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MONEY DEMAND STABILITY AND CURRENCY SUBSTITUTION IN SIX EUROPEAN COUNTRIES (1980-1992)

by

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1. Introduction[1]

During the 1980s the role of monetary aggregates in the overall framework of monetary policy changed dramatically in Europe from one where the money stock performed the function of the main intermediate target in the largest European economies to one where, except in Germany, monetary developments are monitored, along with other indicators, in a much more eclectic approach to monetary policy. Several economic developments explain this regime shift.

First, the transition from direct to indirect instruments of monetary control, together with financial liberalisation and market innovations, increased the volatility of monetary aggregates, affecting their relationship with the final goals of monetary policy. In particular, following the progressive liberalisation of capital account transactions, currency substitution may have become an important source of instability of national monetary aggregates, to the extent that cross-border deposits, a fast-growing share of banks' liabilities not included in the traditional definitions of the money stock, move in ways that traditional determinants of money demand explain poorly.

A second, and perhaps more important, determinant of the reduced importance of monetary targeting was the increased priority assigned to the control of the exchange rate in the ERM. Exchange rate commitments induced a shift from a money rule to an interest rate rule and a much constrained scope for independent action in the control of money.

Third, the reduced reliance on monetary targeting can be traced to the growing perception that interest rate changes, rather than money, influence spending. As a result of financial innovation it became increasingly evident that the control of liquid assets would not have constrained spending as effectively as it did during the 1970s.

Finally, money demand was perceived as being less controllable by central banks through changes in short-term interest rates: as documented in a large and growing body of econometric evidence, changes in the term structure of interest rates have important effects on money holdings.

In sum, monetary aggregates were perceived as being less stably related to real income and prices, less controllable by central banks and less effective in constraining nominal demand. Consequently, except in Germany, monetary aggregates nowadays mainly play the role of information variables.

1 I am grateful to Ignazio Angeloni, Carlo Cottarelli, Peter Dittus, Carlo Monticelli and Ignazio Visco for many useful comments that led to significant improvements in the paper and to Stephan Arthur and Henri Bernard for the accurate preparation of the database. I would also like to express my special thanks to Stefan Gerlach for many insightful suggestions and careful reading of earlier versions of the paper and to Joyce Ogilvie Steuri for her perseverance and sense of humour during the painstaking typing of various versions of the manuscript and the preparation of charts. Of course, any remaining errors are solely my responsibility.

Yet stability of the demand for money remains a necessary property of monetary aggregates, irrespective of whether they are used as intermediate targets, in which case they need to be controllable and stably related to nominal income, or perform the role of information variables, in which case they need to be stably related to their determinants. From a policy perspective, therefore, the issue of ascertaining whether the demand for money balances is driven by long-term forces or is subject to unpredictable shifts, remains a central concern in the conduct of monetary policy and is the main focus of this paper.

The paper is structured as follows:

Section 2 discusses the main potential sources of instability of money demand in Europe originating from institutional changes in the financial system and currency substitution and illustrates the main approaches to model them. It then goes on to consider factors affecting the controllability of money demand and examines the rationale for, and the implications of, introducing into the estimated equations various rates of return on alternative financial assets.

In the literature - briefly reviewed in Section 3 - it is frequently argued that money demand equations may appear unstable if the dynamic specification of the equation is too rigid, as in the case of the partial adjustment models. The literature suggests that when error-correction models are used, these problems can be largely overcome. Section 4 introduces the mathematical specification of the estimated equations that belong to the general class of error-correction models. In Section 5 the statistical and economic properties of the estimated equations are discussed.

The last section summarises the main conclusions suggested by the empirical evidence: money demand in the countries reviewed in this study is reasonably stable and economically well behaved. The study also offers clear evidence that currency substitution is an important characteristic of the financial behaviour of European countries and an important source of instability of money demand if it is not properly accounted for in the specification of the equations.

2. Policy issues

The existence of a stable demand for money function has been increasingly challenged over the past fifteen years, both in the Anglo-Saxon countries and in continental Europe. At the beginning of the 1980s it was thought that the continental European countries experienced a satisfactory degree of stability in the monetary aggregates relative to North America and the United Kingdom, *"perhaps because they had not undergone such severe financial and economic disturbances"* (Boughton, 1992, p. 324).

In the course of the 1980s, however, the process of financial innovation, driven by technology and by the market, gained momentum. At the same time, important institutional changes led to a very much increased liberalisation of domestic and international financial transactions which fundamentally altered the working of financial markets.

Although the scope and speed of the deregulation process has not been uniform, in the majority of European countries it has been felt that the basic economic properties of the aggregate money demand function - an important nominal anchor for the conduct of monetary policy and a well-understood indicator of the stance of policy - have been significantly affected, and perhaps irreparably, damaged. First, the relationship between money holdings and nominal spending was perceived as being unstable. Second, money demand was considered less controllable by monetary authorities. Third, in some instances the economic properties of estimated money demand did not correspond to prior expectations suggested by theory.

The perception that money demand no longer possessed the two necessary properties (stability and controllability) that warrant monetary targeting led the majority of European central banks to abandon the targeting strategy that they adopted during the 1970s. Following the complete liberalisation of the capital account transactions of the balance of payments, this perception has been reinforced by increasing evidence of currency substitution.

Econometric evidence lent some support to the perceived instability of money demand. However, as pointed out by Boughton (1992, p. 324), *"at least some of the instabilities and statistical problems that have plagued the partial adjustment model may have resulted from the limited dynamics present in that model, rather than from shifts in portfolio behaviour"*. For this reason considerable attention has been given by the literature on how to best specify dynamic processes and to model financial innovations. Indeed, the error-correction approach has revived the expectation that once an unconstrained dynamic adjustment process is adopted, and once financial innovations are accounted for in the specification of money demand models, money demand equations may be no more unstable than they were in the past.

A. Domestic financial innovation, liberalisation and money demand instability

The deregulation process that took place in Europe during the 1970s, and which accelerated in the course of the following decade, took several directions.[2] A useful taxonomy includes the following main components of the deregulatory process:

- the transition from direct to indirect instruments of monetary control;

2 For a more detailed analysis of this process, with a special focus on the banking sector, see Borio and Filosa (1994).

- the broadening of the range of financial products available in the market;
- the diversification of financial intermediaries.

The progressive abandonment of the system of direct controls which, except in Germany, characterised the conduct of monetary policy in Europe during the 1970s, implied the lifting of monetary and credit ceilings, the removal of compulsory investment requirements and the elimination of restrictions on the setting of interest rates on the assets and liabilities of the banking sector. Significant changes in the reserve requirements regime also were introduced. As a consequence, money and credit tended - at least temporarily - to grow faster and to exhibit a greater variability than in the past. The regime shift may therefore have weakened the relationship between money and income because of changes in the monetary multiplier. In turn the liberalisation of interest rates may have lessened the ability of central banks to influence interest rate spreads and thus reduced the controllability of monetary aggregates.

In addition, the introduction of new financial instruments and the diversification of intermediaries, by increasing the overall liquidity of the system and by offering the public greater opportunities for allocating financial wealth across a much broadened range of assets, affected money demand in several ways. First, the direct liquidity constraint on spending was weakened or even disappeared altogether. Second, the availability of new short-term instruments has blurred the distinction between money and other liquid assets. Short-term instruments included in broad money may, in fact, be held by the public for speculative and not necessarily for transactions purposes; conversely, newly created instruments, not included in the definitions of money, may well be used as a medium of exchange. Money could therefore tend to be less strictly related to spending, while other liquid assets may be used to carry out non-financial transactions.

The effects of deregulation seem to have affected velocity differently across countries. The money stock may - in the long run - grow faster than nominal income to the extent that the public holds some components of broad money as financial wealth. In this case, one would expect the estimates of the elasticity of real income with respect to money to be greater than one and the velocity of money to follow a declining trend. It may also happen, however, that the introduction of new financial instruments induces the public to reallocate its liquid assets from currency and bank deposits to the newly created financial instruments. Since they are not included in the definition of money, velocity may increase. This, as Chart 1 shows, has been the case in Italy, the only country among those considered here showing a clear tendency to economise on money holdings.

