shocks hit the other channels.

This section decomposes the net change in output that follows a temporary rise in the federal funds rate into the contributions made by the various transmission channels. Tables III.1 and III.2 present the decompositions. The allocation to a particular transmission channel includes the channel's direct and indirect effects on output. The latter measures the degree to which a disturbance to one channel (that is, the direct effect) sets off other channels and thereby further affects output. As noted above, the sensitivity of one channel to another channel can be large in the MPS model because inflation and real interest rate movements are not very subtle when the nominal interest rate is targeted, especially after the first few years of a simulation. To identify the initial disturbance, the shock to the *nominal* federal funds rate is "recognized" only in one channel at a time. For example, when quantifying the importance of the exchange rate channel, the change to the nominal funds rate passes through to other short-term and long-term nominal rates, as specified by the model's interest rate arbitrage and term structure equations. And the change in the long-term interest rate induces a change in the exchange rate consistent with the open interest parity condition. However, only in the trade sector is this sequence of changes to nominal interest rates allowed to play out. Elsewhere,

10 If the output gap depended on nominal, not real, rates, then the return to baseline of the nominal rate would cause the gap to return to baseline. But, with a long-run vertical Phillips curve, the inflation rate would still stabilize at a rate below baseline if the nominal rate had been pegged above baseline for an extended period.

11 The wage equation was estimated over the period 1963-89, and the VAR inflation equation was estimated over 1957-93.

12 The common finding is that, at least for the period after 1960, the hypothesis of a unit root in US inflation rates cannot be rejected. See, for instance, Allan D. Brunner and Gregory D. Hess: "Are higher levels of inflation less predictable: a state-dependent conditional heteroscedasticity approach", *Journal of Business and Economic Statistics*, April 1993, Vol. 11, 2, pp. 187-197. Also, Robert B. Barsky: "The Fisher hypothesis and the forecastability and persistence of inflation", *Journal of Monetary Economics*, January 1987, Vol. 19, 1, pp. 3-23.

short-term and long-term *nominal* rates are held at baseline.[13] However, because the change in the exchange rate alters the rate of inflation, *real* interest rates change everywhere, triggering the other transmission channels. In this accounting, the effect of the latter on output is allocated to the exchange rate channel.[14]

1. Nominal exchange rate exogenous

The contribution to output change is largest for disturbances originating with the *cost of capital*.[15] This channel dominates the other channels throughout the five years of the simulation horizon. The shock to the nominal interest rate, along with the decline this induces in inflation, has sizable impacts on the cost of capital. For long-lived assets, such as business structures and housing, costs of capital rise by 4.5% and 7.5% respectively by the fifth year. Changes to the costs of capital for shorter-lived assets, such as equipment and consumer durables, are more moderate (up by 2.5% by the end of the simulation). The dynamic response of investment to changes in the cost of capital depends both on the underlying production function in which the capital is used and on whether or not capital-labor ratios on capital already in place can be altered. For all assets other than equipment, factor proportions are assumed to be variable even after installation. Thus, a given change to the cost of capital causes a change in investment that is larger in the short run than in the long run. The repercussion from this channel to the other channels is sizable. Although not shown in Table III.1, the nominal interest rate shock that occurs in the cost of capital channel lowers prices by an amount sufficient to induce a 1.0% real depreciation of the dollar and a 4.0% decline in equity prices.

Comparing the other two channels, the *income/cash flow* channel is larger over the first two years of the simulation and the wealth channel is larger over the final three years. Given past levels of output, changes to income and cash flow have only a limited influence on aggregate demand. The only significant independent role for either is the *positive* relationship between household receipt of government interest payments and household consumption.

Because the Federal Government is not forced to balance its budget, a rise in real interest payments on federal government debt stimulates consumption as long as expected disposable income is not revised down by the (present value of) future tax liabilities associated with these interest payments. With federal government debt of $3.4 trillion, a percentage point increase in the average interest rate paid on government debt raises personal income by $34 billion (0.6%), boosting real consumption by about 0.3% and real GDP by about 0.2%.[16] State and local governments face tighter budget balance requirements than does the Federal Government. MPS model estimates suggest that about 90% of any increase in interest payments by state and local government is offset within three

13 The resulting changes to the rate of inflation cause small changes to some nominal rates outside the specific channel being studied, even assuming that nominal short-term rates are held at baseline values in the other channels. This is because equations for some long-term rates include the rate of inflation among the determinants. However, the sums of the distributed lag coefficients on inflation rates are always constrained to zero, so the impact of inflation on nominal rates is transitory for all channels.

14 An alternative method of decomposing the transmission channels is provided in "The transmission channels of monetary policy: how have they changed?" in the *Federal Reserve Bulletin*, December 1990. This alternative method exogenizes wages and prices and all sectors and transmission channels other than the one being examined. Thus, there is no multiplier action in the simulation. Because of the significant changes in inflation under the assumption on nominal interest rate targeting, this alternative method provides a clearer picture of the relative importance of the different transmission channels. Nevertheless, when this alternative method was applied at an earlier stage in preparing this paper, the relative contributions of the different transmission channels were broadly similar to those indicated by the current decomposition procedure.

15 The cost of capital effect is defined broadly here and includes both the effect on investment in business plant and equipment and investment in consumer durables. Although figures for the latter are included in the heading "direct interest rate effects on consumption", all text references to the cost of capital are to the broader concept.

16 The increase in personal income of $34 billion assumes that government debt is held entirely by households. Obviously some is held by business and some by foreigners.

years by increased state and local government taxes. All told, the quantitative significance of this channel as a means of diffusing interest rate changes to the real economy is small in the United States. Moreover, the existence of this channel depends on households displaying non-Ricardian behavior. Up to now, explicit attempts to test for the presence of Ricardian-equivalence have failed to uncover such "forward-looking" behavior by consumers. However, it may be that the apparent shortsightedness on the part of households stems from the small percentage of personal income accounted for by interest payments on the federal government debt. Were government debt to grow (say, as a percentage of GDP), the behavior of consumers could change markedly so that a rise in government interest payments - rather than raising consumption - might ultimately be neutral with respect to aggregate consumption.

The *wealth* channel starts off slowly but builds up over time. As real rates of return on long-term bonds rise, the price of equity falls and depresses consumption. The transmission from a higher funds rate to lower consumption takes a while: nominal long-term bond yields are modeled as eighteen-quarter distributed lags on short-term rates; the nominal return on debt is translated to an expected real return on debt by subtracting a seven-year distributed lag on past values of inflation; and consumption responds over six quarters to changes in wealth. Unlike the overshooting in the cost of capital channel, the wealth channel grows over time. Although, in theory, the value of all assets should change with a change in real interest rates, the current version of the MPS model only recapitalizes the value of equity when rates change. Other assets are measured at book value or are modeled as moving with output price indices. Thus, the model may underestimate the sensitivity of consumption to changes in wealth. This is less likely to be true if the covariance is high between stock market wealth and the true values of other components of wealth. In that case, the estimated propensity to consume out of stock market wealth may be biased upward, compensating for the mismeasurement of the interest rate sensitivity of wealth.

By component of final demand, private investment accounts for the largest contribution to the decline in aggregate output. Its contribution is significantly larger than that of consumption, suggesting that the difference between the interest elasticities of these two components is substantially larger than the difference in the relative sizes of these two sectors.[17] In part, this reflects the offsetting effects on consumption of a negative influence from the drop in wealth and a positive influence from the increase in government interest payments. The decline in production is not as large as the decline in final demand because imports also fall, mainly due to a high estimate of the income-elasticity of imports (around 1.7) but also because there is a real depreciation of the dollar (due to the combination of an exogenously fixed nominal exchange rate and a decline in domestic prices).

2. Nominal exchange rate endogenous

When the exchange rate is endogenously determined, the response of aggregate GDP to a nominal interest rate shock is magnified. In addition to being an important source for transmitting interest rate shocks to the real economy, the endogeneity of the exchange rate also raises the contributions of the other transmission channels to GDP change. This can be seen by comparing Table III.1 to Table III.2 for a given channel.

An upward disturbance to the funds rate causes a real appreciation of the US dollar in line with the open interest parity condition. The appreciation is large: 0.7% in the first year, climbing to 6.6% in the fifth year as the downward pressure on inflation builds (figures not shown in Table III.2). Despite the sizable appreciation, the effects on output are slow in coming, both because import prices adjust only gradually to exchange rate changes and because the volume of imports and exports responds with a lag to changes in the terms of trade. Nevertheless, by the fourth and fifth years of the simulation, the higher exchange value of the dollar shaves 0.6% and 1.0% respectively off

17 That is, the ratio of the interest-elasticity of investment relative to the interest-elasticity of consumption is greater than the ratio of consumption to investment.

the level of GDP. In addition, for a given impact on GDP, the response of prices (especially consumption prices) is greater for this channel than for other channels because the price mark-up is sensitive to the degree of competition from foreign goods. In importance, the exchange rate channel lags behind the wealth and cost of capital channels until the fifth year of the simulation, although part of its apparent "slow-start" is due to a specification of the interest parity condition in which the response of the exchange rate to interest rates is gradual.

By sector, private investment remains the largest contributor to aggregate GDP change. By the fifth year of the simulation, the decline in investment shaves 1.4% off GDP when the exchange rate is endogenous, up from 1.0% when the exchange rate is exogenous. The contribution of consumption is the same as when the exchange rate is fixed. Finally, by contrast with the earlier decomposition, net exports contribute an additional 0.14% to the contraction in real GDP in year five. The real appreciation of the dollar is quite costly to exports and limits the drop in imports that would otherwise occur with the weakening economy.

VI. CONCLUSION

Simulations with the MPS model indicate that monetary policy exerts a powerful influence on output in the medium run through changes to interest rates. These effects are especially large, even destabilizing, if monetary policy attempts to target the nominal interest rate over an extended period. In this case, a given change to the nominal rate metastasizes into bigger and bigger changes to the real rate.

In the MPS model, consumption and investment decisions are much more dependent on long-term interest rates than they are on short-term rates. Thus, to a large extent, the efficacy of the monetary transmission mechanism, and the accuracy of the story told by these simulations, rests on the degree to which changes made to the nominal federal funds rate are reflected in predictable changes to long-term interest rates and asset prices. Implicit in model equations for interest rates and asset prices is an assumption that rational investors will take advantage of arbitrage opportunities between assets so that expected rates of return on all assets are equalized over common holding periods. Unfortunately, the historical fit of the long-term asset equations is not particularly good. The equation for the rate of return on equity shows sizable serial correlation in the errors: from 1973 through 1983, the stock market appeared to be greatly undervalued compared to the bond market. In recent years, the stock market has appeared overvalued relative to its fundamentals. The open interest parity condition used to determine the real exchange rate does a poor job of tracking actual changes to the exchange rate. Errors are very large and are serially correlated. Even when the open interest parity condition is modified to allow a gradual response of exchange rates to interest rate differentials - a concept inconsistent with the belief that exchange markets are efficient - the fit is not impressive. Finally, the model's equation for the nominal yield on long-term corporate bonds has deteriorated sharply over the past year, with rates in 1994 Q3 some 240 basis points above the level predicted by the model equation. Until recently, this equation had a good track record.

