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

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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]

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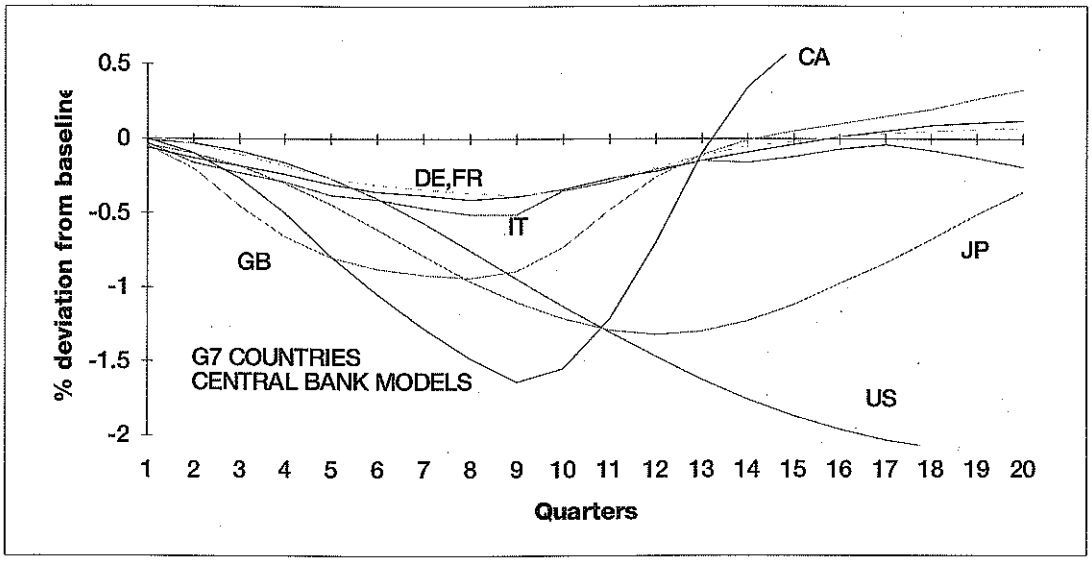
12 To the extent that multiplier effects become more important over time, they can also explain the more persistent effects in Japan and the United States in the third year and beyond.

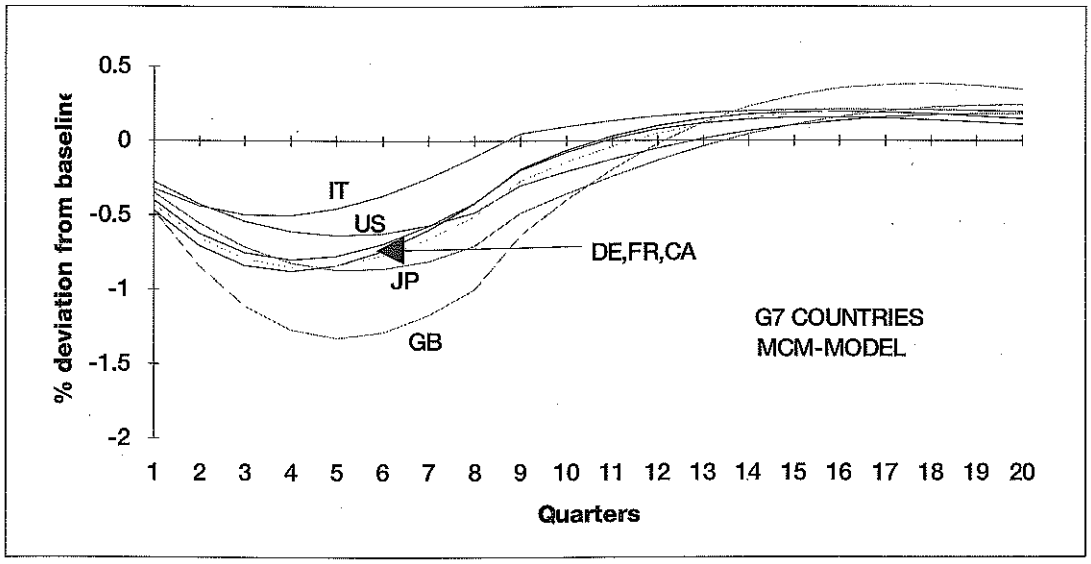
13 See Section IV.2.

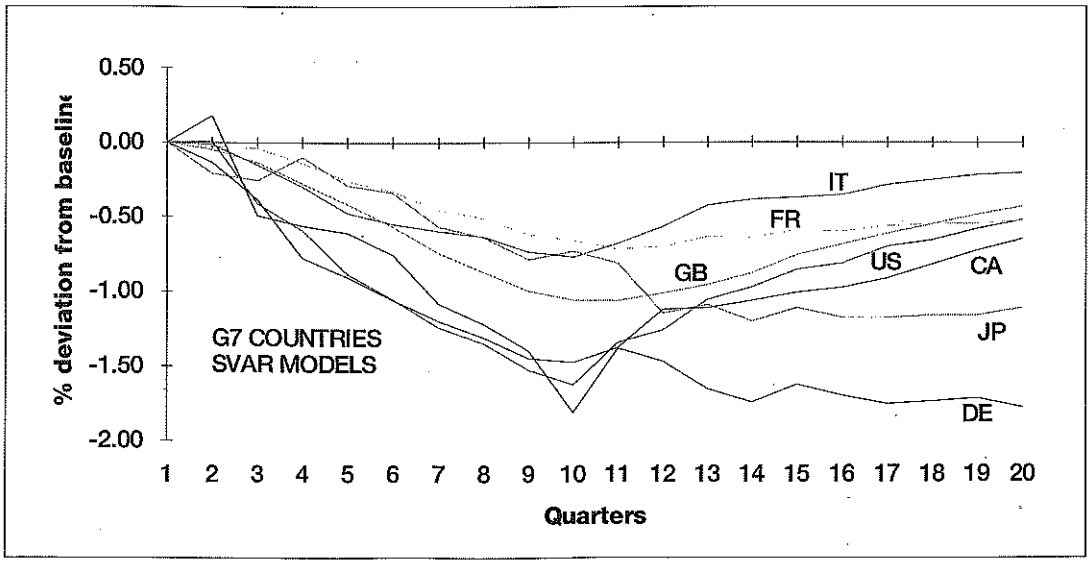
Graph 1

Real GDP responses to a 100 basis point increase in policy-determined interest rates during eight quarters