The potential effects of deregulation on the dynamics of money demand and velocity have stimulated research on how to model financial innovation. Shift dummies are useful only when it is possible to identify the specific dates at which financial innovation occurs and when the effects on money are either of a one-off nature or permanent. In the majority of cases, however, the process has been evolutionary and, in general, the public has to go through a learning process before becoming accustomed to the innovation and changes its financial preferences. In these cases, the use of deterministic trends may be a better way to model financial innovation and the investors' learning process, and to eliminate instability from the estimated equations. For example, Porter, Spindt and Lindsey (1989) used a trend to explain the succession of innovations that led the private sector to economise on money holdings in the United States. Similarly, in the case of Italy, Muscatelli and Papi (1990) and Angelini, Hendry and Rinaldi (1994) used a logistic function to model the transition of money as a financial asset to money as a medium of transaction. Baba, Hendry and Starr (1992) and Hendry and Ericsson (1991) used exponential functions to model the time-varying coefficients of returns on various financial assets in their studies on the behaviour of M1 in the United States and the United Kingdom.

B. Currency substitution

The ability of money holders to shift among currencies in response to changes in certain economic variables is a second broad source of instability and misspecification of money demand equations. There are good reasons for believing that the importance of currency substitution has increased in Europe as a consequence of the progressive liberalisation of international financial transactions.

The effects of currency substitution on money demand are not a novel phenomenon, nor do they affect European countries in particular. The occurrence of currency substitution has been abundantly investigated and its relevance to the demand for money has been detected in a number of studies. However, a systematic pattern has failed to emerge and the question of its relevance is still controversial.

Several reasons make it difficult to demonstrate convincingly that currency substitution affects money demand. It is hard to evaluate whether the private sector can improve liquidity services at all by holding money denominated in different currencies (Giovannini and Turtelboom (1994)). In addition, to the extent that foreign variables influence the portfolio decisions of the public, the econometric specifications of money demand equations encounter severe difficulties because of the large number of highly collinear variables that potentially enter the demand equation. Finally, the measurement of devaluation expectations, which is a crucial determinant of currency substitution and an inherently unobservable variable, is the object of an unsettled theoretical and empirical debate.

For the purposes of this paper currency substitution is defined as the tendency of residents to replace domestic money with foreign currencies in response to changes in their relative rate of return, in particular the expected devaluation of the domestic currency. This definition implies that the mere ownership of foreign currency denominated balances by residents is not, on its own, a sufficient condition for currency substitution to occur. What is essential is that money holdings denominated in different currencies are responsive to economic variables: currency substitution then results when economic factors alter the relative importance of different currencies as a store of value.

The mechanism through which currency substitution operates is essentially the one described by McKinnon (1982), which assumes that Uncovered Interest Parity (UIP) holds. In a context of high capital mobility, UIP requires that the difference between domestic and foreign interest rates be equal to the devaluation expectation. If a devaluation of the currency is expected, residents reduce their domestic money balances and increase foreign currency denominated liquid assets whose return - namely the expected devaluation of the domestic currency - has increased. This effect is what McKinnon calls the "direct" currency substitution effect. In addition, residents who are sensitive to changes in the yield of domestic and foreign bonds will decrease domestic money holdings to buy both domestic bonds (under the assumption that UIP holds, the domestic interest rate will have increased) and foreign bonds (whose return will also have increased because of the expected devaluation). Thus, domestic money is substituted "indirectly" in the portfolio as a result of the increase in the yield on domestic and foreign bonds.[3] Direct and indirect currency substitution would thus reduce demand for the devaluing money and increase that of the revaluing currency.

Following this approach, it is natural to consider the money demand equation in the context of the portfolio balance framework used, for example, by Cuddington (1983) and more recently by Mizen and Pentecost (1994). Assuming that the interest rate on money is equal to zero and that there are only two alternative assets (domestic and foreign bonds) the portfolio model can be written as follows:

$$\begin{aligned}
M-P &= \alpha_0 Y + \alpha_1 r + \alpha_2(r^* + EE) + \alpha_3 EE \\
B-P &= \beta_0 Y + \beta_1 r + \beta_2(r^* + EE) + \beta_3 EE \\
M^*-P^*+s &= \gamma_0 Y + \gamma_1 r + \gamma_2(r^* + EE) + \gamma_3 EE \\
B^*-P^*+s &= \delta_0 Y + \delta_1 r + \delta_2(r^* + EE) + \delta_3 EE
\end{aligned}$$

where M, P, Y, B and s are the logarithms of money, price level, real income, the stock of bonds and the spot exchange rate respectively; r is the interest rate and EE is the expected devaluation rate of the domestic currency (the asterisk denotes foreign variables).

In this framework, if the return on foreign bonds (r^* + EE) and that on foreign currency (EE) increase because the domestic currency is expected to devalue, the demand

3 McKinnon assumes that domestic and foreign interest rates may both adjust in response to the expected devaluation (the domestic rate rises instantaneously and the foreign rate falls): in this case the indirect currency substitution may be stronger.

for domestic money will be reduced as α_2, $\alpha_3 < 0$. Under the assumption that UIP holds ($r\text{-}r^* = EE$), the money demand equation becomes:

$$M\text{-}P \quad = \quad \alpha_0 Y + (\alpha_1 + \alpha_2)\, r + \alpha_3 EE.$$

The error-correction specification of this basic equation is provided in Section 5.

C. The economic properties of estimated money demand equations

Several studies have shown that the economic properties of estimated money demand equations sometimes do not correspond to prior expectations suggested by theory, or that the estimated elasticities are implausible. More precisely:

- data sometimes reject the hypothesis of unitary long-term price elasticity;
- estimated real income long-run elasticities range from negative values or may be unrealistically high;
- estimated short-term interest rate elasticities are positive and money demand seems to be significantly affected by the slope of the yield curve.

Concerning the *long-run price level elasticity*, theoretical models postulate that the demand for real balances is independent of the price level. For this reason, the long-run unitary price level elasticity has often been imposed *a priori* in the specification of the equations. However, when this assumption is empirically tested, data reject the hypothesis with some frequency.

There are several reasons for these empirical findings which theory does not justify. One is simultaneity bias; a second is aggregation bias, which may result if different economic agents, in their decisions concerning holdings of liquid assets, are guided by price developments whose behaviour differs from that of the aggregate price indices used in the estimated equations or if different sectors of the economy have different money holding propensities and strategies. Estimated price elasticities that differ from one may also arise because of an inadequate dynamic specification of the model, in particular when inflation is highly volatile - as was the case during the 1980s. In these cases, the rejection of unitary long-term price elasticities is best interpreted as evidence of misspecification.

As far as the *elasticity of real income* is concerned, there is no theoretical basis for expecting unitary long-run elasticity. The Baumol-Tobin type of model leads one to expect real income elasticities of the order of 0.5; Friedman-type models, on the other hand, allow for long-run elasticities that may well be in excess of one. Indeed, as suggested above, broad monetary aggregates may include liquid assets that represent an accumulation of financial wealth rather than monetary holdings for transactions purposes. If so, money stock may grow faster than income, in particular if wealth accumulation outpaces income growth. Discriminating between the two models is an empirical question. However, whether or not real income elasticity is greater or lower than one has an important bearing on the interpretation of the observed changes in velocity.

It is, in fact, incorrect to conclude that the pronounced trends and variability of velocity is evidence that the demand for money is unstable: upward or downward trends of velocity could be merely the effect of real income elasticities being, respectively, lower or higher than one. In addition, short-term changes in the rate of growth of real income inevitably produce cyclical fluctuations in velocity without necessarily indicating that the underlying relationship between money and real income is unstable. Finally, since short-run real income elasticities normally are smaller than longer-run ones, the observed variability in velocity may well be the result of a complex dynamics that some models fail to capture.