A final qualification that should be made to the picture presented above of the monetary transmission mechanism is that it ignores the emerging micro evidence which suggests that the transmission mechanism is not symmetric across stages of a business cycle.[18] Such evidence argues that imperfections in capital markets will cause spending decisions to be more sensitive to cyclical fluctuations than indicated by models that assume perfect capital markets. For instance, cross section studies of investment, inventory and consumption behavior reveal that changes in either current earnings or income have much larger effects than are consistent with neoclassical investment and

18 See, for instance, Mark Gertler and Simon Gilchrist: "Monetary policy, business cycles and the behavior of small manufacturing firms", in *Quarterly Journal of Economics*, May 1994, Volume CIX, pp. 309-340. Also, Ben Bernanke, Mark Gertler and Simon Gilchrist: "The financial accelerator and the flight to quality", forthcoming in *Review of Economics and Statistics*.

life-cycle consumption models. Similarly, research using time-series data disaggregated by type of borrower or size of firm finds that small firms do not have the access to debt that large firms do when faced with adverse income shocks. As a consequence, their spending and output fall more sharply than those of less constrained firms, and their investment and inventory behavior is more sensitive to their balance sheets.

Table A

Baseline values of selected exogenous variables

	1993	1994	1995	1996	1997	1998
1. Foreign interest rates (%)						
Foreign long-term real interest rate, G-10	3.44	4.34	4.64	3.92	3.36	2.89
2. Oil prices and other commodity prices						
Average price per barrel of imported oil (US$)	15.70	14.64	15.94	16.00	16.00	16.00
3. Foreign prices						
G-10 CPI (index)	148.80	151.60	154.80	158.30	161.80	165.50
(Growth rate in parentheses)		(1.90)	(2.10)	(2.20)	(2.20)	(2.30)
4. Foreign output						
World output, index	144.50	149.30	154.50	160.60	166.70	172.50
(Growth rate in parentheses)		(3.30)	(3.40)	(3.90)	(3.80)	(3.40)

Table I.1

Interest rates, exchange rates and asset prices

Policy experiment: Temporary interest rate increase (exchange rates exogenous)

Deviations from baseline*	1994	1995	1996	1997	1998
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Representative short-term interest rate	0.86	0.85	0.00	0.00	0.00
Representative long-term interest rate	0.19	0.47	0.43	0.42	0.28
3. Other interest rates (%)					
Mortgage rate	0.30	0.58	0.44	0.40	0.27
Deposit rate	0.49	0.58	0.15	0.11	0.08
4. Real interest rates					
Real short-term interest rate (%)	1.01	1.07	0.23	0.44	0.59
Real long-term interest rate (%)	0.14	0.43	0.54	0.60	0.61
User cost of capital					
Equipment	0.81	2.37	2.93	3.14	3.04
Non-residential structure	1.00	3.41	4.45	3.99	4.06
Housing	3.29	6.36	5.96	7.39	8.46
Consumer durables excluding cars	0.52	1.68	2.30	2.72	2.83
5. Exchange rates					
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	- 0.01	- 0.06	- 0.24	- 0.57	- 0.96
6. Asset prices and wealth					
Stock prices	- 1.45	- 5.73	- 9.02	- 9.28	- 9.49
7. Monetary aggregate					
M_2	- 0.81	- 1.64	- 1.73	- 1.89	- 2.60

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table I.2

Interest rates, exchange rates and asset prices

Policy experiment: Temporary interest rate shock
(exchange rates endogenous with no reaction in foreign interest rates)

Deviations from baseline*	1994	1995	1996	1997	1998
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market-determined interest rates (%)					
Representative short-term interest rate	0.86	0.85	0.00	0.00	0.00
Representative long-term interest rate	0.19	0.47	0.43	0.41	0.27
3. Other interest rates (%)					
Mortgage rate	0.30	0.58	0.43	0.39	0.26
Deposit rate	0.49	0.58	0.15	0.11	0.08
4. Real interest rates					
Real short-term interest rate (%)	1.03	1.21	0.52	0.93	1.40
Real long-term interest rate (%)	0.15	0.46	0.63	0.79	0.98
User cost of capital					
Equipment	0.82	2.46	3.19	3.85	4.32
Non-residential structure	0.99	3.44	4.64	4.57	5.39
Housing	3.31	6.52	6.66	9.38	12.81
Consumer durables excluding cars	0.57	1.93	2.94	4.01	5.02
5. Exchange rates					
Nominal effective exchange rate	0.73	2.95	5.56	8.74	13.10
Real effective exchange rate	0.69	2.71	4.77	6.95	9.72
6. Asset prices and wealth					
Stock prices	- 1.50	- 6.06	- 10.02	- 11.22	- 12.99
7. Monetary aggregate					
M_2	- 0.82	- 1.72	- 2.04	- 2.76	- 4.46

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.1

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary interest rate increase (exchange rates exogenous)

Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.07	- 0.45	- 0.99	- 1.26	- 1.10
Private consumption	- 0.01	- 0.27	- 0.75	- 1.01	- 0.88
Government expenditure	0.01	0.03	0.01	- 0.07	- 0.13
Private investment	- 0.46	- 2.28	- 4.45	- 5.48	- 5.09
Residential private investment	- 0.99	- 3.75	- 5.57	- 6.06	- 5.95
Non-residential private investment	- 0.18	- 1.24	- 3.18	- 4.64	- 4.71
Inventories	- 2.41	- 18.39	- 37.44	- 28.99	- 9.65
Exports	- 0.01	- 0.07	- 0.19	- 0.23	- 0.09
Imports	- 0.12	- 0.97	- 2.25	- 2.92	- 2.76
2. Unemployment rate (%)	0.02	0.15	0.39	0.54	0.49
3. Real disposable income	0.13	0.04	- 0.33	- 0.53	- 0.45
4. Inflation and wages					
GDP deflator	0.00	- 0.03	- 0.26	- 0.77	- 1.49
Consumer prices	0.00	- 0.05	- 0.25	- 0.67	- 1.25
Wages/earnings	- 0.01	- 0.10	- 0.43	- 1.10	- 1.97
Unit labour cost	0.03	0.07	- 0.21	- 0.95	- 1.93
Import prices	0.00	- 0.01	- 0.05	- 0.14	- 0.32
5. Government accounts (% of nominal GDP)					
Revenues	0.03	0.05	0.01	- 0.03	- 0.01
Primary expenditures	0.01	0.10	0.23	0.32	0.33
Interest payments	0.13	0.29	0.28	0.28	0.30
Government budget balance	- 0.14	- 0.43	- 0.65	- 0.82	- 0.82
Public sector debt	0.09	0.54	1.36	2.31	3.20
6. Current account (% of nominal GDP)	0.01	0.10	0.22	0.25	0.19
Trade balance	0.01	0.11	0.23	0.26	0.19
Net interest payments abroad	0.00	0.00	0.00	0.00	0.01

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table II.2

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary interest rate shock
(exchange rates endogenous with no reaction in foreign interest rates)

Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.07	- 0.50	- 1.21	- 1.80	- 2.09
Private consumption	0.00	- 0.22	- 0.67	- 0.94	- 0.83
Government expenditure	0.01	0.05	0.04	- 0.03	- 0.07
Private investment	- 0.47	- 2.34	- 4.79	- 6.57	- 7.38
Residential private investment	- 0.98	- 3.64	- 5.31	- 6.12	- 7.01
Non-residential private investment	- 0.18	- 1.33	- 3.59	- 5.77	- 6.92
Inventories	- 2.48	- 19.21	- 41.64	- 39.85	- 27.99
Exports	- 0.02	- 0.29	- 1.06	- 1.99	- 2.82
Imports	- 0.07	- 0.65	- 1.55	- 1.99	- 1.63
2. Unemployment rate (%)	0.02	0.17	0.47	0.76	0.91
3. Real disposable income	0.15	0.10	- 0.25	- 0.49	- 0.48
4. Inflation and wages					
GDP deflator	0.00	- 0.09	- 0.45	- 1.24	- 2.51
Consumer prices	- 0.03	- 0.21	- 0.68	- 1.56	- 2.90
Wages/earnings	- 0.01	- 0.16	- 0.69	- 1.78	- 3.42
Unit labour cost	0.03	0.03	- 0.40	- 1.52	- 3.22
Import prices	- 0.23	- 1.12	- 2.49	- 4.17	- 6.42
5. Government accounts (% of nominal GDP)					
Revenues	0.03	0.05	0.00	- 0.03	- 0.02
Primary expenditures	0.01	0.10	0.26	0.41	0.51
Interest payments	0.13	0.29	0.29	0.32	0.38
Government budget balance	- 0.14	- 0.44	- 0.71	- 0.98	- 1.15
Public sector debt	0.09	0.60	1.61	2.99	4.66
6. Current account (% of nominal GDP)	0.02	0.12	0.21	0.19	0.08
Trade balance	0.02	0.13	0.22	0.21	0.11
Net interest payments abroad	0.00	0.00	0.00	0.00	- 0.01

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (%).

Table III.1

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary interest rate shock (exchange rates exogenous)

	Total	**Income/ cash flow**	**Wealth**	**Direct interest rate effect on consumption[2]**	**Cost of capital[3]**	**Discrepancy[4]**
Real GDP: first year after shock[1]	**- 0.07**	**0.06**	**- 0.01**	**- 0.03**	**- 0.07**	**- 0.02**
of which:						
Private consumption	0.00	0.05	- 0.01	- 0.03	- 0.01	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.08	0.02	0.00	- 0.02	- 0.07	- 0.01
Residential private investment	*- 0.04*	*0.00*	*0.00*	*0.00*	*- 0.05*	*0.01*
Non-residential private investment	*- 0.02*	*0.01*	*0.00*	*- 0.01*	*- 0.02*	*0.00*
Inventories	*- 0.02*	*0.01*	*0.00*	*- 0.01*	*0.00*	*- 0.02*
Exports	0.00	0.00	0.00	0.00	0.00	0.00
Imports	- 0.02	0.02	0.00	- 0.01	- 0.02	- 0.01
Real GDP: second year after shock[1]	**- 0.45**	**0.19**	**- 0.14**	**- 0.15**	**- 0.29**	**- 0.06**
of which:						
Private consumption	- 0.18	0.14	- 0.12	- 0.11	- 0.06	- 0.03
Government expenditure	0.01	0.01	0.00	0.00	0.00	0.00
Private investment	- 0.41	0.09	- 0.06	- 0.07	- 0.32	- 0.05
Residential private investment	*- 0.16*	*0.03*	*- 0.02*	*0.00*	*- 0.16*	*- 0.01*
Non-residential private investment	*- 0.16*	*0.04*	*- 0.03*	*- 0.03*	*- 0.14*	*0.00*
Inventories	*- 0.09*	*0.02*	*- 0.01*	*- 0.04*	*- 0.02*	*- 0.04*
Exports	- 0.01	0.00	0.00	0.00	- 0.01	0.00
Imports	- 0.14	0.06	- 0.05	- 0.05	- 0.09	- 0.01
Real GDP: third year after shock[1]	**- 0.99**	**0.26**	**- 0.42**	**- 0.22**	**- 0.54**	**- 0.07**
of which:						
Private consumption	- 0.50	0.18	- 0.33	- 0.17	- 0.14	- 0.04
Government expenditure	0.00	0.02	0.00	0.00	- 0.01	0.01
Private investment	- 0.80	0.14	- 0.22	- 0.12	- 0.58	- 0.02
Residential private investment	*- 0.23*	*0.05*	*- 0.07*	*- 0.02*	*- 0.19*	*0.00*
Non-residential private investment	*- 0.43*	*0.07*	*- 0.10*	*- 0.06*	*- 0.33*	*- 0.01*
Inventories	*- 0.14*	*0.02*	*- 0.05*	*- 0.04*	*- 0.06*	*- 0.01*
Exports	- 0.03	0.00	- 0.01	0.00	- 0.01	- 0.01
Imports	- 0.35	0.09	- 0.15	- 0.08	- 0.19	- 0.03