(G-7 countries)



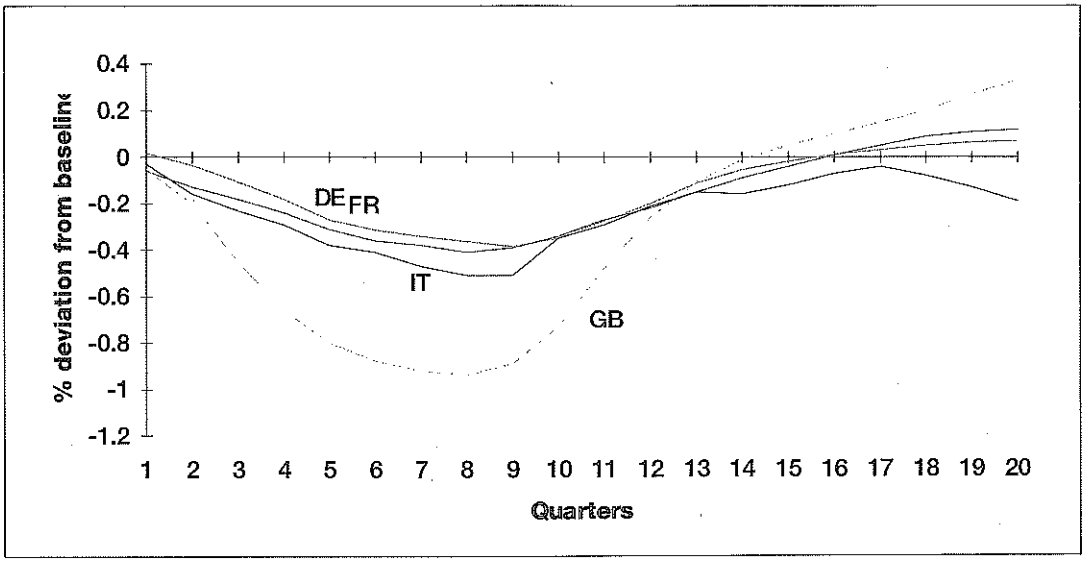


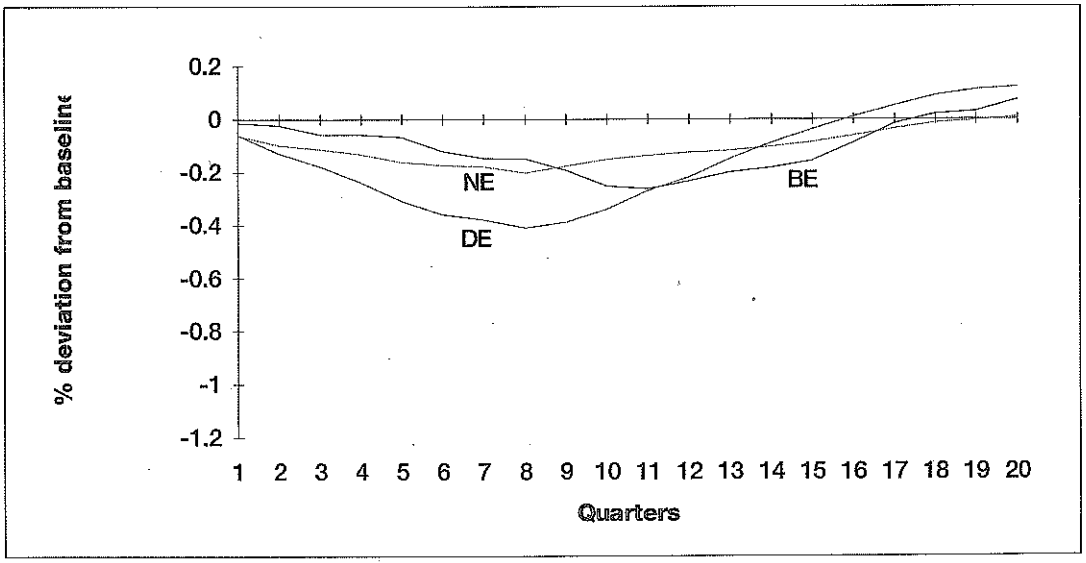


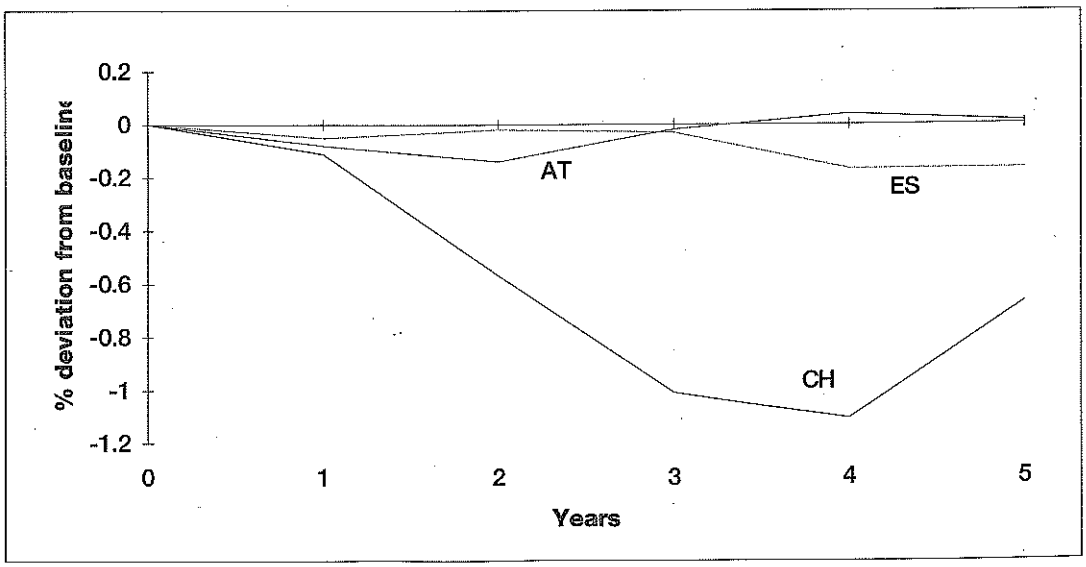
Graph 1 (cont.)

Real GDP responses to a 100 basis point increase in policy-determined interest rates during eight quarters

(selected European countries (central bank models))