If changes in velocity and demand for money balances are due to the working of real income elasticities that differ from unity important policy implications follow:

(a) the stability of money demand (and perhaps its information content) may not be in question;

(b) monetary targeting is an appropriate long-term strategy (once the effect of real long-run income elasticities is allowed for) as the short-term variability of velocity around a stable longer-term trend does not necessarily reduce the nominal anchor role of monetary aggregates for the conduct of monetary policy;

(c) conversely, a fixed monetary target is not appropriate in the short run.

Whether changes in the *term structure of interest rates* affect the demand for real balances is a long-standing and unsettled issue.

One issue is whether only short-term interest rates should be entered in the demand for real balances or, alternatively, whether long-term interest rates should also be included in the set of explanatory variables. Friedman (1956) argued that the whole range of rates of return on financial and non-financial assets should be included in the explanation of demand for money balances. Examples of the opposite view are offered, for example, by Laidler (1966), who finds that short-term rates offer better results, at least from an empirical point of view.

Ando and Shell (1975) provide the theoretical justification for entering only short-term interest rates in the money equation. They argue that economic agents allocate their financial wealth between long-term risky assets and short-term assets (in their model money and saving deposits) independently of the demand for money and that transaction costs, that drive the split between money and saving deposits, do not depend on the riskier long-term assets. In this case only the rate of saving deposits enters the money demand function (assuming that the own rate on money is zero). This conclusion has been challenged by Baba, Hendry and Starr (1992). They demonstrate that if capital market imperfections are introduced in the Ando and Shell model - specifically if *"on the short-*

term money market, the individual can borrow only at a higher interest rate at which he can lend" or he can be rationed by lenders - *"long-term asset yield and risk enter the money demand function"* (Baba, Hendry and Starr (1992), p. 28).

A second set of issues concerns the value of the interest rate elasticities when short and long-term rates are used as separate explanatory variables. In a number of empirical studies the elasticities of long-term rates were found to be higher than the corresponding elasticities of short-term rates. Poole (1988) challenged the theoretical foundation of those findings by arguing that, under the expectation theory of the term structure of interest rates, the steady state elasticity of long-term and short-term rates should be equal since the long-term rate is a weighted average of expected short-term rates. However, empirical work has failed to confirm this hypothesis. For example, Boughton (1991) and Fase and Winder (1992 and 1993) show that not only do the elasticities of short-term interest rates differ from those of long-term rates, but also that they are normally positive, especially when equations for broad money aggregates are estimated. In these cases, the demand for real balances is affected by the slope of the yield curve. These findings, however, have two disturbing features: first, rises in short-term rates increase the demand for real balances rather than decrease it; and second, in the steady state, if the yield curve is stationary, real balances are unaffected by a general increase in interest rates if the short-term rate elasticity is equal, in absolute values, to that of long rates. In other words, these results may well imply that a monetary tightening would either have perverse effects or be ineffective.[4]

Following the removal or easing of restrictions on interest rates on banks' liabilities, there is no justification for assuming that the own rate on money is either zero or constant. In this case, to test whether the slope of the yield curve affects money demand one should include a measure of the own rate on money along with short and long-term interest rates and expect a positive elasticity for the own rate and negative elasticities for the returns on alternative assets. In interpreting the results of equations which include interest rates at different maturities, caution is required because, as Rasche (1994) has shown, when interest rates are non-stationary it is impossible to identify the elasticities of the various rates and only their sum can be identified.

4 However, money demand would still be indirectly reduced by the effects of monetary policy action on income and prices.

3. A selective review of existing econometric studies

Multi-country studies

An evaluation of the empirical performance of the three main competing research strategies followed in the modelling of money demand equations (partial adjustment, buffer-stock and error-correction models) and the assessment of the economic properties of the estimated equations are the two broad research subjects of a series of comparative studies on money demand for the five major industrial countries (Boughton and Tavlas 1990 and 1991; Boughton 1990, 1991 and 1992).

Prompted by dissatisfaction with the ability of the partial adjustment model to cope with the institutional changes that fundamentally altered the monetary transmission mechanism, but also encouraged by the emergence of new econometric techniques that have *"raised the possibility that models that combine a conventional steady-state function with a complex set of dynamics may be reasonably stable even over periods of substantial institutional change"* (Boughton, 1991, p. 2), the authors reach four conclusions about estimated money equations.

First. The partial adjustment model is an inadequate representation of the short-term dynamics: the rigidity it imposes on the complex adjustment process of money holdings after a shock may lead to the incorrect inference that the money demand equation is unstable. Buffer-stock and, even more so, error-correction models[5] suggest that the less restrictive the models are, the more satisfactory are the statistical properties of estimated equations (within-sample parameter stability and out-of-sample forecasting accuracy). Overall, their conclusion is that *"the demand for money is not generally less stable now than it was before* (institutional) *change occurred"* (Boughton, 1992, p. 323).

Second. The long-run economic properties of estimated equations differ substantially and the hypothesis of price homogeneity is often rejected by data.

Third. There is no stable link between money and nominal income, as real income and price elasticity differ. Concerning real income elasticity, there is no general evidence in support of the Baumol-Tobin hypothesis of economies of scale in money holdings. Long-run real income elasticities are found to be greater than one more frequently in the case of broad money than in the case of narrow money equations. In addition, in a few cases, estimated elasticities have either the wrong sign or are unrealistically large.

Fourth. Empirical evidence strongly supports the hypothesis of term structure effects, even on narrow money holdings: the negative elasticity of long-term rates is normally greater, in absolute value, than the positive elasticity of short-term rates, which

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5 They find some evidence that the one-step unrestricted error-correction model often performs better than two-step Engle-Granger equations.

are assumed - an assumption frequently discarded in many individual country studies - to represent the return on money.

Fase and Winder (1992 and 1993) and Fase (1993) present estimated equations for EC countries and a survey on the stability of the demand for money in the G-7 and EC countries respectively. Both studies conclude that there are marked differences in estimated elasticities: Fase's (1993) analysis of the frequency distribution of estimated parameters shows that the range of estimated elasticity is large, includes "outliers" and wrong signs for crucial elasticities, shows little evidence, outside the United States, of economies of scale in money holdings (in particular for broad aggregates), indicates frequent rejection of price homogeneity and shows little consistency across studies on the question of whether only short-term rates, to the exclusion of the long-term ones, have to be entered in the equation. While these conclusions confirm those of Boughton et al., Fase (1993) concludes that the *"survey presents little explicit indication for the stability of the demand for money"*. However, it has to be noted that he draws this conclusion with the rather unsophisticated support of the mere comparison of the size of the standard errors of the equations.

Multi-country studies that analyse the issue of currency substitution reach mixed conclusions. Systematic evidence in support of the hypothesis that money demand is affected by devaluation expectations vis-à-vis major currencies is far from being firmly established for several reasons. One is that the different indicators of the expected devaluation are often collinear. The second is that currency substitution in Europe is a recent phenomenon, as full capital account liberalisation - in particular for Italy and France - occurred only in the late 1980s or early 1990s. The third explanation is that currency substitution also depends on factors like tax changes and the removal of administrative barriers, which often produce only one-off effects. Finally, devaluation expectations are difficult to quantify and the use of uncovered interest parity may not measure expected devaluation appropriately as argued, for example, by Branson (1994).