Table III.1 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary interest rate shock (exchange rates exogenous)	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption[2]	Cost of capital[3]	Discrepancy[4]
Real GDP: fourth year after shock[1]	**- 1.26**	**0.25**	**- 0.63**	**- 0.17**	**- 0.65**	**- 0.06**
of which:						
Private consumption	- 0.68	0.18	- 0.47	- 0.14	- 0.21	- 0.04
Government expenditure	- 0.01	0.02	- 0.01	- 0.01	- 0.01	0.00
Private investment	- 1.01	0.14	- 0.38	- 0.10	- 0.68	0.01
Residential private investment	*- 0.26*	*0.06*	*- 0.13*	*- 0.04*	*- 0.14*	*- 0.01*
Non-residential private investment	*- 0.64*	*0.07*	*- 0.18*	*- 0.06*	*- 0.47*	*0.00*
Inventories	*- 0.11*	*0.01*	*- 0.07*	*0.00*	*- 0.07*	*0.02*
Exports	- 0.03	0.00	- 0.01	0.00	0.00	- 0.02
Imports	- 0.48	0.10	- 0.24	- 0.07	- 0.25	- 0.02
Real GDP: final year after shock[1]	**- 1.10**	**0.20**	**- 0.58**	**- 0.04**	**- 0.63**	**- 0.05**
of which:						
Private consumption	- 0.59	0.17	- 0.44	- 0.05	- 0.23	- 0.04
Government expenditure	- 0.02	0.01	- 0.01	0.00	- 0.02	0.00
Private investment	- 0.95	0.13	- 0.38	- 0.03	- 0.68	0.01
Residential private investment	*- 0.25*	*0.06*	*- 0.15*	*- 0.04*	*- 0.12*	*0.00*
Non-residential private investment	*- 0.66*	*0.06*	*- 0.19*	*- 0.02*	*- 0.51*	*0.00*
Inventories	*- 0.04*	*0.01*	*- 0.04*	*0.03*	*- 0.05*	*0.01*
Exports	- 0.01	- 0.01	0.01	0.01	0.02	- 0.04
Imports	- 0.47	0.10	- 0.25	- 0.03	- 0.29	- 0.02

[1] In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect. [2] This is the cost-of-capital effect on consumer durables spending. [3] This is the cost-of-capital effect on business investment. [4] Due to interaction between the different channels.

Table III.2

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary interest rate shock
(exchange rates endogenous with no reaction in foreign interest rates)

	Total	Income/ cash flow	Wealth	Direct interest rate effect on con-sumption[2]	Cost of capital[3]	Exchange rate	Discre-pancy[4]
Real GDP: first year after shock[1]	**- 0.07**	**0.06**	**- 0.01**	**- 0.03**	**- 0.06**	**- 0.01**	**- 0.02**
of which:							
Private consumption	0.00	0.05	- 0.01	- 0.03	- 0.01	0.01	- 0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.08	0.02	0.00	- 0.02	- 0.07	0.00	- 0.01
Residential private investment	*- 0.04*	*0.00*	*0.00*	*0.00*	*- 0.05*	*0.00*	*0.01*
Non-residential private investment	*- 0.02*	*0.01*	*0.00*	*- 0.01*	*- 0.02*	*0.00*	*0.00*
Inventories	*- 0.02*	*0.01*	*0.00*	*- 0.01*	*0.00*	*0.00*	*- 0.02*
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	- 0.01	0.02	0.00	- 0.01	- 0.02	0.01	- 0.01
Real GDP: second year after shock[1]	**- 0.50**	**0.18**	**- 0.14**	**- 0.14**	**- 0.29**	**- 0.06**	**- 0.05**
of which:							
Private consumption	- 0.15	0.14	- 0.12	- 0.11	- 0.06	0.03	0.03
Government expenditure	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.42	0.09	- 0.06	- 0.07	- 0.32	- 0.01	- 0.05
Residential private investment	*- 0.15*	*0.03*	*- 0.02*	*0.00*	*- 0.16*	*0.00*	*0.00*
Non-residential private investment	*- 0.18*	*0.04*	*- 0.03*	*- 0.03*	*- 0.14*	*- 0.01*	*- 0.01*
Inventories	*- 0.09*	*0.02*	*- 0.01*	*- 0.04*	*- 0.02*	*0.00*	*- 0.04*
Exports	- 0.04	0.00	0.00	0.00	0.00	- 0.04	0.00
Imports	- 0.10	0.06	- 0.04	- 0.05	- 0.09	0.04	- 0.02
Real GDP: third year after shock[1]	**- 1.21**	**0.26**	**- 0.41**	**- 0.22**	**- 0.54**	**- 0.26**	**- 0.04**
of which:							
Private consumption	- 0.45	0.18	- 0.33	- 0.16	- 0.14	0.04	- 0.04
Government expenditure	0.01	0.02	0.00	0.00	- 0.01	0.00	0.00
Private investment	- 0.87	0.14	- 0.22	- 0.12	- 0.58	- 0.08	- 0.01
Residential private investment	*- 0.22*	*0.05*	*- 0.07*	*- 0.02*	*- 0.19*	*0.01*	*0.00*
Non-residential private investment	*- 0.49*	*0.07*	*- 0.10*	*- 0.06*	*- 0.33*	*- 0.07*	*0.00*
Inventories	*- 0.16*	*0.02*	*- 0.05*	*- 0.04*	*- 0.06*	*- 0.02*	*- 0.01*
Exports	- 0.14	0.00	0.00	0.00	- 0.01	- 0.13	0.00
Imports	- 0.24	0.09	- 0.14	- 0.08	- 0.18	0.09	- 0.02

Table III.2 (cont.)

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary interest rate shock
(exchange rates endogenous with no reaction in foreign interest rates)

	Total	Income/ cash flow	Wealth	Direct interest rate effect on consumption[2]	Cost of capital[3]	Exchange rate	Discrepancy[4]
Real GDP: fourth year after shock[1]	**- 1.80**	**0.27**	**- 0.63**	**- 0.19**	**- 0.68**	**- 0.58**	**0.01**
of which:							
Private consumption	- 0.63	0.17	- 0.46	- 0.13	- 0.20	- 0.01	0.00
Government expenditure	- 0.00	0.02	- 0.01	- 0.01	- 0.01	0.01	0.00
Private investment	- 1.22	0.15	- 0.38	- 0.09	- 0.69	- 0.23	0.02
Residential private investment	*- 0.26*	*0.06*	*- 0.13*	*- 0.03*	*- 0.14*	*- 0.01*	*- 0.01*
Non-residential private investment	*- 0.80*	*0.08*	*- 0.18*	*- 0.06*	*- 0.48*	*- 0.17*	*0.01*
Inventories	*- 0.16*	*0.01*	*- 0.07*	*0.00*	*- 0.07*	*- 0.05*	*0.02*
Exports	- 0.29	0.01	- 0.01	- 0.01	- 0.02	- 0.25	- 0.01
Imports	- 0.32	0.08	- 0.23	- 0.06	- 0.22	0.09	0.02
Real GDP: final year after shock[1]	**- 2.09**	**0.28**	**- 0.64**	**- 0.10**	**- 0.76**	**- 0.94**	**0.07**
of which:							
Private consumption	- 0.55	0.15	- 0.42	- 0.04	- 0.21	- 0.07	0.04
Government expenditure	- 0.01	0.01	- 0.01	0.00	- 0.01	0.00	0.00
Private investment	- 1.38	0.15	- 0.39	- 0.06	- 0.71	- 0.45	0.08
Residential private investment	*- 0.30*	*0.06*	*- 0.14*	*- 0.04*	*- 0.11*	*- 0.07*	*0.00*
Non-residential private investment	*- 0.97*	*0.08*	*- 0.20*	*- 0.04*	*- 0.55*	*- 0.31*	*0.05*
Inventories	*- 0.11*	*0.01*	*- 0.05*	*0.02*	*- 0.05*	*- 0.07*	*0.03*
Exports	- 0.42	0.03	0.03	- 0.02	- 0.05	- 0.35	- 0.06
Imports	- 0.28	0.07	- 0.21	- 0.02	- 0.23	0.08	0.03

[1] In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect. [2] This is the cost-of-capital effect on consumer durables spending. [3] This is the cost-of-capital effect on business investment. [4] Due to interaction between the different channels.

Monetary policy in a multi-country econometric model with rational expectations

Ralph W. Tryon[1]

I. INTRODUCTION

This paper describes results of simulations of monetary policy scenarios in the G-7 countries. The paper was prepared as part of a study of the channels of monetary policy transmission by the Bank for International Settlements to be presented at the November economists' meeting on 15th-16th November 1994. The simulations are performed using the rational-expectations version of the FRB Multi-Country Model (MCM).[2] In this paper we use the multi-country structure of the MCM to compare the channels of monetary transmission across countries, as well as to examine the "spill-over" effects of monetary policy abroad.

II. MONETARY POLICY SCENARIOS

The basic monetary policy scenario we consider is a temporary increase in the policy-controlled short-term interest rate of 100 basis points, lasting for two years. At the end of the two-year period, the policy-controlled rate is assumed to return to its baseline path. As proposed by the BIS staff, we consider two variants of this scenario. In the first, nominal exchange rates are assumed to be endogenous, determined by the open interest parity condition. In the second variant, exchange rates are held exogenous. (This is not a fixed rate regime, with exchange rates fixed by policy action; rather, the exchange rate equations are dropped from the model for this simulation.) We also consider a global increase in interest rates in which nominal exchange rates are unchanged because interest differentials remain constant.

We assume that the authorities can target nominal interest rates exactly, and in the scenarios reported here the target interest rate rises above baseline by exactly 100 basis points for eight quarters, and then returns to baseline. In the MCM, the monetary authorities are assumed to control the short-term interest rate using a reaction function that depends on deviations from target levels for real GDP, the price level, and the short-term interest rate itself. In general, the model cannot be solved if the authorities target only the nominal interest rate, because in this case the price level is indeterminate. However, because in these simulations the change in policy is temporary, there is no

1 The views expressed in this paper are those of the author and should not be interpreted as representing the views of the Board of Governors or other members of its staff. The author is grateful to Jaime Marquez and David Bowman for many helpful contributions, and to Yun Sun for very competent research assistance.