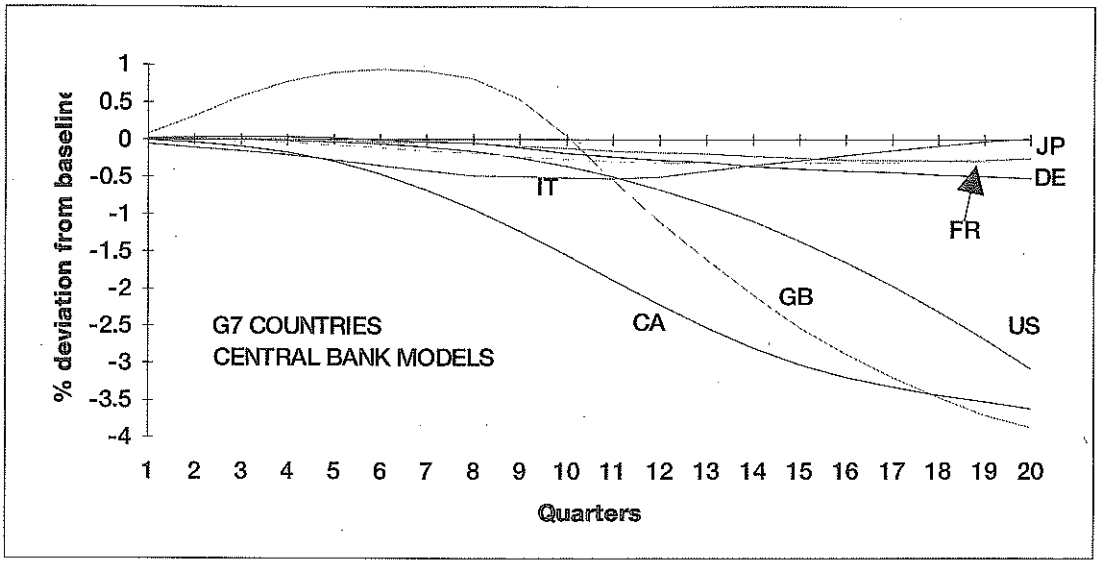


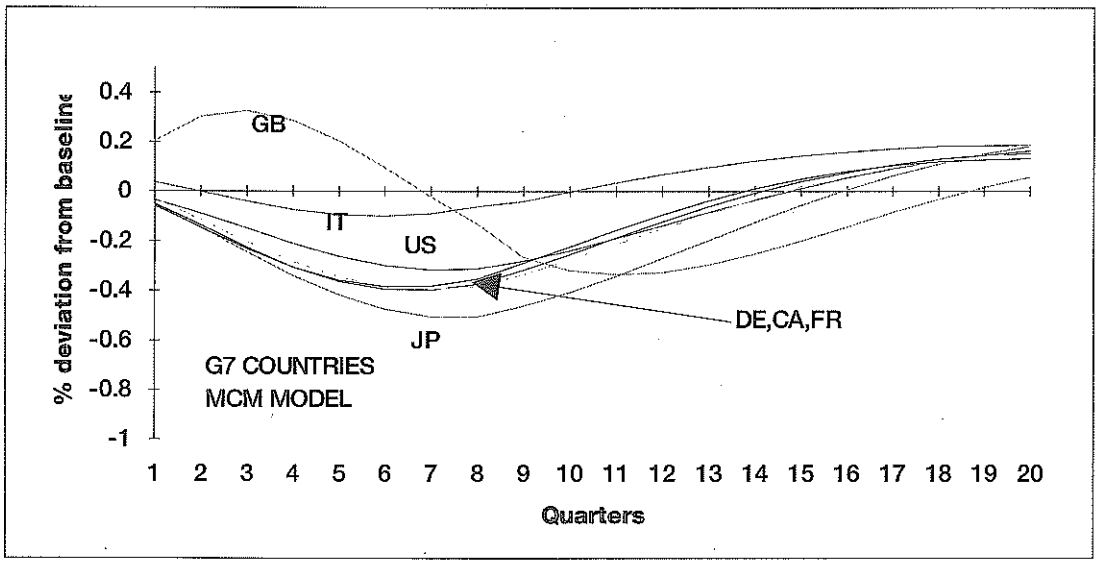


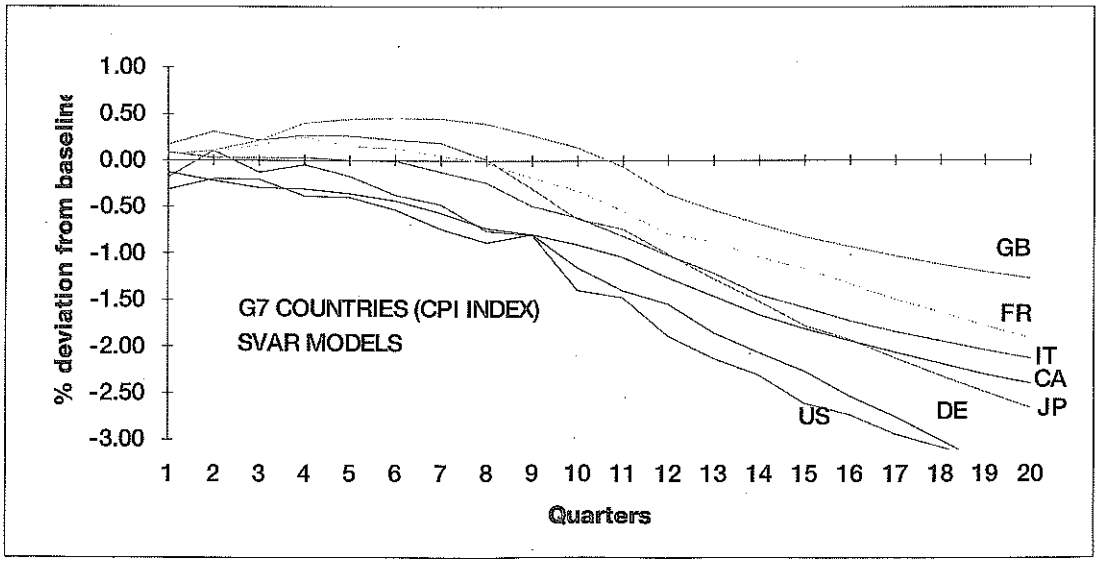
Graph 2

Responses of the GDP deflator to a 100 basis point increase in policy-determined interest rates during eight quarters

(G-7 countries (various models))