In the European context, Angeloni, Cottarelli and Levy (1994) find that the pronounced increase in cross-border deposits (CBDs) in the EMS countries in the late 1980s has a bearing on the properties of individual countries' money demand equations. In particular, they show that broad money aggregates that include some categories of CBDs have a superior information content than that of traditional national aggregates which exclude CBDs. However, they fail to find any significant influence of devaluation expectations (proxied by the change in the spot exchange rate) on national money demand equations nor do they detect negative cross-country correlation among money demand residuals such as one would expect if currency substitution is important. By contrast, Monticelli and Papi (1994) find that the inclusion of various components of CBDs in the definition of "national" money stock adds little to the overall properties of money demand. Lane and Poloz (1992, p. iii) conclude from their study on currency substitution in the G-7 countries that *"tests reject the hypothesis that currency substitution does not affect money demand"* and also that *"both the static and dynamic equations yield significant and often negative correlations among the errors in money demand in different countries"*. Finally, while the studies of both Angeloni, Cottarelli and Levy and Lane and Poloz conclude that devaluation expectations do not have a statistically significant impact on money demand, Artis, Bladen-Hovell and Zhang (1993) find, by contrast, that devaluation expectations (proxied by the three-month forward premium) have a powerful and uniform influence on the money demand equations of individual EMS countries.

Individual country studies

Belgium

The existence of two cointegrating vectors for M3 and real income, price level and short and long-term interest rates was demonstrated by Jeanfils (1992 and 1994). He also finds that estimated equations are both remarkably stable and that they accurately predict out-of-sample. Statistical tests do not reject price homogeneity; he finds that the long-term real income elasticity is markedly greater than one, suggesting the presence of speculative motives in the decisions of money holders. The term structure of interest rates has significant effects on money holdings, as the short-term rate (which he regards as representative of the return on money) and the long-term rate have significant coefficients of opposite sign. The positive coefficient on the short term rate leads the author to conclude that despite the good stability and economic properties of the estimated equation, money demand lacks the necessary controllability properties to serve monetary targeting purposes. In the case of M1, he also finds potential currency substitution effects.

France

Less clear-cut results concerning both the stability and economic properties of the French money demand emerge from existing studies. Bordes and Strauss-Kahn (1989) fail to find the existence of a cointegrating relationship for M3 in the first stage of the Engle and Granger approach they adopt (money demand equations for M1 and M2A instead reveal cointegration).

More recently, Cassard, Lane and Masson (1994) have obtained more encouraging results: they find that real M3 cointegrates with real income, the price level (price homogeneity is imposed) and the spread between one measure of the own rate on money and a long-term interest rate. They also conclude that the stability of the equation cannot be rejected at the 1% confidence level but that it can be rejected at the 5% level. They also seem to argue that the equation shows controllability in the short run (as it emerges in the short-term dynamic equation of the second step of the Engle and Granger procedure). Finally, they hint at the presence of currency substitution as the short-term interest rate differential with Germany is found to be significant in some variants of the equation.

Germany

When pre-unification data are used, existing studies (Schmid and Herrmann (1991) and OECD (1993)) show that the money demand (M3) equations exhibit all the properties that make M3 suitable for monetary targeting. Since 1990, doubts about its stability have been raised by some authors, but existing studies are far from unanimous on this issue.

Von Hagen (1993) finds that German reunification has *"added monetary policy uncertainty"* as the variability of M3 quarterly velocity has increased and, more important, that parameter stability must be rejected for M3 (it can be accepted, however, for M1). A less firm conclusion is reached by the OECD. After allowing for a one-off shift of M3 in 1990, the OECD study does not detect significant changes in the parameters of the estimated equations and concludes that this result is *"not inconsistent with the proposition that - in the longer run - a stable relationship between monetary growth, changes in the real GDP and inflation may re-establish themselves once the system adjusts to the shock of unification"* (OECD, 1993, p. 118). Similar conclusions are also reached by Cassard, Lane and Masson (1994) as the existence of a cointegrating vector is established only in particular cases. The hypothesis of M3 stability after reunification is not rejected by Issing and Tödter (1994), Gerlach (1994) and the Deutsche Bundesbank (1995).

With regard to the economic properties of the estimated equation, the results lack uniformity. The long-run real income elasticity is found to be significantly greater than one by Issing and Tödter, and to be slightly greater than one by the OECD and the Deutsche Bundesbank; unitary elasticity is imposed by Gerlach and Fase and Winder. In most studies short-term rates are not found to be significant; the own rate on M3 has a positive effect on the demand for money balances in some of the studies mentioned above, which also show that long-term interest rates have a negative effect on the demand for M3 (larger than the positive one of the own rate).

Italy

The stability of the Italian demand for money (M2) and the consistency of its economic properties with theory have been established by recent studies (Banca d'Italia (1986), Muscatelli and Papi (1990) and Angelini, Hendry and Rinaldi (1994)), only when the significant shift away from money resulting from the institutional changes in the Italian financial markets is properly modelled. In the above-mentioned studies this is accomplished by adding a non-linear trend (see Section 5 below for details) to the set of explanatory variables.

The economic properties of the demand for money that emerge from these studies differ. In the Muscatelli and Papi equation the long-run elasticity of real income is significantly greater than one; in contrast, Angelini, Hendry and Rinaldi find a value that is consistent with that of the Baumol-Tobin model. These latter authors also conclude that M2 can be controlled by the central bank as the negative elasticity of the short-term rate implies effects on M2 that are greater than the positive ones owing to the positive elasticities of the own rate on money. In this study they also conclude that price homogeneity cannot be rejected by statistical tests.

Netherlands

Several recent studies give empirical evidence of the stability of the Dutch money demand and of the importance of portfolio considerations of money holders, as long-term rates and, more generally, term structure effects are significant. Estimated equations often indicate unitary long-run real income elasticities and price homogeneity. However, in their multi-country study Fase and Winder (1992 and 1993, p. 480) reject price homogeneity. Fase and Winder (1990) and Sterken (1992) also find, however, that the fit of the equation worsens towards the end of the 1980s in coincidence with a sharp increase in money demand of corporations and financial institutions. Both studies suggest the importance of disaggregating money demand by sector - disaggregate estimates can be found in the Sterken study - and the importance of wealth as a separate explanatory variable. Finally, Traa (1991) finds evidence of currency substitution (the level and the first difference of the US dollar/Dutch guilder exchange rate are found to be statistically significant). He also rejects price homogeneity.

United Kingdom

The instability of money demand equations for both narrow money and broader aggregates in the United Kingdom has been identified in many studies. Hall, Henry and Wilcox (1990) argue that instability is apparent so long as the set of explanatory variables is limited to the restricted number of conventional variables (income, price level and interest rates), particularly in the estimation of broad money equations. The stability of the equations is re-established when a more appropriate scale variable (i.e. wealth) is also used and when inflation and return on assets are included in the set of independent variables. Wealth becomes the determinant scale variable (with a long-run elasticity of around 0.70 compared with the a value of 0.3 for real income). In the case of M3 the coefficient of wealth is allowed to vary over time to better capture financial innovation. They fail to find any significant interest rate effect both in the long-run cointegrating vector and in the short-term dynamic equation of the second step of the Engle and Granger approach they use.

Hendry and Ericsson (1991) focus on M1 and find that the instability of conventional error-correction equation disappears when interest rate elasticity is allowed to vary according to a logistic "learning process" they derive from the Baba, Hendry and Starr (1992) model. Finally, Mizen and Pentecost (1994) test currency substitution effects on sterling real money demand held by EC residents. They find evidence of currency substitution between the currencies of some European countries (Germany, Belgium and Eire) and sterling holdings but also that currency substitution *"is not widespread in either the short or the long-run"* (p. 1,068).

4. Model specification

A standard specification of the error-correction model applied to the money demand equation is given by:

$$(1) \qquad \Delta(M-P)_t = -\alpha[(M-P)_{t-1} - \beta X_{t-1}] + \overline{\beta}_j \Delta X_{t-j} + \varepsilon_t$$

where X_t is the logarithm of a vector of explanatory variables.

Equation (1) allows the simultaneous estimation of both the long-run model and its short-term dynamic adjustment process[6] and is equivalent to a linear transformation of a linear autoregressive distributed lag model (see, for example, Banerjee, Dolado, Galbraith and Hendry (1993)).