2 The Multi-Country Model (MCM) was developed in the Division of International Finance at the Board of Governors of the Federal Reserve System. The basic structure of the (adaptive expectations) MCM is described in Edison, Marquez and Tryon, "The structure and properties of the Federal Reserve Board Multicountry Model", *Economic Modelling* 4 (2), 115-315 (1987). The rational expectations version of the model has separate country blocks for each of the G-7 industrial countries and Mexico, as well as blocks for the rest-of-OECD, newly industrialized economies, OPEC, and other developing countries. The model is quarterly, and has 1,317 equations in total, including identities.

change in the steady state price level, and the model can be simulated with an exact nominal interest rate peg.[3]

These scenarios are simulated for each of the G-7 countries in turn. Each country is assumed to act independently - thus, for example, in the first scenario the Canadian authorities are assumed to raise short-term interest rates in Canada by 100 basis points for two years while nominal interest rates in the other G-7 countries remain at their baseline values. Income, prices, and other endogenous variables in Canada and the other countries adjust in response to the policy change as predicted by the model.

III. TREATMENT OF EXPECTATIONS

The MCM is a perfect-foresight model that incorporates adjustment costs. Agents can perfectly anticipate the effects of changes in exogenous variables on future prices, exchange rates, interest rates, wages and output. However, agents' behavior changes only gradually in response to information about the future, because adjustment is costly.

Nominal long-term interest rates depend on expected future short rates. Exchange rates are determined by the open interest parity condition - agents are assumed to correctly anticipate next period's exchange rate.[4] Nominal wages are determined in a Taylor contracting framework; again, agents are assumed to know the level of future wages. Prices are determined by a markup over marginal cost; the level of the markup depends on excess capacity and expectations do not enter directly. The level of output is determined by aggregate demand; expectations affect demand through the real interest rate and the real exchange rate.

The modelling of expectations in the MCM has strong implications for the effects of a simulated change in monetary policy. Temporary changes in monetary policy do not affect the long-run equilibrium of the model, and in this exercise agents can correctly forecast that the increase in interest rates will last only eight quarters. However, money is not entirely neutral in this model: sticky prices and lagged adjustment lead to significant changes in real activity when interest rates rise or fall.

IV. RESULTS FOR ENDOGENOUS EXCHANGE RATES

Table I reports results for interest rates, exchange rates, and the money supply in each of the G-7 countries, for an interest rate increase in that country. Monetary policy in each of the other countries is assumed unchanged; nominal exchange rates are endogenous. For each country scenario, the table reports deviations from baseline for each variable using annual average data; the interest rates are measured in percentage points, and the other variables are percent deviations from baseline.

Table II reports real activity and price variables for the same simulations. Again, there is one page in the table for each G-7 country scenario. Variables are annual averages, percent deviations from baseline, except for the unemployment rate (percentage points), and the government and external accounts variables, which are measured as percent of GDP.

As shown in, for example, Table I for the United States, long-term nominal interest rates rise by much less than the increase in short rates, and return to baseline along with the policy in the third year of the simulation. This result comes directly from the forward-looking expectations in the

3 Paul Fisher helped clarify this point. In the preliminary simulations prepared for this meeting the interest rate reaction function was included, and the short-term rate differed slightly from its target.

4 The MCM is sometimes simulated with an *ad hoc* risk premium in the open interest parity condition; this risk premium term was taken out for the final versions of the BIS simulations reported here.

MCM - agents anticipate that short rates will fall in the future, and the initial change in the long rate reflects this anticipation. Real interest rates rise by slightly less than nominal rates because expected inflation rises slightly. The price level falls initially, with the exchange rate appreciation and the fall in output, and then it rises steadily back toward its original equilibrium. Again, agents anticipate this recovery, which is reflected in the real interest rate.

Nominal exchange rates are governed entirely by the nominal interest parity condition. Because the short-term interest rate is higher by 100 basis points for two years, the nominal exchange rate must depreciate by 1% per year for exactly two years, and then remain at its previous baseline. The nominal exchange rate appreciates initially by 2%; the average appreciation in the first year is 1.64%. The real exchange appreciation is somewhat lower, reflecting the initial fall in the price level. The last line of the table reports money demand, which falls as expected in response to higher interest rates and lower nominal income. With the authorities targeting nominal interest rates, there is no feedback from money demand to the rest of the economy in these simulations.

As shown in Table II, real GDP falls in the first year, by about ½% (in the United States). It stays at about that level in the second year, and then returns to baseline. As seen in the pages for the United States and other countries, real output cycles somewhat after interest rates return to baseline - this oscillation gradually damps out in the next few years.[5] It appears from the table that most of the change in GDP comes from the effect on investment and real net exports - the change in consumption is relatively modest.

Prices fall as a result of the exchange rate appreciation and, more gradually, as a result of the fall in output. The CPI falls more at first than the GDP deflator, as import prices fall, but then returns to baseline before the deflator, which is affected by the output gap with a lag in the MCM's wage-contracting equations. The price changes are small, in any event.

In the government sector, revenue is slightly lower, and primary expenditure slightly higher, both as a result of the fall in output. Interest payments are noticeably higher, as would be expected. The government deficit returns to baseline shortly after the end of the policy change; the debt/GDP ratio stabilizes, and then begins to decline slowly.[6] The current account deteriorates as a result of increased interest payments on liabilities to foreigners; there is little change in the nominal trade balance (as a share of GDP) although real net exports do decline somewhat, as noted above.

The expectations term structure of interest rates and the exchange rate parity conditions are imposed in these simulations and do not differ across countries, so the results in Table I are broadly similar for each of the G-7 countries. The response of prices to changes in exchange rates and aggregate demand does differ across countries. While there is some cross-country variation in the effects of the monetary policy action on real activity shown in Table II, the pattern is broadly the same in each of the G-7 countries. In all cases, a temporary monetary tightening brings about a modest temporary reduction in the level of real output, primarily through the effect on investment and real net exports.

V. RESULTS FOR FIXED EXCHANGE RATES

We consider two alternative scenarios in which exchange rates are held fixed while interest rates rise. In the first alternative, the open interest parity equations are dropped from the MCM, and exchange rates are exogenous to the model - no policy action is required to keep them

5 In these simulations the MCM is solved over a 25-year horizon, to ensure a long enough horizon to return to the initial equilibrium. After 10 years all variables are essentially at their baseline values.

6 There is a tax reaction function in the MCM that imposes the Government's intertemporal budget constraint. The tax rate will remain slightly higher as long as the debt/GDP ratio is above its baseline value.

fixed. In the second alternative, nominal interest rates are increased globally, so that interest rate differentials are constant and nominal exchange rates are unchanged.

Tables Ia and IIa report the results of the first alternative scenario for the United States. The qualitative effects are quite similar for the other G-7 countries (although the exchange rate effect is more important outside the United States), and the tables for these countries are omitted to save space. As shown in the tables, the nominal interest rates change by the same amount as before; because the nominal exchange rate is fixed there is hardly any change in prices, and the increase in real interest rates is slightly higher. The decline in real GDP is more modest, reflecting the improvement in net exports.

Tables Ib and IIb report the results of the second alternative, also for the United States. Vis-à-vis the United States, the scenarios differ only in that foreign interest rates are higher, so that foreign GDP is lower. Nominal exchange rates are unchanged in both cases, so there is only a slight impact on import prices. As expected, US exports are slightly lower in these scenarios, reflecting weaker foreign demand. However, the effect on real output is negligible, and for most variables the two scenarios give virtually identical results. While we would expect somewhat larger differentials in the more open economies in the rest of the G-7, these effects do not appear to be economically significant, and in order to save space they are not reported.

VI. SPILLOVERS TO OTHER COUNTRIES

Tables Ic and IIc show the simulated effects of an interest rate increase in the United States (with floating exchange rates) on real activity in Canada. There is a slight stimulus to GDP from the external sector, as exports to the United States rise while imports fall - the positive effects of the real appreciation of the dollar offset the negative effect of lower US output. Some of this stimulus is in effect crowded out by lower investment - real interest rates are slightly higher outside the United States, as prices fall after the one-time depreciation against the dollar. These effects are qualitatively similar in the other G-7 countries (not shown), although there is considerable variation in the (very small) magnitudes reflecting different shares in trade with the United States.

VII. CHANNELS OF TRANSMISSION OF MONETARY POLICY

Table III decomposes the effect of an interest rate increase on real GDP by channel of transmission and by component of GDP. Results are shown for each G-7 country for three years - the out years (which show only very slight changes in any event) are omitted to save space. The decompositions are calculated using the "Banca d'Italia" method, running the simulations with the nominal interest rate variable used in the target equation(s) held exogenous.[7] This procedure in effect sets the partial derivative of the variable of interest (e.g. consumption expenditure) with respect to the nominal interest rate equal to zero. The contribution of a given channel is then the difference between the full simulation and the simulation with the channel shut off. As shown in the tables, the discrepancy between the total change and the sum of the channels is essentially zero.[8]

The definitions of the channels correspond to those specified by the BIS staff. The income/cash flow channel is the effect of interest paid on government debt and net foreign assets on

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7 The income/cash flow channel is calculated as a residual, since there is no simple way of isolating this channel in the MCM. The discrepancy reported is the difference between the sum of the individual consumption, cost of capital, and exchange rate effects, and the three effects combined.

8 David Bowman worked out the conditions under which this procedure yields an exact decomposition of the total change, and helped resolve a number of difficulties in the coding.

personal disposal income. The wealth effect is identically zero in the MCM, since wealth is not modelled separately from permanent income. The direct consumption channel is the partial effect of the (nominal) long-term interest rate on consumption expenditure. The cost of capital channel is the partial effect of the (nominal) long-term rate on investment expenditure, including inventories. The exchange rate channel is, in this case, the open interest parity condition; with it closed nominal exchange rates are exogenous.

As shown in the table, almost all the effect of a monetary policy action on GDP is transmitted through the cost of capital and exchange rate channels (investment and net exports). Except in the United States, these channels are roughly equal in importance. The cost of capital channel is about equally divided between residential and non-residential investment; inventories make only a modest contribution. The income/cash flow and direct consumption channels are almost negligible.

VIII. CONCLUSIONS

Two results seem to emerge from this analysis. One is that, in each of the G-7 countries investigated, changes in monetary policy appear to have only modest and impermanent effects on real activity. This is perhaps to be expected in a forward-looking model such as the MCM when we assume perfect certainty about future policy. The second result is that there appear to be broad similarity effects of monetary policy in the G-7 industrial countries. One exception to this generalization is that exchange rate effects of monetary policy are clearly less important in the United States than elsewhere. A possible qualification to the results is that the MCM was not designed to identify the cross-country differences in financial structure that may significantly affect the response of the economy to interest rate changes. However, the macroeconometric approach used in the MCM is consistently applied in each sector of the model, and seems to provide a solid basis for making cross-country comparisons.