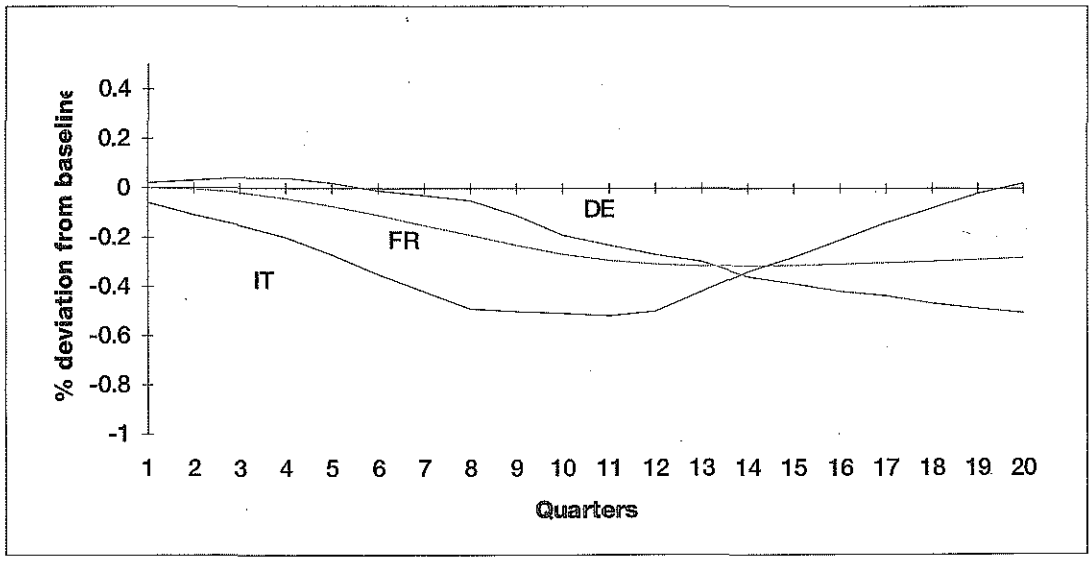


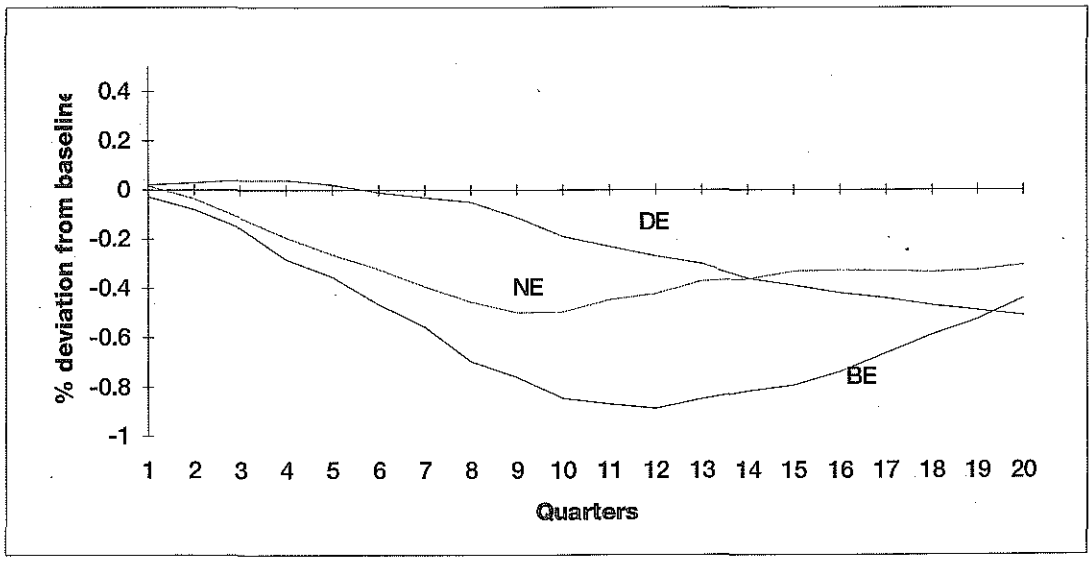


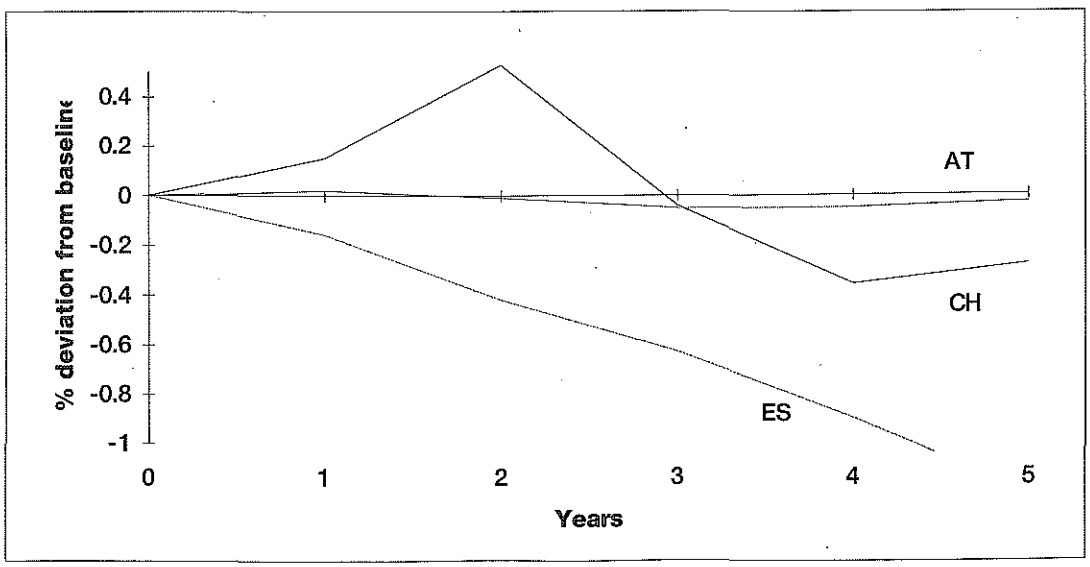
Graph 2 (cont.)

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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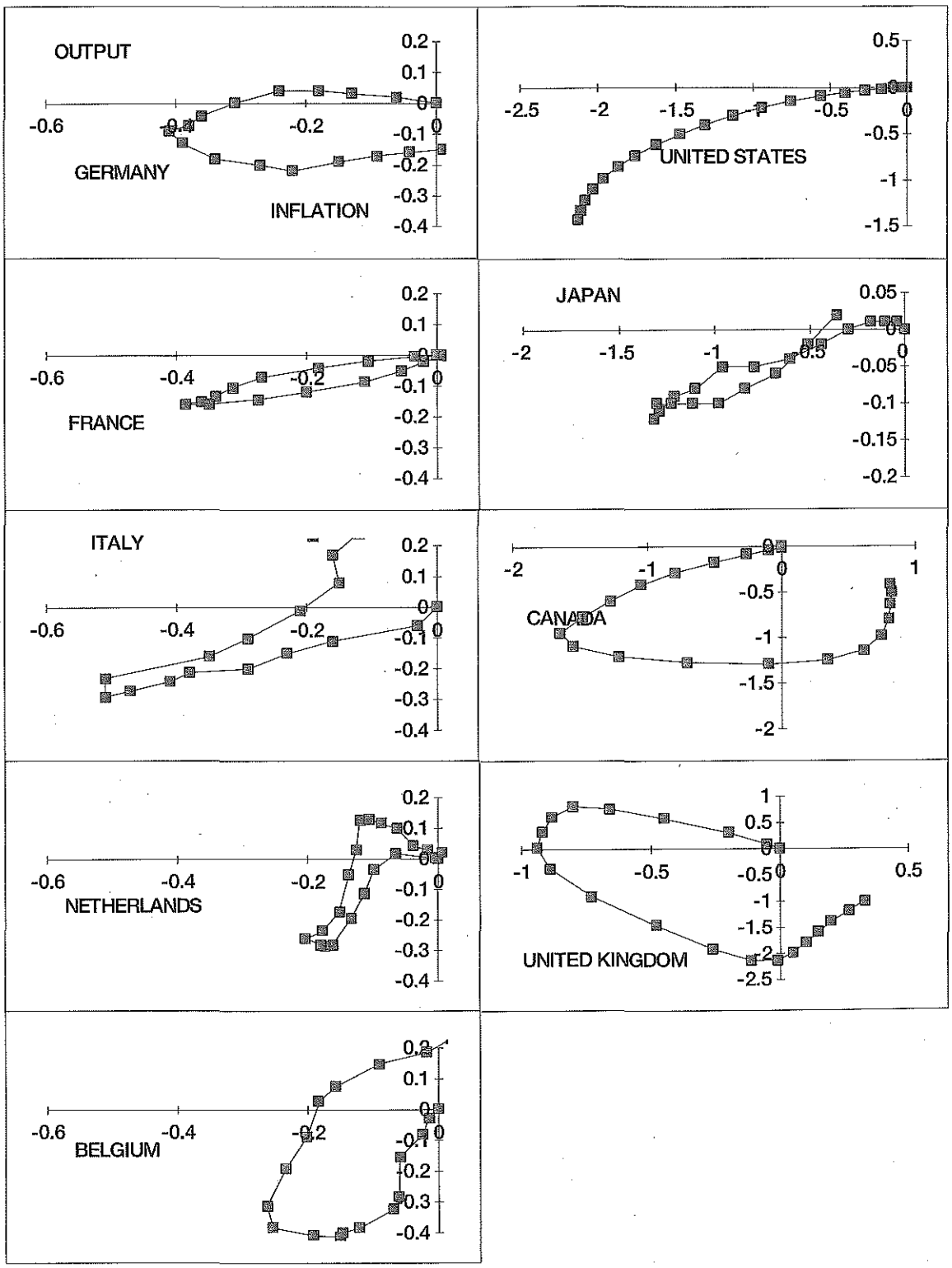
14 See e.g. Longworth and Poloz (1995) and Nicoletti Altimari et al. (1995). Whether this is a consensus view (as in the Bank of Canada) depends on the central bank in question. It should be mentioned that the use and importance of the central bank macroeconometric models in actual policy formulation 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.