The error-correction model used in this paper follows the specification adopted by Fase and Winder (1992 and 1993) and is designed, inter alia, to make testable the hypothesis that the long-run price elasticity is unitary. To do this, let Y, P and ΔP be, respectively, the logarithms of real income, the price level and its first differences. The short and long-term interest rates are indicated by r and R respectively. Let also X_k be a set of additional explanatory variables that capture financial innovation and currency substitution effects. If the time subscript is dropped for simplicity's sake, the general autoregressive distributed lag version of the nominal demand for money equivalent to (1) is:

$$(2) \qquad \alpha(L)M = c + \alpha^*(L)P + \beta_y(L)Y + \beta_r(L)r + \beta_R(L)R + \Sigma\, \beta_k(L)X_k + \varepsilon_t$$

where:
$$\alpha(L) = 1 - \alpha_1 L - \alpha_2 L^2 - .. - \alpha_n L^n$$
$$\alpha^*(L) = \alpha_0^* - \alpha_1^* L - \alpha_2^* L^2 - .. - \alpha_n^* L^n$$
$$\beta_i(L) = \beta_{i0} + \beta_{i1} L + \beta_{i2} L^2 + \; .. \; + \beta_{ini} L^{ni}$$

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6 Equation (1) is equivalent to the two-step approach proposed by Engle and Granger (1987). In the context of the money demand equation their specification could be written as follows:

$$(a) \qquad M_t - P_t = \beta X_t + \varepsilon_t$$
$$(b) \qquad \Delta(M-P)_t = -\alpha\hat{\varepsilon}_{t-1} + \overline{\beta}_j \Delta X_{t-j} + \mu_t$$

where $j \geq 0$, μ_t = N.I.D. $(0,\sigma^2)$, $\alpha > 0$, and ε_t is stationary.

Equation (a) is the long-run money demand equation whose formulation is suggested by economic theory; equation (b) is the short-term dynamic specification of the adjustment to the long-run solution. In the two-step approach equation (a) is estimated first to obtain $\hat{\varepsilon}_t$. If $\hat{\varepsilon}_t$ is stationary, it is used, in the second step, as an explanatory variable in equation (b). Equation (1) is obtained by substituting into equation (b) the expression for ε_{t-1} obtained from equation (b).

In (2) the restriction has been imposed that the number of lags is the same for M and P, while other variables' lags (ni) could differ. To avoid the perfect multi-collinearity between P and ΔP and their lagged values, the restrictions $\alpha_j^* = -\alpha_j$ for j=1, ..., n are imposed so that equation (2) can be rewritten as:

$$(3) \quad \alpha(L)(M-P) = c + (\alpha_0^* - 1)P + \beta_p(L)\Delta P + \beta_y(L)Y + \beta_r(L)r + \beta_R(L)R + \Sigma\, \beta_k(L)X_k + \varepsilon$$

The error-correction model corresponding to the autoregressive distributed lag expression (2) is obtained by a linear transformation expression to obtain:

$$(4) \quad \overline{\alpha}(L)\Delta(M-P) = c - \alpha(M-P)_{-1} + (\alpha_0^* - 1)P + \beta_p \Delta P + \overline{\beta}_p(L)\Delta P + \beta_y Y_{-1} + \overline{\beta}_y(L)\Delta Y$$
$$+ \beta_r r + \overline{\beta}_r(L)\Delta r + \beta_R R + \overline{\beta}_R(L)\Delta R + \Sigma\left[\beta_k X_k + \overline{\beta}_k(L)\Delta X_k\right] + \varepsilon_t$$

where

$$\alpha = 1 - \alpha_1 - \alpha_2 - .. - \alpha_n$$

$$\beta_i = \sum_{j=o}^{ni} \beta_{ij}$$

$$\overline{\alpha}(L) = 1 - \overline{\alpha}_1 L - \overline{\alpha}_2 L^2 - .. - \overline{\alpha}_{n-1} L^{n-1} \qquad \left(\overline{\alpha}_i = -\sum_{j=i+1}^{n} \alpha_j \quad \text{for } i = 1,\ 2,\ .....n\right)$$

$$\overline{\beta}_i(L) = \overline{\beta}_{i0} - \overline{\beta}_{i1} L - \overline{\beta}_{i2} L^2 - .. - \overline{\beta}_{i(ni-1)} L^{ni} \qquad \left(\overline{\beta}_{ij} = -\sum_{j=i+1}^{ni} \beta ij\right)$$

The expressions of the long-run elasticities of all variables are the short-term elasticities divided by α (the long-run price elasticity is equal to $(\alpha_o^* - 1 + \alpha)/\alpha$). A t-test on α^*-1 = 0 can be used to verify the assumption of unit price elasticity and unit elasticity for real income is easily tested by means of the Wald test to verify whether α is significantly different from β_y.

In the estimated equations the vector X_k includes:

- a measure of the own return on monetary assets (calculated as the weighted average of interest rates applied to the various financial instruments included in the definition of money in each country);
- a linear trend (for the Netherlands and the United Kingdom) and a logistic trend (for Italy) to proxy financial innovation;
- one or more measures of devaluation expectation to capture currency substitution.

The changes to (4) to include the own rate of money and the trend are obvious. On the other hand, how expression (4) has to be modified to specify the channels through which currency substitution takes place depends on the choice of the currency substitution model.

Following the approach discussed in Section 2B, if one assumes that the UIP condition holds, the coefficient of the domestic interest rate is indeed the sum of the coefficient of the domestic rate and of the coefficient of the relevant foreign asset included in the money demand equation. In this case, (4) becomes:

$$(5)\quad \bar{\alpha}(L)\Delta(M-P) = c-\alpha(M-P)_{-1}+(\alpha^{*}-1)P+\beta_{p}\Delta P+\bar{\beta}_{p}(L)\Delta P+\beta_{y}Y$$
$$+\bar{\beta}_{y}(L)\Delta Y+\beta_{r}r+\bar{\beta}_{r}(L)\Delta r+\beta_{R}R+\bar{\beta}_{R}(L)\Delta R$$
$$+\Sigma_{j}\left[\beta_{E_j}EE_{j}+\bar{\beta}_{E_j}(L)\Delta EE_{j}\right] + \varepsilon_{t}$$

where EE_j stands for devaluation expectations relative to the "j" currency and $\beta_{E_j} < 0$.

Various indicators have been used in the literature to proxy EE. The change in the spot exchange rate has proved to be less than satisfactory, both on theoretical grounds and in terms of its actual statistical significance. In contrast, promising conclusions have been reached by Artis, Bladen-Hovell and Zhang (1993), who use the UIP to quantify devaluation expectations.

In the estimated equations the existence of currency substitution is tested by specifying EE as:

- the three-month forward premium vis-à-vis the US dollar;
- the devaluation expectations vis-à-vis the central parity of the Deutsche Mark following the Bertola and Svensson (1993) approach briefly summarised below.

Let the UIP condition be represented by:

$$(6)\quad r_t - r_t^{*} = E_t(\Delta s_{t+k})/k$$

where E_t indicates expectations at time t, r and r* stand for the domestic and the German interest rate respectively, k is the maturity period and s_{t+k} is the logarithm of the spot exchange rate measured in units of domestic currency per Deutsche Mark.[7]

Following Bertola and Svensson (1993) let the level of the exchange rate within the ERM band be denoted by $x_t = s_t - c_t$, where c_t is the central parity of an ERM currency

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[7] Expression (6) is indeed an approximation of the UIP condition, stating that market equilibrium under the assumption of no risk premium, perfect capital mobility and asset substitutability requires that, for k=1

$$1+r_t = E_t\left[S_{t+1}(1+r_t^{*})/S_t\right] = (1+r_t^{*})E_t\left[(S_{t+1}-S_t)/S_t\right]+1$$

(where S_t is the spot exchange rate and $E_t(.)$ denotes the expected values of (.) conditional upon information available at time t) holds to allow for a hypothetical investor to be indifferent in his choice between two alternative (perfectly substitutable) assets denominated in different currencies.