Table I - UNITED STATES

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in US short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.11	0.92	- 0.18	- 0.16	- 0.08
Real long-term interest rate (%)	0.25	0.06	- 0.05	- 0.02	0.01
5. Exchange rates					
Nominal effective exchange rate	1.64	0.63	0.00	0.00	0.00
Real effective exchange rate	1.23	0.16	- 0.25	- 0.06	0.05
6. Asset prices					
7. Monetary aggregate	- 2.08	- 3.20	- 1.30	- 0.13	0.25

Table II - UNITED STATES

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in US short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.46	- 0.58	- 0.17	0.08	0.17
Private consumption	- 0.08	- 0.20	- 0.19	- 0.09	- 0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.77	- 2.52	- 0.64	0.68	1.16
Residential	- 1.95	- 3.30	- 1.04	1.23	2.02
Non-residential	- 0.84	- 1.53	- 0.67	0.32	0.75
Inventories	- 26.00	- 22.03	4.77	5.04	3.59
Exports	- 0.77	- 0.58	- 0.04	0.06	0.03
Imports	0.40	- 0.23	- 0.55	- 0.18	0.20
2. Unemployment rate (%)	0.46	0.53	0.09	- 0.15	- 0.22
3. Real disposable income	- 0.08	- 0.31	- 0.11	0.13	0.20
4. Inflation and wages					
GDP deflator	- 0.12	- 0.30	- 0.21	- 0.01	0.13
Consumer prices (consumption deflator)	- 0.25	- 0.32	- 0.18	- 0.01	0.12
Wages/earnings	- 0.05	- 0.11	- 0.06	0.02	0.07
Unit labour cost	- 0.07	- 0.09	0.02	0.10	0.13
Import prices	- 1.41	- 0.47	0.02	0.01	0.04
5. Government accounts (% of nominal GDP)					
Revenues	- 0.10	- 0.08	0.01	0.02	0.02
Primary expenditures	0.15	0.20	0.06	- 0.04	- 0.07
Interest payments	0.39	0.41	0.11	0.10	0.08
Financial deficit	0.63	0.69	0.16	0.04	- 0.00
Public sector debt	0.69	1.50	1.50	1.26	1.08
6. Current account (% of nominal GDP)	- 0.34	- 0.36	- 0.03	- 0.03	- 0.07
Trade balance	0.00	- 0.01	0.03	0.02	- 0.01
Net interest payments abroad	0.34	0.34	0.06	0.06	0.06

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - UNITED STATES

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in US short-term interest rates with floating exchange rates

	Total	**Income/ cash flow**	**Wealth**	**Direct con-sumption**	**Cost of capital**	**Exchange rate**	**Discre-pancy**
Real GDP: first year after shock*	**- 0.46**	**0.04**	**0.00**	**- 0.07**	**- 0.31**	**- 0.13**	**0.01**
of which:							
Private consumption	- 0.05	0.03	0.00	- 0.07	- 0.03	0.01	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.18	0.01	0.00	- 0.01	- 0.20	0.02	0.00
Residential private investment	*- 0.09*	*0.00*	*0.00*	*- 0.00*	*- 0.10*	*0.01*	*0.00*
Non-residential private investment	*- 0.10*	*0.00*	*0.00*	*- 0.00*	*- 0.11*	*0.01*	*0.00*
Inventory formation	- 0.11	0.00	0.00	- 0.00	- 0.11	0.01	0.00
Exports	- 0.07	0.00	0.00	- 0.00	0.00	- 0.08	0.00
Imports	0.05	0.00	0.00	- 0.01	- 0.03	0.08	0.00
Real GDP: second year after shock*	**- 0.58**	**0.09**	**0.00**	**- 0.11**	**- 0.46**	**- 0.11**	**0.01**
of which:							
Private consumption	- 0.13	0.08	0.00	- 0.11	- 0.09	- 0.01	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.33	0.01	0.00	- 0.01	- 0.36	0.02	0.01
Residential private investment	*- 0.15*	*0.01*	0.00	*- 0.00*	*- 0.17*	*0.01*	*0.00*
Non-residential private investment	*- 0.18*	*0.00*	0.00	*- 0.01*	*- 0.19*	*0.01*	*0.00*
Inventory formation	- 0.09	0.00	0.00	- 0.00	- 0.10	0.01	0.00
Exports	- 0.06	0.01	0.00	0.00	0.00	- 0.06	0.00
Imports	- 0.03	0.01	0.00	- 0.02	- 0.09	0.07	0.00
Real GDP: third year after shock*	**- 0.17**	**0.08**	**0.00**	**- 0.08**	**- 0.15**	**- 0.03**	**0.01**
of which:							
Private consumption	- 0.12	0.08	0.00	- 0.10	- 0.09	- 0.02	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.12	0.00	0.00	- 0.00	- 0.14	0.01	0.00
Residential private investment	*- 0.05*	*0.00*	0.00	*0.00*	*- 0.06*	*0.01*	*0.00*
Non-residential private investment	*- 0.08*	*0.00*	0.00	*- 0.00*	*- 0.09*	*0.01*	*0.00*
Inventory formation	0.02	- 0.00	0.00	- 0.00	0.02	0.00	0.00
Exports	- 0.00	0.01	0.00	0.00	0.00	- 0.01	0.00
Imports	- 0.06	0.02	0.00	- 0.02	- 0.07	0.01	0.00

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table I - CANADA

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in Canadian short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	- 0.00	- 0.00	- 0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	0.93	0.68	- 0.19	- 0.10	- 0.01
Real long-term interest rate (%)	0.19	0.04	- 0.03	- 0.00	0.01
5. Exchange rates					
Nominal effective exchange rate	1.64	0.63	0.00	0.00	0.00
Real effective exchange rate	1.14	0.13	- 0.20	- 0.02	0.07
6. Asset prices					
7. Monetary aggregate	- 2.52	- 3.75	- 1.41	- 0.10	0.16

Table II - CANADA

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in Canadian short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.65	- 0.61	- 0.05	0.14	0.13
Private consumption	- 0.01	- 0.24	- 0.18	0.02	0.13
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.10	- 1.50	- 0.34	0.40	0.64
Residential	- 0.98	- 1.62	- 0.45	0.58	0.86
Non-residential	- 0.55	- 1.04	- 0.44	0.24	0.51
Inventories	- 20.45	- 14.77	4.56	3.14	1.67
Exports	- 0.65	- 0.41	0.04	0.07	- 0.01
Imports	0.57	0.01	- 0.38	- 0.05	0.27
2. Unemployment rate (%)	0.64	0.58	- 0.01	- 0.20	- 0.17
3. Real disposable income	0.00	- 0.36	- 0.03	0.20	0.20
4. Inflation and wages					
GDP deflator	- 0.19	- 0.37	- 0.19	0.03	0.12
Consumer prices (consumption deflator)	- 0.55	- 0.42	- 0.13	0.03	0.10
Wages/earnings	- 0.05	- 0.10	- 0.04	0.02	0.04
Unit labour cost	- 0.10	- 0.11	0.02	0.09	0.09
Import prices	- 1.59	- 0.61	0.00	0.00	0.01
5. Government accounts (% of nominal GDP)					
Revenues	- 0.10	- 0.05	0.02	0.03	0.04
Primary expenditures	0.15	0.21	0.02	- 0.06	- 0.06
Interest payments	0.41	0.46	0.16	0.14	0.13
Financial deficit	0.66	0.72	0.16	0.05	0.04
Public sector debt	0.79	1.55	1.46	1.27	1.20
6. Current account (% of nominal GDP)	- 0.41	- 0.53	- 0.03	- 0.03	- 0.13
Trade balance	- 0.03	- 0.09	0.06	0.03	- 0.05
Net interest payments abroad	0.38	0.41	0.10	0.07	0.07

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - CANADA

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in Canadian short-term interest rates with floating exchange rates

	Total	**Income/ cash flow**	**Wealth**	**Direct con-sumption**	**Cost of capital**	**Exchange rate**	**Discre-pancy**
Real GDP: first year after shock*	**- 0.65**	**0.04**	**0.00**	**- 0.04**	**- 0.27**	**- 0.37**	**0.00**
of which:							
Private consumption	- 0.01	0.04	0.00	- 0.06	- 0.06	0.06	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.16	0.00	0.00	- 0.00	- 0.22	0.06	0.00
Residential private investment	*- 0.07*	*0.00*	*0.00*	*- 0.00*	*- 0.10*	*0.03*	*0.00*
Non-residential private investment	*- 0.09*	*0.00*	*0.00*	*- 0.00*	*- 0.11*	*0.03*	*0.00*
Inventory formation	- 0.10	0.00	0.00	- 0.00	- 0.12	0.02	0.00
Exports	- 0.18	0.00	0.00	0.00	0.01	- 0.18	- 0.00
Imports	0.20	0.01	0.00	- 0.02	- 0.11	0.32	0.00
Real GDP: second year after shock*	**- 0.61**	**0.06**	**0.00**	**- 0.04**	**- 0.30**	**- 0.34**	**0.01**
of which:							
Private consumption	- 0.15	0.08	0.00	- 0.08	- 0.12	- 0.04	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.28	0.01	0.00	- 0.00	- 0.38	0.09	0.01
Residential private investment	*- 0.12*	*0.00*	*0.00*	*0.00*	*- 0.18*	*0.05*	*0.00*
Non-residential private investment	*- 0.16*	*0.00*	*0.00*	*- 0.00*	*- 0.21*	*0.04*	*0.00*
Inventory formation	- 0.07	0.00	0.00	- 0.00	- 0.10	0.03	0.00
Exports	- 0.11	- 0.00	0.00	0.00	0.02	- 0.13	- 0.00
Imports	0.00	0.03	0.00	- 0.04	- 0.28	0.28	0.01
Real GDP: third year after shock*	**- 0.05**	**0.02**	**0.00**	**- 0.00**	**0.03**	**- 0.10**	**0.00**
of which:							
Private consumption	- 0.11	0.07	0.00	- 0.04	- 0.05	- 0.11	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.10	0.00	0.00	0.00	- 0.17	0.06	0.01
Residential private investment	*- 0.03*	*0.00*	*0.00*	*0.00*	*- 0.07*	*0.03*	*0.00*
Non-residential private investment	*- 0.07*	*0.00*	*0.00*	*0.00*	*- 0.10*	*0.03*	*0.00*
Inventory formation	0.02	- 0.00	0.00	0.00	0.02	0.00	0.00
Exports	0.01	- 0.00	0.00	0.00	0.02	- 0.01	- 0.00
Imports	- 0.14	0.04	0.00	- 0.03	- 0.21	0.04	0.01

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table I - FRANCE

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in French short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.07	0.73	- 0.22	- 0.13	- 0.04
Real long-term interest rate (%)	0.21	0.03	- 0.04	- 0.01	0.01
5. Exchange rates					
Nominal effective exchange rate	1.64	0.63	0.00	0.00	0.00
Real effective exchange rate	1.15	0.13	- 0.23	- 0.05	0.07
6. Asset prices					
7. Monetary aggregate	- 2.35	- 3.56	- 1.39	- 0.07	0.28