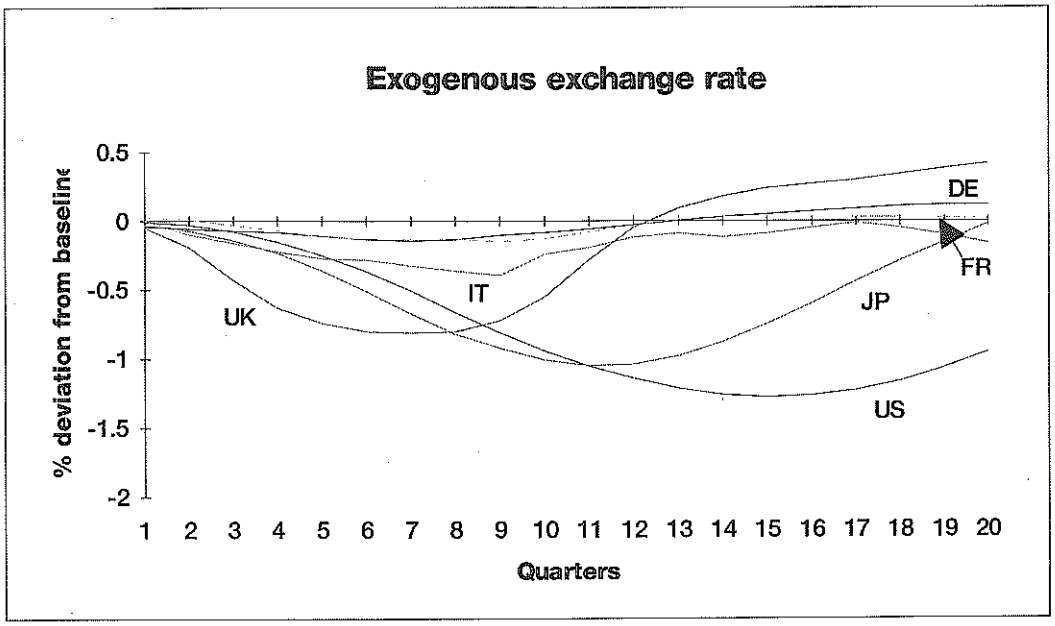
In order to control for the exchange rate channel (which is not at the heart of the issues that we want to address in this exercise), it was also agreed to perform the simulation experiment with exogenous nominal exchange rates. The resulting differences in output responses are depicted in Graph 4. Alternatively, we can look at the contribution of the exchange rate channel to the decline in

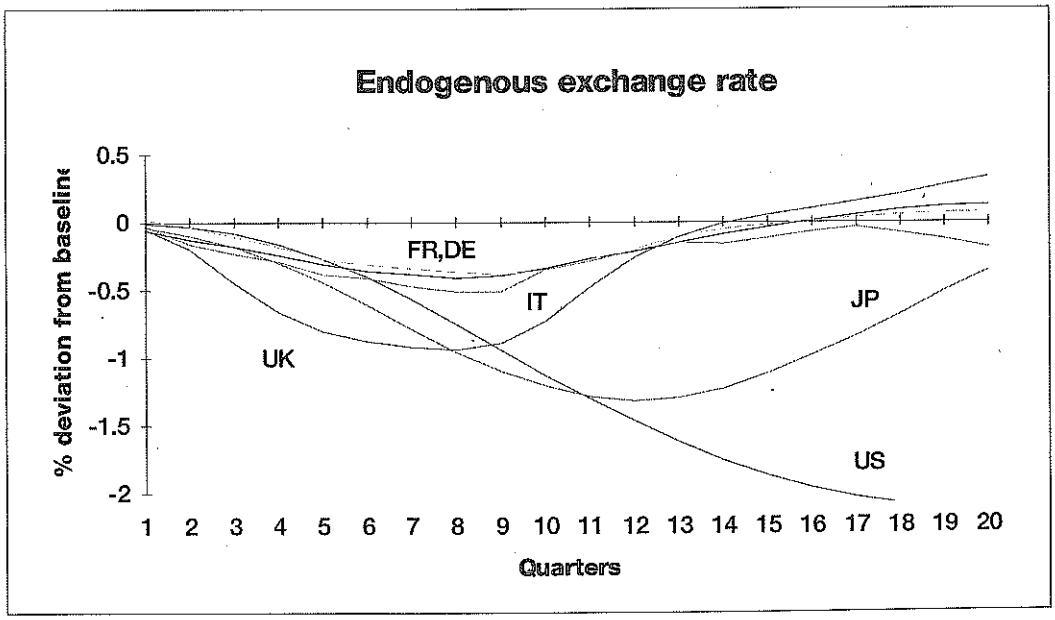
16 In order to increase the comparability with the other European countries, the Italian simulation results plotted in Graphs 1 to 6 are taken from the second policy experiment reported in Nicoletti Altimari et al. (1995), which involves an ERM-coordinated interest rate increase. The different effect 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.