For small values of r_t and r_t* this expression can be approximated by:

$$r_t - r_t^{*} = E_t\left[s_{t+1} - s_t\right] = E_t(\Delta s_{t+1})$$

relative to the DM. Its expected rate of change ($E_t[\Delta x_{t+k}]/k$) is related to the expected rate of change of the central parity ($E_t[\Delta c_{t+k}]/k$) and the expected rate of change of the spot rate $E_t[\Delta s_{t+k}]/k$ by the following expression:

$$E_t[\Delta c_{t+k}]/k = E_t[\Delta s_{t+k}]/k - E_t[\Delta x_{t+k}]/k$$

Svensson (1993) argues that the expected rate of depreciation within the band can be estimated as a linear function of the level of the exchange rate within the band (namely, $E_t[\Delta x_{t+k}]/k = a + bx_t + \varepsilon_t$). Therefore, the expected rate of change of the central parity - i.e. the expected rate of devaluation vis-à-vis the Deutsche Mark - is given by the interest rate differential less the estimated rate of depreciation within the band, that is:

$$E_t[\Delta c_{t+k}]/k = r_t - r_t^* - \hat{a} - \hat{b}\, x_t$$

The devaluation expectation of the Belgian franc, the French franc, the Italian lira and the Dutch guilder vis-à-vis the Deutsche Mark so calculated are reported in Chart 2 together with the forward/discount premia.

Finally, in some of the equations the three-month forward premium (discount) calculated using bilateral (non-German) European currencies has also been used to test whether data support evidence of currency substitution vis-à-vis individual currencies.

5. Estimation results

Augmented Dickey-Fuller (ADF) tests were performed on both the levels and the first differences of each variable[8] to assess the univariate properties of the time series to be used in the estimates. Table 1 reports the Dickey-Fuller t-statistics and shows that all series, with one exception, are I(1) at the 1% level of significance.[9] In the case of the United Kingdom the ADF test does not allow rejection of the unit root hypothesis for the first difference of nominal money stock; it does so, however, for the real money stock, thus permitting the derivation of correct statistical inference in the equations where it appears as the dependent variable.

A less standard feature emerges as far as the price level is concerned: in the case of Italy and the United Kingdom, the ADF tests reject at the 1% significance level the unit root hypothesis for the level of the GDP deflator. This contrasts, for example, with the evidence produced by Artis, Bladen-Hovell and Zhang (1993, pp. 245-6) who show that

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8 The logarithms of all variables except interest rates, their spreads and the various measures of devaluation expectations. Table 1A in the Appendix describes how the tests were specified.

9 According to MacKinnon (1990) critical values.

the consumer price indices that they use are integrated of order two and that their result *"is consistent with a large body of evidence contained in the literature"*.

One intuitive explanation for the findings reported here may be seen in the strong deceleration of inflation that took place in the late 1980s. In both Italy and the United Kingdom inflation was high in the early 1980s and declined sharply to very low levels in the late 1980s and in the early 1990s. Chart 3 shows that there is a pronounced negative correlation between inflation and the price level in Italy and the United Kingdom, resulting in a significant Dickey-Fuller t-statistic despite the introduction of a trend in the specification of the ADF tests. In the case of France, however, where the relationship between the inflation rate and the price level shows a similar pattern, the ADF test rejects the unit root hypothesis only when no trend is included in the test. The same chart clearly shows that no correlation exists between inflation and the price level in Belgium, Germany and the Netherlands, where the GDP deflator is I(1).

Another feature of the ADF tests is that, while the first differences of devaluation expectations are stationary in all countries, a more uneven pattern is present as far as the same tests on the levels of the variables are concerned. In particular, it is not clear why the level of expected depreciation vis-à-vis the Deutsche Mark, of the Belgian franc, the Italian lira and the Dutch guilder (calculated according to the Bertola and Svensson method) are stationary, while that of the French franc is not, despite the fact that they share a common pattern throughout the entire period (Chart 2).

Finally, unit root tests were performed to test whether the real money stock, real income, interest rates and devaluation expectations are cointegrated. Engle and Granger cointegration tests (not reported) systematically failed to detect cointegration among these variables irrespective of whether unitary elasticity is imposed on the price level, real income or both. These inconclusive results, however, do not exclude cointegration, as the Engle and Granger test is known to have little power.

(a) *Statistical properties of estimated equations*

Tables 2-7 report, for each country, the final estimated equations of the demand for real balances derived from expression (5) in the previous section.[10] For all countries some alternative specifications are also reported to show how the result changes when different interest rates and currency substitution indicators are used.[11]

As documented in Kremers, Ericsson and Dolado (1992), a more powerful cointegration test than the Engle and Granger one can be found in the statistical

10 The estimation sample period is 1980-91. The data used are described in the Appendix.

11 In the case of Italy, France and the United Kingdom one dummy variable was used to deal with outliers. In the case of Italy, as indicated by Angelini, Hendry and Rinaldi (1994), the dummy reflects disturbance originating from a strike in the banking sector; in the case of France, the outlier is present at the beginning of the important changes in the monetary policy regime that started in 1987.

significance of the coefficient of the error-correction term (ECT) of the estimated equation. In all estimated equations the coefficients of the ECTs are strongly significant, indicating the existence of a cointegrating relationship between real money demand and the selected explanatory variables. The estimated values of the ECTs indicate a rather high speed of adjustment: for most countries the estimated coefficients indicate that some 12-25% of the deviation in the actual real money balances from their long-term levels is adjusted within the quarter. The speed of adjustment is particularly high in the case of Italy and the United Kingdom, with an adjustment of the discrepancy within the quarter of about 43-67% and more than 30%, respectively.

Concerning other statistical properties of the estimated equations, all diagnostic tests do not signal the possibility of inaccurate inference.

First, the fourth-order Breusch-Godfrey Lagrange Multiplier tests on the residuals (reported as LM(4) tests in the Tables) fail to reject the hypothesis that the estimated residuals of the equations are serially uncorrelated. Box-Pierce and Ljung-Box Q statistics confirm this in all cases.

Second, the fourth-order Arch tests do not reject the hypothesis of homoskedasticity for all equations.

Third, Reset tests strongly reject the hypothesis of misspecification when the predicted values of the dependent variables are raised to the power of two and three.

(b) Economic properties of the equations

The first economic feature of the estimated equation is that, contrary to what emerged from many of the studies summarised before, the *long-run price elasticities* were found to be equal to one in all cases (see Table 8). In all estimated equations, in fact, the price level coefficient, (α^*-1) in expression (5), was not found to be significantly different from zero and the variable was therefore dropped from the equations. However, the equations clearly indicate that inflation has important effects on the short-term money demand, although there are differences between countries. *Current inflation* is translated into an equivalent reduction of real money balances in Belgium, France, Italy and the United Kingdom, as the coefficient of ΔP is not significantly different from minus one,[12] but not in Germany and the Netherlands where the same coefficients are significantly different from minus one. Thus, these results only partially confirm the common finding that the equations of real money holdings are equivalent to nominal money demand equations. Point estimates of the inflation coefficient indicate that in many cases the increase in nominal money demand in the short run is lower in percentage terms than

[12] The marginal significance level of the restriction that the coefficient of ΔP is equal to minus one is shown in Tables 2-7.

inflation, particularly in the Netherlands and the United Kingdom, the sole exception being Germany, where the elasticity of the inflation rate is of the order of -1.2.

The second important property of estimated equations is that *long-run real income elasticities* generally differ from one and are not unrealistically large or implausibly low. Point estimates, in fact, range from about 0.5 for Italy to around 1.7 for Germany. Belgium is the sole country where real income elasticity is equal to one. For this country the unitary long-run elasticity was imposed.[13]

In the case of Germany the values of the long-run real income elasticities reported in Table 4 are consistent with the findings of other studies (see, for example, Issing and Tödter (1994)), suggesting that the imposition of unitary elasticities (as done, for example, by Fase and Winder (1992 and 1993) and Gerlach (1994)) is not warranted.