Table II - FRANCE

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in French short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.68	- 0.70	- 0.10	0.16	0.20
Private consumption	- 0.11	- 0.35	- 0.29	- 0.06	0.11
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.49	- 2.00	- 0.44	0.64	1.04
Residential	- 1.28	- 2.12	- 0.61	0.85	1.35
Non-residential	- 0.82	- 1.47	- 0.59	0.42	0.87
Inventories	- 10.38	- 7.10	2.35	1.68	0.98
Exports	- 0.71	- 0.46	0.04	0.09	0.00
Imports	0.59	- 0.10	- 0.58	- 0.18	0.29
2. Unemployment rate (%)	0.63	0.62	0.05	- 0.19	- 0.21
3. Real disposable income	- 0.21	- 0.49	- 0.13	0.17	0.24
4. Inflation and wages					
GDP deflator	- 0.16	- 0.38	- 0.24	- 0.01	0.13
Consumer prices (consumption deflator)	- 0.48	- 0.44	- 0.17	0.02	0.11
Wages/earnings	- 0.06	- 0.12	- 0.06	0.01	0.05
Unit labour cost	- 0.08	- 0.11	- 0.01	0.06	0.09
Import prices	- 1.59	- 0.61	0.00	0.00	0.00
5. Government accounts (% of nominal GDP)					
Revenues	0.02	0.04	0.02	0.02	0.01
Primary expenditures	0.16	0.21	0.05	- 0.05	- 0.07
Interest payments	0.19	0.22	0.08	0.07	0.06
Financial deficit	0.33	0.39	0.11	0.00	- 0.03
Public sector debt	0.40	0.84	0.85	0.72	0.62
6. Current account (% of nominal GDP)	- 0.15	- 0.19	0.05	0.03	- 0.06
Trade balance	- 0.01	- 0.04	0.06	0.04	- 0.03
Net interest payments abroad	0.13	0.14	0.03	0.02	0.01

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - FRANCE

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in French short-term interest rates

	Total	Income/ cash flow	Wealth	Direct con-sumption	Cost of capital	Exchange rate	Discre-pancy
Real GDP: first year after shock*	**- 0.68**	**0.02**	**0.00**	**- 0.04**	**- 0.31**	**- 0.36**	**0.00**
of which:							
Private consumption	- 0.07	0.02	0.00	- 0.05	- 0.06	0.02	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.18	0.00	0.00	- 0.00	- 0.22	0.03	0.00
Residential private investment	*- 0.09*	*0.00*	*0.00*	*- 0.00*	*- 0.11*	*0.02*	*0.00*
Non-residential private investment	*- 0.10*	*0.00*	*0.00*	*- 0.00*	*- 0.12*	*0.02*	*0.00*
Inventory formation	- 0.11	0.00	0.00	- 0.00	- 0.12	0.01	0.00
Exports	- 0.17	- 0.00	0.00	0.00	0.00	- 0.17	- 0.00
Imports	0.16	0.01	0.00	- 0.01	- 0.09	0.25	0.00
Real GDP: second year after shock*	**- 0.70**	**0.04**	**0.00**	**- 0.04**	**- 0.39**	**- 0.30**	**0.01**
of which:							
Private consumption	- 0.22	0.05	0.00	- 0.07	- 0.15	- 0.05	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.32	0.01	0.00	- 0.00	- 0.40	0.06	0.01
Residential private investment	*- 0.14*	*0.00*	0.00	*- 0.00*	*- 0.19*	*0.04*	*0.00*
Non-residential private investment	*- 0.18*	*0.00*	0.00	*- 0.00*	*- 0.21*	*0.03*	*0.00*
Inventory formation	- 0.08	0.00	0.00	- 0.00	- 0.10	0.02	0.00
Exports	- 0.11	- 0.00	0.00	0.00	0.02	- 0.13	- 0.00
Imports	- 0.03	0.02	0.00	- 0.03	- 0.24	0.21	0.01
Real GDP: third year after shock*	**- 0.10**	**0.02**	**0.00**	**- 0.01**	**- 0.03**	**- 0.08**	**0.00**
of which:							
Private consumption	- 0.18	0.04	0.00	- 0.04	- 0.10	- 0.08	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.11	0.00	0.00	0.00	- 0.17	0.05	0.01
Residential private investment	*- 0.04*	*0.00*	0.00	*0.00*	*- 0.07*	*0.02*	*0.00*
Non-residential private investment	*- 0.07*	*0.00*	0.00	*- 0.00*	*- 0.10*	*0.02*	*0.00*
Inventory formation	0.03	- 0.00	0.00	0.00	0.02	0.01	0.00
Exports	0.01	0.00	0.00	0.00	0.02	- 0.01	- 0.00
Imports	- 0.15	0.02	0.00	- 0.03	- 0.20	0.04	0.01

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table I - GERMANY

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in German short-term interest rates with floating rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.03	0.66	- 0.21	- 0.10	- 0.01
Real long-term interest rate (%)	0.20	0.03	- 0.03	- 0.00	0.01
5. Exchange rates					
Nominal effective exchange rate	1.64	0.63	0.00	0.00	0.00
Real effective exchange rate	1.05	0.12	- 0.21	- 0.03	0.06
6. Asset prices					
7. Monetary aggregate	- 2.40	- 3.53	- 1.30	- 0.02	0.26

Table II - GERMANY

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in German short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.72	- 0.65	- 0.03	0.18	0.17
Private consumption	- 0.09	- 0.29	- 0.20	0.01	0.15
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 2.20	- 2.84	- 0.57	0.87	1.38
Residential	- 1.98	- 3.20	- 0.90	1.18	1.87
Non-residential	- 0.93	- 1.66	- 0.63	0.49	0.94
Inventories	8.87	5.62	- 2.13	- 1.29	- 0.70
Exports	- 0.63	- 0.42	0.02	0.08	0.02
Imports	0.44	- 0.15	- 0.46	- 0.08	0.31
2. Unemployment rate (%)	0.71	0.62	- 0.01	- 0.21	- 0.19
3. Real disposable income	- 0.09	- 0.35	- 0.07	0.22	0.26
4. Inflation and wages					
GDP deflator	- 0.18	- 0.38	- 0.22	0.01	0.13
Consumer prices (consumption deflator)	- 0.54	- 0.44	- 0.13	0.04	0.10
Wages/earnings	- 0.06	- 0.12	- 0.05	0.02	0.06
Unit labour cost	- 0.08	- 0.11	- 0.01	0.06	0.08
Import prices	- 1.47	- 0.59	- 0.02	0.00	0.02
5. Government accounts (% of nominal GDP)					
Revenues	- 0.06	- 0.03	0.03	0.04	0.04
Primary expenditures	0.11	0.15	0.02	- 0.04	- 0.05
Interest payments	0.31	0.32	0.09	0.08	0.07
Financial deficit	0.48	0.51	0.09	- 0.00	- 0.02
Public sector debt	0.65	1.19	1.05	0.85	0.74
6. Current account (% of nominal GDP)	- 0.18	- 0.18	0.05	0.00	- 0.10
Trade balance	- 0.03	- 0.03	0.06	0.02	- 0.06
Net interest payments abroad	0.14	0.13	0.03	0.03	0.03

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - GERMANY

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in German short-term interest rates

	Total	**Income/ cash flow**	**Wealth**	**Direct con-sumption**	**Cost of capital**	**Exchange rate**	**Discre-pancy**
Real GDP: first year after shock*	**- 0.72**	**0.08**	**0.00**	**- 0.07**	**- 0.29**	**- 0.45**	**0.01**
of which:							
Private consumption	- 0.06	0.10	0.00	- 0.10	- 0.07	0.01	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.17	0.01	0.00	- 0.00	- 0.22	0.04	0.00
Residential private investment	*- 0.08*	*0.01*	*0.00*	*- 0.00*	*- 0.11*	*0.02*	*0.00*
Non-residential private investment	*- 0.09*	*0.00*	*0.00*	*- 0.00*	*- 0.12*	*0.02*	*0.00*
Inventory formation	- 0.11	0.00	0.00	- 0.00	- 0.12	0.01	0.00
Exports	- 0.23	0.00	0.00	- 0.00	- 0.00	- 0.23	0.00
Imports	0.16	0.03	0.00	- 0.03	- 0.12	0.28	0.01
Real GDP: second year after shock*	**- 0.65**	**0.12**	**0.00**	**- 0.07**	**- 0.33**	**- 0.37**	**- 0.00**
of which:							
Private consumption	- 0.20	0.19	0.00	- 0.14	- 0.17	- 0.08	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.29	0.02	0.00	- 0.00	- 0.39	0.08	0.01
Residential private investment	*- 0.12*	*0.01*	0.00	*0.00*	*- 0.18*	*0.05*	*0.00*
Non-residential private investment	*- 0.17*	*0.01*	0.00	*- 0.00*	*- 0.21*	*0.04*	*0.00*
Inventory formation	*- 0.07*	*0.00*	0.00	*- 0.00*	*- 0.10*	*0.03*	*0.00*
Exports	- 0.15	0.00	0.00	0.00	0.01	- 0.16	- 0.00
Imports	- 0.06	0.09	0.00	- 0.07	- 0.32	0.23	0.02
Real GDP: third year after shock*	**- 0.03**	**0.05**	**0.00**	**- 0.01**	**0.02**	**- 0.07**	**- 0.03**
of which:							
Private consumption	- 0.14	0.15	0.00	- 0.08	- 0.10	- 0.11	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.10	0.01	0.00	0.00	- 0.17	0.07	- 0.00
Residential private investment	*- 0.04*	*0.00*	0.00	*0.00*	*- 0.08*	*0.04*	*- 0.00*
Non-residential private investment	*- 0.06*	*0.00*	0.00	*0.00*	*- 0.10*	*0.03*	*- 0.00*
Inventory formation	0.03	- 0.00	0.00	0.00	0.02	0.01	0.00
Exports	0.01	0.00	0.00	0.00	0.02	- 0.01	- 0.01
Imports	- 0.17	0.10	0.00	- 0.06	- 0.26	0.03	0.02

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table I - ITALY

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in Italian short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.00	0.70	- 0.14	- 0.06	- 0.00
Real long-term interest rate (%)	0.22	0.06	- 0.01	0.01	0.02
5. Exchange rates					
Nominal effective exchange rate	1.63	0.63	0.00	0.00	0.00
Real effective exchange rate	1.21	0.30	- 0.05	0.06	0.11
6. Asset prices					
7. Monetary aggregate	- 2.01	- 2.84	- 0.83	0.14	0.31

Table II - ITALY

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in Italian short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.44	- 0.30	0.11	0.20	0.20
Private consumption	0.30	0.53	0.48	0.40	0.37
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.19	- 1.52	- 0.35	0.35	0.67
Residential	- 0.74	- 1.23	- 0.48	0.22	0.54
Non-residential	- 0.76	- 1.31	- 0.51	0.35	0.74
Inventories	- 8.24	- 5.47	1.91	1.19	0.80
Exports	- 0.73	- 0.57	- 0.11	- 0.03	- 0.05
Imports	0.67	0.54	0.35	0.50	0.66
2. Unemployment rate (%)	0.38	0.23	- 0.14	- 0.21	- 0.20
3. Real disposable income	0.85	0.77	0.30	0.36	0.34
4. Inflation and wages					
GDP deflator	- 0.02	- 0.09	0.02	0.13	0.18
Consumer prices (consumption deflator)	- 0.39	- 0.28	- 0.02	0.09	0.12
Wages/earnings	- 0.02	- 0.02	0.02	0.04	0.05
Unit labour cost	- 0.03	0.00	0.07	0.09	0.08
Import prices	- 1.58	- 0.60	0.01	0.01	0.01
5. Government accounts (% of nominal GDP)					
Revenues	0.02	0.06	0.04	0.04	0.03
Primary expenditures	0.10	0.07	- 0.06	- 0.09	- 0.09
Interest payments	0.70	0.71	0.17	0.14	0.13
Financial deficit	0.79	0.73	0.07	0.02	0.01
Public sector debt	0.91	1.53	1.26	1.04	0.96
6. Current account (% of nominal GDP)	- 0.09	- 0.20	- 0.13	- 0.13	- 0.17
Trade balance	- 0.03	- 0.12	- 0.08	- 0.07	- 0.09
Net interest payments abroad	0.05	0.05	0.04	0.05	0.07