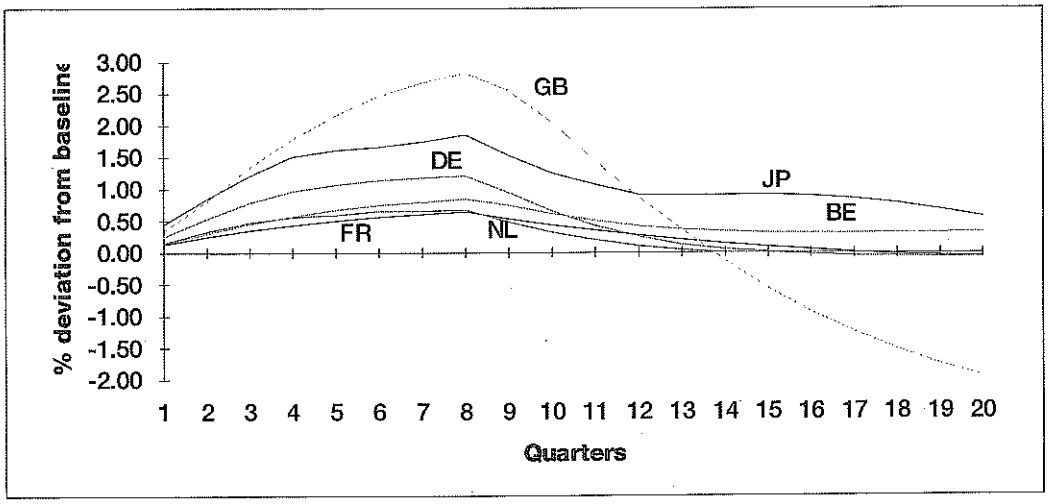
19 See Table III.2.

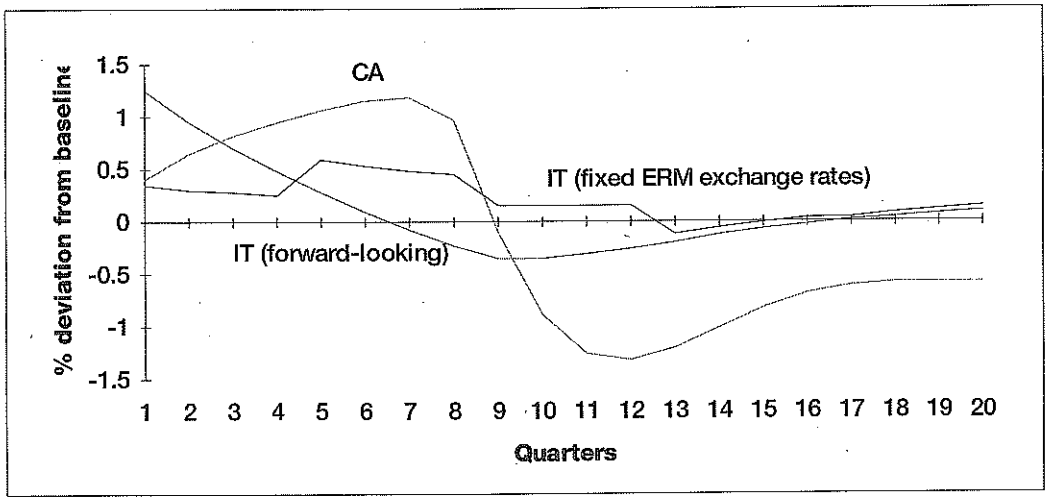
20 For the United Kingdom this depends on the exclusion of the mortgage payments and real balance channel. If the latter are included the effect on domestic demand in the United Kingdom more than doubles.