In three cases (Italy, the Netherlands and the United Kingdom), however, preliminary estimates yielding implausible results suggested the need to introduce into the equation proxies capable of capturing the effects on money demand of the process of financial innovation and liberalisation. In the case of Italy negative values of the real income elasticity have been obtained in some previous studies (see, for example, Artis, Bladen-Hovell and Zhang (1993), Muscatelli and Papi (1990) and Angelini, Hendry and Rinaldi (1994)) and, indeed, if no allowance is made for the process of financial innovation, conventional estimates consistently yield negative coefficients for real GDP. Following an approach similar to that developed by the Banca d'Italia (1986) and by Angelini, Hendry and Rinaldi (1994),[14] a logistic trend has been added to the set of explanatory variables in order to capture the reduction of money demand relative to real income attributable to the development of the money market instruments that took place during the 1980s. When such a trend is included in the equation, the negative real income elasticity disappears and the estimated long-run elasticity is strikingly similar to that obtained in the above-mentioned studies despite the different functional form of the equation, the use of real GDP instead of domestic demand and the inclusion, in this study, of indicators capturing currency substitution. It is worth noting that the importance of the logistic trend included in the equations shown in Table 5 monotonically declines very rapidly: at the beginning of 1984 its value is approximately equal to zero.

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[13] In the case of Belgium the inverse of velocity lagged one period was entered in the equation after it was tested that the absolute value of the coefficients of $(M\text{-}P)_{-1}$ and Y_{-1}, entered as separate variables, were not significantly different from one another. The marginal significance level of this restriction is reported in Table 2.

[14] Banca d'Italia (1986) and Angelini, Hendry and Rinaldi (1994) argue that during the second half of the 1970s money demand was essentially linked to the growth of real financial wealth and that, afterwards, following the establishment of the Treasury bill market, real domestic demand gradually became the relevant scale variable for money demand. Consequently, they model the progressively decreasing importance of financial wealth and the parallel increased relevance of real domestic demand as the appropriate scale variable by using a logistic trend.

In the case of the Netherlands, the money stock grew at high rates - despite low and decreasing inflation - owing to the combined effects of the choice of the exchange rate regime; the liberalisation of cross-border capital movements and the deregulation of the Dutch capital markets; the "deliberate policy" of the business sector to increase liquid asset holdings.[15] Under these circumstances, to avoid aggregation bias, it would have been appropriate either to use wealth as an additional scale variable or to estimate a separate money demand equation for the business sector, whose strategy of holding large and growing liquid assets seems to have differed from that of other sectors of the economy. The simpler approach followed here, which has been to add to the set of explanatory variables a deterministic trend, is consistent with that of several individual country studies. In the final estimate a linear time trend emerged as being strongly significant. The inclusion of the trend had the effect of almost halving the otherwise high real income elasticity (see Table 6).

A similar effect resulted from the inclusion of a linear trend in the equations for the United Kingdom. In both the Netherlands and the United Kingdom there is no evidence that the effects captured by the trend have changed over time. While the inclusion of the linear trends has markedly improved the economic and stability properties of the estimated equations, the extent to which the equations can be used for forecasting exercises remains an open question. However, out-of-sample projections for the 1991-92 period seem to suggest that the effects of the process of financial liberalisation and innovation as proxied by the trend continued in the two-year extrapolation period at the same pace as in the 1980s.

A third feature of estimates is that in all countries there is strong evidence that the *term structure of interest rates* affects money demand in a statistically significant way. This finding lends support to the hypothesis that the allocation of financial resources into monetary assets is based on portfolio choices that are broader than those assumed in the Ando and Shell model.

Several studies show that long-term interest rates have explanatory power in the money demand equation. In these studies long-term rates are entered into the money balance equations along with short-term rates as proxies of the own rate on money. In the equations the coefficients of short-term rates are normally positive while those of long-term rates are negative, reflecting the effects of changes in the return on alternative financial assets. Two objections are usually made to such an approach. The first, which is essentially a statistical one, raises the issue that the coefficient may be biased if short-term rates do not reflect the return on monetary assets. A second more important objection is that such an approach provides the wrong answer to the question of whether monetary aggregates can be "controlled" by the central bank through changes in the short-term rate,

15 For a comprehensive analysis of these developments and their effects on money, see De Nederlandsche Bank (1991), pp. 24-27.

as, if the estimated response coefficients are positive, an increase in the short-term rate would raise money demand rather than reduce it.

To better estimate the effects of interest rates on different assets and at different maturities, a measure of the own interest rate on money was included as a separate explanatory variable along with short and/or long-term rates.

As expected, for all countries estimated coefficients of the own rate on money are positive and statistically significant while the returns on alternative assets have the correct negative coefficients. As the own rate and the short-term rate exhibit strong collinearity in all countries, it has not been possible to estimate equations where both are present for all countries. However, in the case of Belgium (Equations 2 and 4), France (Equation 3) and Italy (Equations 1 and 3), estimated equations provide evidence that short-term interest rates directly controllable by the central banks have negative long-term effects on the demand for real balances that are larger than the positive one due to the effects of own rates of money. This feature cannot be gauged just by comparing the absolute size of the coefficients of the own and short-term rates (the estimated coefficients of the own rate on money are greater in absolute value than those of short-term rates) as it is also necessary to know how fast and to what extent changes in the short-term rates feed into the own rate on money. In all countries the own rate on money and the short-term rate move in parallel; simple partial adjustment regressions, however, indicate that, except in the United Kingdom, short-term interest rate changes are "transmitted" to the own rate only partially in the long run (between 20% and 40%) and that, in the short run, the own rates move by an amount which is between 15% and 25% of that of the short-term rates. The same qualitative results hold in the equations where the term structure effects are captured by the coefficients of the own rate and the long-term interest rates.

Finally, the hypothesis that *currency substitution* affects money demand in all countries is amply confirmed by data (the estimated coefficients have been multiplied by 100 in Tables 2-7; taking this into account, it is worth noting that the value of the estimated coefficients is of the same order of magnitude as that of the coefficients of the interest rates). The rate of expected depreciation vis-à-vis the US dollar (proxied by the forward premium or discount) reduces money demand in all countries; the effects are the strongest in Belgium, Germany and the Netherlands. Thus, overall these results do not confirm the findings of Artis, Bladen-Hovell and Zhang (1993, p. 254), according to whom currency substitution in Europe *"is confined to the European currencies and - except for Italy - does not embrace the US dollar"*.

Concerning other currencies, estimates show that the coefficients of the Bertola and Svensson indicator of expected depreciation of the central parities vis-à-vis the Deutsche Mark are highly significant. The negative effects on money demand of the rate of expected depreciation vis-à-vis the Deutsche Mark are substantial for Belgium and the Netherlands. In general, devaluation expectations vis-à-vis the Deutsche Mark have a permanent negative effect on money demand as the level of the indicator of expected devaluation enters the cointegrating vector and its coefficient is significant. France is the sole exception as only the first difference of expected devaluation is significant.

In the case of the United Kingdom, for which the Bertola and Svensson index cannot be computed for the entire sample period, it has not been possible to find a statistically significant influence of the forward premium vis-à-vis European currencies.

By contrast, for all other countries depreciation expectations relative to the US dollar and at least one of the other major European currencies are highly significant and with the correct negative sign. In particular, in the case of Belgium, Germany and the Netherlands money demand is affected by depreciation expectations relative to more than one European currency in addition to the US dollar: by the expected rate of depreciation of the Deutsche Mark, the French franc or the Italian lira in the case of Belgium (Equations 3 and 4); by the expected depreciation of the French franc and the Italian lira for Germany (Equations 1, 2 and 4); by the expected depreciation of the French franc and the Deutsche Mark for the Netherlands (Equation 3).

The strong and systematic empirical evidence that emerges from data warrants the conclusion that if currency substitution is not accounted for in the estimation of money demand, a source of bias of the estimates and instability of money demand is overlooked.