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - ITALY

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in Italian short-term interest rates	Total	Income/ cash flow	Wealth	Direct con- sumption	Cost of capital	Exchange rate	Discre- pancy
Real GDP: first year after shock*	**- 0.44**	**0.26**	**0.00**	**- 0.05**	**- 0.33**	**- 0.33**	**0.01**
of which:							
Private consumption	0.20	0.29	0.00	- 0.06	- 0.06	0.03	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.17	0.03	0.00	- 0.00	- 0.24	0.03	0.01
Residential private investment	*- 0.07*	*0.02*	*0.00*	*- 0.00*	*- 0.11*	*0.02*	*0.00*
Non-residential private investment	*- 0.10*	*0.01*	*0.00*	*- 0.00*	*- 0.12*	*0.02*	*0.00*
Inventory formation	- 0.12	0.01	0.00	- 0.00	- 0.13	0.00	0.00
Exports	- 0.17	- 0.00	0.00	0.00	0.00	- 0.17	- 0.00
Imports	0.19	0.07	0.00	- 0.01	- 0.09	0.22	0.00
Real GDP: second year after shock*	**- 0.30**	**0.43**	**0.00**	**- 0.06**	**- 0.44**	**- 0.25**	**0.03**
of which:							
Private consumption	0.35	0.59	0.00	- 0.09	- 0.15	- 0.02	0.03
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.29	0.07	0.00	- 0.00	- 0.43	0.07	0.02
Residential private investment	*- 0.12*	*0.04*	*0.00*	*- 0.00*	*- 0.20*	*0.04*	*0.01*
Non-residential private investment	*- 0.17*	*0.03*	*0.00*	*- 0.00*	*- 0.23*	*0.03*	*0.01*
Inventory formation	- 0.08	0.01	0.00	- 0.00	- 0.11	0.03	0.00
Exports	- 0.13	- 0.01	0.00	0.00	0.01	- 0.13	- 0.00
Imports	0.15	0.22	0.00	- 0.04	- 0.24	0.20	0.02
Real GDP: third year after shock*	**0.11**	**0.23**	**0.00**	**- 0.02**	**- 0.07**	**- 0.05**	**0.02**
of which:							
Private consumption	0.32	0.49	0.00	- 0.06	- 0.10	- 0.04	0.03
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.11	0.05	0.00	- 0.00	- 0.22	0.05	0.02
Residential private investment	*- 0.05*	*0.02*	*0.00*	*0.00*	*- 0.10*	*0.03*	*0.01*
Non-residential private investment	*- 0.07*	*0.03*	*0.00*	*- 0.00*	*- 0.12*	*0.02*	*0.01*
Inventory formation	0.03	0.00	0.00	0.00	0.02	0.01	0.00
Exports	- 0.03	- 0.02	0.00	0.00	0.01	- 0.02	- 0.00
Imports	0.10	0.29	0.00	- 0.04	- 0.22	0.05	0.03

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table I - JAPAN

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in Japanese short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.24	0.92	- 0.25	- 0.22	- 0.11
Real long-term interest rate (%)	0.24	0.03	- 0.07	- 0.03	0.01
5. Exchange rates					
Nominal effective exchange rate	1.64	0.63	0.00	0.00	0.00
Real effective exchange rate	0.89	- 0.01	- 0.26	- 0.08	0.04
6. Asset prices					
7. Monetary aggregate	- 2.46	- 3.84	- 1.73	- 0.30	0.24

Table II - JAPAN

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in Japanese short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.61	- 0.81	- 0.30	0.07	0.23
Private consumption	- 0.27	- 0.68	- 0.59	- 0.24	0.07
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.36	- 1.83	- 0.41	0.54	0.84
Residential	- 1.92	- 3.06	- 0.70	1.41	1.89
Non-residential	- 0.59	- 1.06	- 0.48	0.19	0.48
Inventories	- 19.55	- 15.04	3.89	4.16	3.04
Exports	- 0.57	- 0.29	0.11	0.12	0.03
Imports	0.22	- 0.51	- 0.85	- 0.39	0.15
2. Unemployment rate (%)	0.62	0.76	0.20	- 0.16	- 0.28
3. Real disposable income	- 0.60	- 0.92	- 0.36	0.12	0.32
4. Inflation and wages					
GDP deflator	- 0.20	- 0.48	- 0.37	- 0.09	0.13
Consumer prices (consumption deflator)	- 0.32	- 0.47	- 0.30	- 0.06	0.12
Wages/earnings	- 0.08	- 0.18	- 0.13	- 0.01	0.08
Unit labour cost	- 0.10	- 0.15	- 0.03	0.08	0.14
Import prices	- 1.58	- 0.61	- 0.00	- 0.00	0.00
5. Government accounts (% of nominal GDP)					
Revenues	- 0.05	0.01	0.05	0.04	0.02
Primary expenditures	0.15	0.22	0.08	- 0.02	- 0.07
Interest payments	0.28	0.30	0.10	0.08	0.06
Financial deficit	0.47	0.51	0.13	0.02	- 0.02
Public sector debt	0.59	1.30	1.30	1.04	0.82
6. Current account (% of nominal GDP)	- 0.33	- 0.24	0.05	0.00	- 0.06
Trade balance	- 0.00	0.03	0.07	0.03	- 0.02
Net interest payments abroad	0.33	0.27	0.03	0.04	0.04

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - JAPAN

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in Japanese short-term interest rates

	Total	**Income/ cash flow**	**Wealth**	**Direct con-sumption**	**Cost of capital**	**Exchange rate**	**Discre-pancy**
Real GDP: first year after shock*	**- 0.61**	**0.02**	**0.00**	**- 0.05**	**- 0.37**	**- 0.22**	**0.01**
of which:							
Private consumption	- 0.16	0.02	0.00	- 0.05	- 0.09	- 0.04	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.20	0.00	0.00	- 0.00	- 0.21	0.01	0.01
Residential private investment	*- 0.09*	*0.00*	*0.00*	*- 0.00*	*- 0.10*	*0.00*	*0.00*
Non-residential private investment	*- 0.11*	*0.00*	*0.00*	*- 0.00*	*- 0.11*	*0.00*	*0.00*
Inventory formation	- 0.12	0.00	0.00	- 0.00	- 0.12	- 0.00	0.00
Exports	- 0.10	0.00	0.00	0.00	0.00	- 0.10	- 0.00
Imports	0.03	- 0.00	0.00	- 0.01	- 0.05	0.08	0.00
Real GDP: second year after shock*	**- 0.81**	**0.04**	**0.00**	**- 0.07**	**- 0.59**	**- 0.21**	**0.02**
of which:							
Private consumption	- 0.39	0.04	0.00	- 0.08	- 0.25	- 0.11	0.01
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.34	0.00	0.00	- 0.00	- 0.38	0.02	0.01
Residential private investment	*- 0.15*	*0.00*	0.00	*- 0.00*	*- 0.17*	*0.01*	*0.00*
Non-residential private investment	*- 0.19*	*0.00*	0.00	*- 0.00*	*- 0.21*	*0.01*	*0.01*
Inventory formation	- 0.10	0.00	0.00	- 0.00	- 0.10	0.01	0.00
Exports	- 0.05	0.00	0.00	0.00	0.01	- 0.06	- 0.00
Imports	- 0.07	0.00	0.00	- 0.02	- 0.13	0.07	0.01
Real GDP: third year after shock*	**- 0.31**	**0.03**	**0.00**	**- 0.04**	**- 0.23**	**- 0.08**	**0.01**
of which:							
Private consumption	- 0.34	0.03	0.00	- 0.06	- 0.23	- 0.11	0.02
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.12	0.00	0.00	0.00	- 0.16	0.03	0.01
Residential private investment	*- 0.03*	*- 0.00*	0.00	*0.00*	*- 0.06*	*0.02*	*0.00*
Non-residential private investment	*- 0.09*	*0.00*	0.00	*- 0.00*	*- 0.11*	*0.02*	*0.00*
Inventory formation	0.02	- 0.00	0.00	0.00	0.02	0.00	0.00
Exports	0.02	0.00	0.00	0.00	0.02	0.00	- 0.00
Imports	- 0.11	0.01	0.00	- 0.02	- 0.12	0.01	0.01

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table I - UNITED KINGDOM

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in UK short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	0.88	1.13	- 0.08	- 0.21	- 0.13
Real long-term interest rate (%)	0.27	0.09	- 0.05	- 0.03	0.00
5. Exchange rates					
Nominal effective exchange rate	1.64	0.63	0.00	0.00	0.00
Real effective exchange rate	1.37	0.44	- 0.20	- 0.17	- 0.04
6. Asset prices					
7. Monetary aggregate	- 2.31	- 3.91	- 1.91	- 0.34	0.26

Table II - UNITED KINGDOM

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in UK short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.93	- 1.20	- 0.31	0.25	0.37
Private consumption	- 0.27	- 0.70	- 0.54	- 0.14	0.12
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 2.13	- 3.94	- 1.46	1.00	2.08
Residential	- 4.60	- 8.89	- 3.57	3.21	6.03
Non-residential	- 1.01	- 2.13	- 1.15	0.40	1.21
Inventories	- 17.40	- 24.27	0.63	5.01	4.77
Exports	- 0.80	- 0.72	- 0.11	0.11	0.09
Imports	0.63	- 0.27	- 0.99	- 0.48	0.23
2. Unemployment rate (%)	0.77	0.95	0.17	- 0.30	- 0.37
3. Real disposable income	- 0.59	- 0.92	- 0.20	0.22	0.30
4. Inflation and wages					
GDP deflator	0.28	0.04	- 0.31	- 0.22	- 0.01
Consumer prices (consumption deflator)	- 0.15	- 0.20	- 0.26	- 0.11	0.07
Wages/earnings	- 0.08	- 0.18	- 0.10	0.02	0.09
Unit labour cost	- 0.18	- 0.24	- 0.01	0.17	0.21
Import prices	- 1.58	- 0.60	- 0.00	- 0.01	- 0.00
5. Government accounts (% of nominal GDP)					
Revenues	- 0.09	- 0.06	0.01	0.05	0.06
Primary expenditures	0.20	0.33	0.10	- 0.07	- 0.11
Interest payments	0.20	0.27	0.17	0.16	0.14
Financial deficit	0.49	0.67	0.26	0.05	- 0.02
Public sector debt	0.46	1.25	1.49	1.36	1.18
6. Current account (% of nominal GDP)	- 0.51	- 0.43	0.09	0.05	- 0.10
Trade balance	- 0.02	- 0.01	0.13	0.08	- 0.03
Net interest payments abroad	0.46	0.42	0.07	0.05	0.05