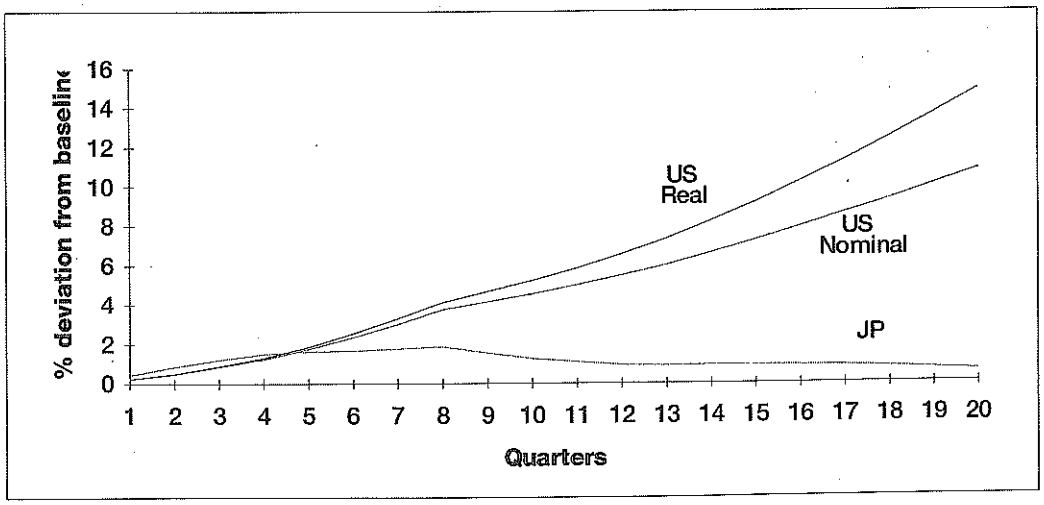
Graph 5

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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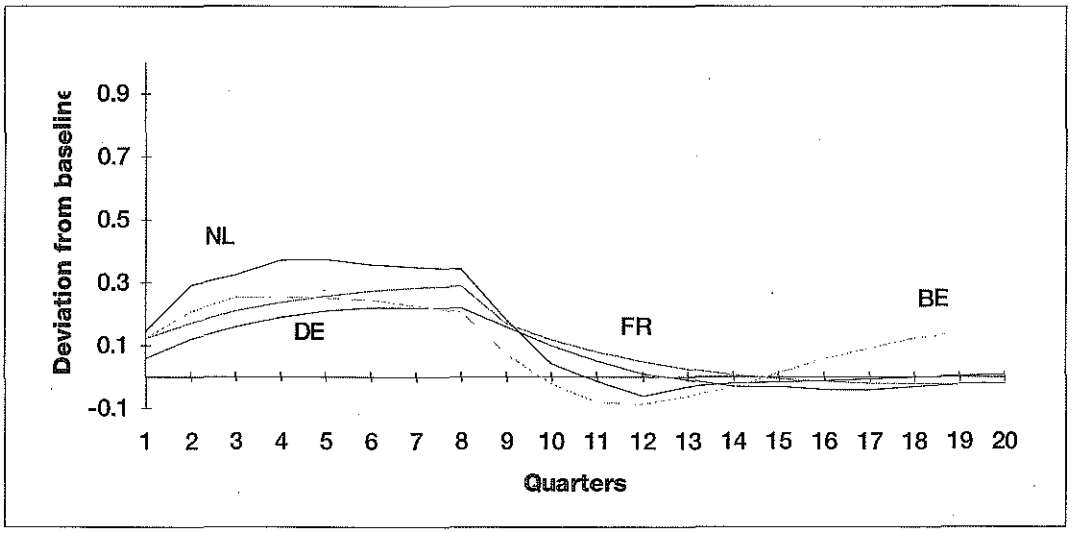
23 Recall that in the MCM simulations this issue does not arise as the response of the nominal long-term rate is identical across countries.

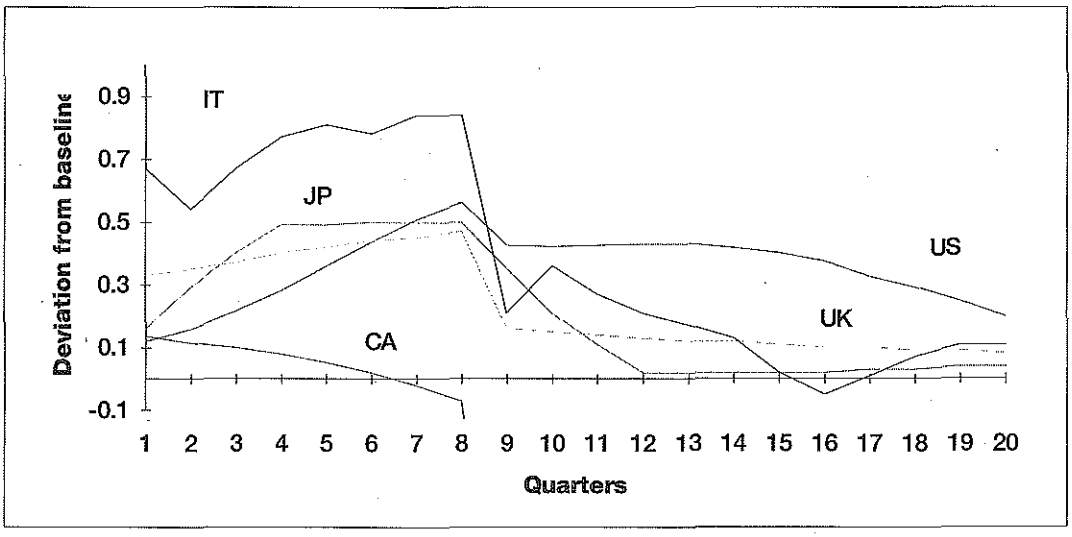
24 The maturity of the long rates will also determine their responsiveness. See e.g. Nicoletti et al. (1995) for one reason why the Italian long rates respond so vigorously.

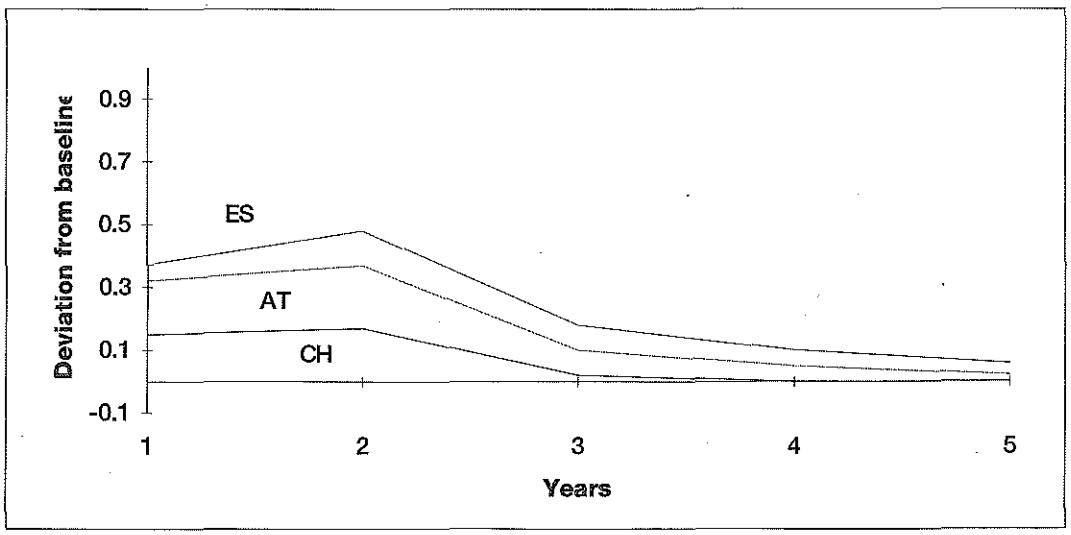
Graph 6

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			Exchange rate channel
			Income/ cash flow	Direct interest rate effect	Cost of capital	
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			Exports	Imports
			Private consumption	Government expenditure	Private investment		
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 consumption**	**Cost of capital**	**Exchange rate**	**Discrepancy[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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