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table III - UNITED KINGDOM

Contributions to GDP changes by channel of transmission and by variable

Policy experiment: Temporary increase in UK short-term interest rates

	Total	**Income/ cash flow**	**Wealth**	**Direct con-sumption**	**Cost of capital**	**Exchange rate**	**Discre-pancy**
Real GDP: first year after shock*	**- 0.92**	**- 0.03**	**0.00**	**- 0.05**	**- 0.36**	**- 0.50**	**0.00**
of which:							
Private consumption	- 0.17	- 0.03	0.00	- 0.05	- 0.05	- 0.03	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.25	- 0.00	0.00	- 0.00	- 0.25	0.01	0.00
Residential private investment	*- 0.11*	*- 0.00*	*0.00*	*- 0.00*	*- 0.12*	*0.01*	*0.00*
Non-residential private investment	*- 0.13*	*- 0.00*	*0.00*	*- 0.00*	*- 0.13*	*0.00*	*0.00*
Inventory formation	- 0.10	0.00	0.00	- 0.00	- 0.12	0.02	0.00
Exports	- 0.23	- 0.00	0.00	- 0.00	- 0.01	- 0.22	- 0.00
Imports	0.19	- 0.01	0.00	- 0.01	- 0.07	0.28	0.00
Real GDP: second year after shock*	**- 1.20**	**- 0.05**	**0.00**	**- 0.05**	**- 0.53**	**- 0.56**	**- 0.00**
of which:							
Private consumption	- 0.44	- 0.07	0.00	- 0.08	- 0.12	- 0.18	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.50	- 0.01	0.00	- 0.01	- 0.48	- 0.00	- 0.00
Residential private investment	*- 0.22*	*- 0.01*	0.00	*- 0.00*	*- 0.22*	*0.01*	*- 0.00*
Non-residential private investment	*- 0.28*	*- 0.00*	0.00	*- 0.01*	*- 0.26*	*- 0.01*	*- 0.00*
Inventory formation	- 0.14	- 0.00	0.00	- 0.00	- 0.13	0.00	0.00
Exports	- 0.21	0.00	0.00	0.00	- 0.02	- 0.18	- 0.00
Imports	- 0.08	- 0.03	0.00	- 0.03	- 0.22	0.20	0.01
Real GDP: third year after shock*	**- 0.31**	**- 0.02**	**0.00**	**- 0.01**	**- 0.09**	**- 0.18**	**- 0.02**
of which:							
Private consumption	- 0.34	- 0.05	0.00	- 0.04	- 0.06	- 0.19	0.00
Government expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.24	- 0.01	0.00	- 0.00	- 0.23	0.01	- 0.01
Residential private investment	*- 0.09*	*- 0.00*	0.00	*0.00*	*- 0.09*	*0.01*	*- 0.01*
Non-residential private investment	*- 0.15*	*- 0.00*	0.00	*- 0.00*	*- 0.14*	*- 0.00*	*- 0.01*
Inventory formation	0.00	- 0.00	0.00	- 0.00	0.01	- 0.00	- 0.00
Exports	- 0.03	0.00	0.00	0.00	- 0.01	- 0.03	- 0.00
Imports	- 0.29	- 0.03	0.00	- 0.03	- 0.21	- 0.03	0.01

* In percentage deviation from baseline. Due to rounding errors, the contributions by variables may not add to the total effect.

Table Ia - UNITED STATES

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in US short-term interest rates with exogenous exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.17	1.00	- 0.17	- 0.16	- 0.08
Real long-term interest rate (%)	0.27	0.07	- 0.04	- 0.01	0.01
5. Exchange rates					
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	- 0.05	- 0.15	- 0.12	0.01	0.10
6. Asset prices					
7. Monetary aggregate	- 1.98	- 3.03	- 1.20	- 0.07	0.30

Table IIa - UNITED STATES

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in US short-term interest rates with exogenous exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.33	- 0.47	- 0.14	0.09	0.19
Private consumption	- 0.09	- 0.19	- 0.16	- 0.06	0.03
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.90	- 2.70	- 0.72	0.68	1.20
Residential	- 2.12	- 3.58	- 1.20	1.23	2.12
Non-residential	- 0.91	- 1.62	- 072	0.31	0.76
Inventories	- 27.50	- 23.92	4.60	4.98	3.64
Exports	0.02	0.09	0.12	0.07	0.01
Imports	- 0.35	- 0.85	- 0.65	- 0.13	0.27
2. Unemployment rate (%)	0.33	0.42	0.05	- 0.17	- 0.24
3. Real disposable income	- 0.07	- 0.21	- 0.05	0.16	0.23
4. Inflation and wages					
GDP deflator	- 0.10	- 0.24	- 0.16	0.02	0.16
Consumer prices (consumption deflator)	- 0.10	- 0.23	- 0.14	0.02	0.15
Wages/earnings	- 0.04	- 0.08	- 0.03	0.04	0.08
Unit labour cost	- 0.05	- 0.06	0.05	0.12	0.15
Import prices	- 0.01	- 0.04	- 0.06	- 0.03	0.02
5. Government accounts (% of nominal GDP)					
Revenues	- 0.09	- 0.07	0.01	0.02	0.02
Primary expenditures	0.13	0.17	0.04	- 0.04	- 0.08
Interest payments	0.39	0.40	0.10	0.09	0.07
Financial deficit	0.60	0.64	0.13	0.02	- 0.03
Public sector debt	0.59	1.35	1.37	1.13	0.94
6. Current account (% of nominal GDP)	- 0.27	- 0.22	0.03	- 0.01	- 0.05
Trade balance	0.03	0.07	0.06	0.02	- 0.01
Net interest payments abroad	0.30	0.30	0.04	0.04	0.04

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table Ib - UNITED STATES

Interest rates, exchange rates and asset prices

Policy experiment: Temporary global increase in short-term interest rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	1.00	1.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	1.00	1.00	0.00	0.00	0.00
Representative long-term interest rate	0.28	0.12	0.00	0.00	0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	1.17	0.99	- 0.19	- 0.20	- 0.11
Real long-term interest rate (%)	0.26	0.06	- 0.05	- 0.02	0.02
5. Exchange rates					
Nominal effective exchange rate	0.00	0.00	0.00	0.00	0.00
Real effective exchange rate	- 0.03	- 0.08	- 0.05	- 0.01	0.01
6. Asset prices					
7. Monetary aggregate	- 1.97	- 3.01	- 1.17	0.01	0.44

Table IIb - UNITED STATES

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary global increase in short-term interest rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	- 0.33	- 0.47	- 0.13	0.14	0.27
Private consumption	- 0.06	- 0.11	- 0.08	0.01	0.09
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 1.86	- 2.60	- 0.59	0.78	1.24
Residential	- 2.02	- 3.36	- 0.98	1.34	2.08
Non-residential	- 0.89	- 1.57	- 0.65	0.38	0.80
Inventories	- 27.58	- 23.81	5.29	6.01	4.49
Exports	- 0.21	- 0.51	- 0.36	0.05	0.39
Imports	- 0.32	- 0.74	- 0.49	- 0.01	0.32
2. Unemployment rate (%)	0.32	0.42	0.05	- 0.21	- 0.31
3. Real disposable income	0.09	- 0.05	- 0.03	0.20	0.29
4. Inflation and wages					
GDP deflator	- 0.09	- 0.23	- 0.14	0.07	0.23
Consumer prices (consumption deflator)	- 0.10	- 0.22	- 0.13	0.07	0.23
Wages/earnings	- 0.04	- 0.07	- 0.01	0.08	0.15
Unit labour cost	- 0.05	- 0.05	0.06	0.16	0.21
Import prices	- 0.03	- 0.12	- 0.11	0.02	0.19
5. Government accounts (% of nominal GDP)					
Revenues	- 0.02	- 0.01	0.02	0.02	0.02
Primary expenditures	0.12	0.16	0.04	- 0.06	- 0.10
Interest payments	0.38	0.39	0.09	0.07	0.05
Financial deficit	0.52	0.56	0.11	- 0.01	- 0.07
Public sector debt	0.54	1.21	1.18	0.90	0.64
6. Current account (% of nominal GDP)	- 0.10	- 0.09	- 0.00	- 0.01	- 0.01
Trade balance	0.01	0.02	0.01	0.01	0.00
Net interest payments abroad	0.10	0.11	0.01	0.02	0.02

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).

Table Ic - CANADA

Interest rates, exchange rates and asset prices

Policy experiment: Temporary increase in US short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Policy-controlled interest rate (%)	0.00	0.00	0.00	0.00	0.00
2. Market determined interest rates (%)					
Representative short-term interest rate	0.00	0.00	0.00	0.00	0.00
Representative long-term interest rate	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00
3. Other interest rates (%)					
4. Real interest rates					
Real short-term interest rate (%)	0.12	0.18	0.00	- 0.05	- 0.05
Real long-term interest rate (%)	0.04	0.02	- 0.01	- 0.01	0.00
5. Exchange rates					
Nominal effective exchange rate	- 1.61	- 0.62	0.00	0.00	0.00
Real effective exchange rate	- 0.61	- 0.09	0.11	0.02	- 0.02
6. Asset prices					
7. Monetary aggregate	0.16	0.21	0.02	0.00	0.10

Table IIc - CANADA

Real economic activity, price developments, fiscal developments and the foreign sector

Policy experiment: Temporary increase in US short-term interest rates with floating exchange rates					
Deviations from baseline*	**1994**	**1995**	**1996**	**1997**	**1998**
1. Real GDP and its components					
Real GDP	0.15	0.05	- 0.06	- 0.02	0.06
Private consumption	- 0.06	- 0.00	0.02	0.01	0.03
Government expenditure	0.00	0.00	0.00	0.00	0.00
Private investment	- 0.21	- 0.35	- 0.13	0.06	0.16
Residential	- 0.23	- 0.39	- 0.15	0.14	0.24
Non-residential	- 0.12	- 0.21	- 0.13	- 0.00	0.09
Inventories	- 2.68	- 4.23	0.07	1.18	1.17
Exports	0.21	- 0.12	- 0.31	- 0.13	0.09
Imports	- 0.48	- 0.45	- 0.12	0.01	0.05
2. Unemployment rate (%)	- 0.14	- 0.05	0.05	0.00	- 0.07
3. Real disposable income	- 0.08	0.07	0.01	0.01	0.05
4. Inflation and wages					
GDP deflator	0.04	0.06	0.02	0.01	0.04
Consumer prices (consumption deflator)	0.25	0.10	- 0.01	0.00	0.05
Wages/earnings	0.01	0.02	0.01	0.01	0.03
Unit labour cost	0.02	0.03	0.02	0.03	0.04
Import prices	0.82	0.23	- 0.10	- 0.02	0.07
5. Government accounts (% of nominal GDP)					
Revenues	0.01	0.01	0.00	0.01	0.01
Primary expenditures	- 0.01	- 0.01	0.01	0.00	- 0.02
Interest payments	- 0.01	- 0.01	- 0.00	- 0.00	- 0.01
Financial deficit	- 0.03	- 0.03	0.01	- 0.01	- 0.05
Public sector debt	- 0.10	- 0.09	- 0.02	- 0.03	- 0.12
6. Current account (% of nominal GDP)	0.05	0.15	0.01	- 0.01	0.02
Trade balance	0.02	0.07	- 0.01	- 0.03	0.00
Net interest payments abroad	- 0.04	- 0.07	- 0.02	- 0.02	- 0.02

* Percentage deviations if the baseline is in levels or an index; absolute differences if the baseline is in percentages (indicated by a % sign).