(c) Stability and the out-of-sample predictive power of the equations

Various statistical tests were performed to answer the question of whether the changes in the economic and financial structure that took place in Europe during the 1980s have fundamentally undermined the stability of money demand, and consequently its usefulness in the conduct of monetary policy. The tests indicate that money demand has remained stable in the process. For all countries the Chow tests for parameter stability and for assessing the accuracy of forecasts do not reject the hypothesis of stable money demand (Tables 2-7).

The cumulative sum of errors (CUSUM Tests in Charts 4-9) does not indicate any significant departure from the zero line and the cumulative sum of squared errors (not reported) show constant variance of residuals: in all cases the cumulative sum of square errors remains within the 5% critical band. A similar picture emerges from the recursive estimates of the equations: short-lived and/or limited changes in the recursive estimates of some coefficients emerge only in a few cases. Finally, forecast tests (Charts 10-12) show that large prediction errors are rare and not persistent (with the possible exception of France in the middle of the period or Germany during 1990).

Out-of-sample predictions for 1991-92 obtained by extrapolating equations estimated on 1980-90 data show that large and persistent deviations in actual nominal money growth (four-quarter changes) from its predicted values do not occur in any country as the predicted values of money growth are generally near the central prediction and never lie outside the ± 2 standard error band shown in the Charts.

Anomalies emerge mainly in connection with the ERM turbulence of 1992, but not in all countries. In the case of France, an outlier is evident in the final quarter of 1991 but the deviation from the path predicted by the equation is very short-lived and no evidence of a significant departure of the actual money stock from the predicted path emerges afterwards. The effects of the ERM crisis are more evident in the case of Germany where the enormous inflows of capital drove the path of M3 to the upper level of the band in the first three quarters of 1992.

6. Conclusions

The empirical evidence presented in the previous pages encourages more than just a cautious expression of optimism about the fact that aggregate money demand in the six countries under review is economically well-behaved and stable.

Concerning the economic properties, estimated equations confound a large body of literature by showing that for all countries in the long run real money demand is independent of the price level; the same equations also show that inflation reduces real money balances in the short run.

Estimates confirm substantial differences in estimated real income elasticities; in particular, except in one case, they do not support the hypothesis that there are economies of scale in holding money. In most cases, money demand tends to increase proportionally more than real GDP, suggesting that money holdings reflect to a large extent portfolio decisions rather than just transactions motives. This is further confirmed by the fact that estimates show that money demand is significantly affected by changes in the term structure of interest rates, with important consequences for the controllability of monetary aggregates through changes in short-term interest rates.

Financial liberalisation and the progressive introduction of interest-bearing monetary instruments have reduced controllability as monetary tightening increases the return on money and the demand for money balances. Direct statistical evidence that increases in short-term rates reduce money demand, thereby allowing central banks to control it, is mixed owing to the difficulty of disentangling the diverse effects on money balances of highly collinear interest rates at different maturities and on different financial instruments.

Estimated equations show that currency substitution is an important feature of the financial behaviour of European countries. Failure to account for currency substitution in the estimation of individual countries' money demand equations leads to biased estimates and distorts the view of the long-run stability of monetary aggregates. The strong and systematic evidence of cross-border links that emerges from estimated equations is of policy relevance as it supports the proposition that an aggregate EC-wide money stock would possess stability properties superior to individual countries' money demand, which is subject to currency substitution shocks.

Finally, a comprehensive set of within-sample stability tests and out-of-sample simulations indicates no fundamental instability in the behaviour of money demand. Of course, occasional swings may occur at any time and past behaviour may not be a safe guide to the future. However, the expressions of mistrust in the role of monetary aggregates in the conduct of monetary policy that often surface in the discussion on this subject are not supported by the empirical evidence presented here.

Table 1

Unit root tests

Series	Belgium		France		Germany		Italy		Netherlands		United Kingdom	
	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)
M	-2.58	-4.96***	-5.28***	-5.68***	-1.90	-5.06***	-3.37**	-5.16***	-1.85	-5.90***	-2.75*	-2.08
P	-2.02	-8.07***	-3.01*	-5.17***	-2.43	-6.15***	-5.15***	-4.30***	-2.60*	-5.83***	-6.60***	-4.14**
M-P	-2.08	-6.40***	-2.69	-4.50***	-2.86	-5.68***	-4.63***	-4.29***	-2.49	-6.77***	-1.40	-3.54**
Y	-1.62	-7.66***	-1.95	-6.62***	-2.69*	-7.10***	-2.20	-6.11***	-2.99	-6.96***	-2.55	-3.68***
or	-1.65	-8.13***	-1.20	-6.57***	-1.86	-4.59***	-1.84	-4.30***	-2.32	-6.53***	-2.20	-6.26***
r	-2.16	-6.13***	-2.02	-6.32***	-1.74	-5.32***	-2.62	-7.05***	-2.68*	-6.42***	-2.02	-6.47***
R	-2.21	-4.36***	-2.83	-4.48***	-1.83	-5.16***	-2.27	-4.58***	-1.79	-5.41***	-2.60	-6.81***
or-r	-2.26	-7.20***	-2.74	-6.49***	-1.65	-6.30***	-3.78**	-8.31***	-2.66*	-6.70***	-3.63**	-9.53***
or-R	-2.66	-6.04***	-3.66**	-5.64***	-2.49	-6.42***	-2.49	-6.03***	-2.12	-6.96***	-2.28	-6.13***
r-R	-3.60***	-6.23***	-3.73**	-8.18***	-1.46	-7.45***	-3.66***	-7.53***	-3.93**	-8.78***	-2.35	-6.53***
EE$	-3.44**	-7.90***	-2.94**	-8.31***	-2.26	-8.49***	-3.80***	-8.85***	-2.66	-7.40***	-3.81**	-6.22***
EEDM	-4.01**	-6.05***	-2.00	-5.97***	-	-	-3.75**	-9.68***	-5.35***	-9.29***	-1.70	-5.95***
EEFF	-3.36**	-9.16***	-	-	-3.41*	-9.62***	-3.74***	-10.55***	-2.49	-9.60***	-2.38	-7.84***
EEIT	-5.98***	-11.08***	-4.38***	-10.54***	-5.42***	-10.28***	-	-	-4.92***	-10.12***	-2.84	-9.16***

Note: Significant at the 1% level (***), 5% level (**) and 10% level (*); no indication when significance is below 10% level. ADF(L) refers to the Augmented Dickey-Fuller test on the levels of the variables; ADF(D) refers to the same test on the first differences. Quarterly data. Sample period 80.1-92.4.

Legend: M = money stock; P = GDP deflator; Y = real GDP; or = own rate; r = short-term interest rate; R = long-term interest rate. EE = expected rate of devaluation calculated as the forward premium discount, except the expected devaluation vis-à-vis the DM for Belgium, France, Italy and the Netherlands, which is estimated according to the Bertola and Svensson (1993) procedure. (All variables, except interest rates and devaluation expectations, are in logarithms.)

Table 2

Estimated demand of real balances: BELGIUM

Equation 1

C	$(M\text{-}P\text{-}Y)_{-1}$	ΔP	ΔP_{-2}	$(\underline{r} - \underline{R})_{-3}$	$\Delta \underline{r}_{-2}$	$\Delta \underline{R}_{-1}$	$\underline{EE\$}$	$EEDM^{1}_{-2}$	$\Delta_2(M\text{-}P)$
-0.310	-0.098	-0.994	-0.268	0.002	-0.004	-0.012	-0.258	-0.449	0.170
-3.305	*-3.530*	*-8.904*	*-2.813*	*2.035*	*-2.538*	*-3.174*	*-3.438*	*-3.251*	*2.833*

Statistical indicators and tests:

R2 adj. = 0.8399	S E R = 0.0070	DW = 2.2421	Log Likelihood = 175.6733	F = 28.39763
LM (4) = 0.8031	*Jarque-Bera = 0.7992*	*Box-Pierce = 0.9070*	*Ljung-Box = 0.8699*	*Arch (4) = 0.9845*
RESET(2) = 0.5108	*RESET(3) = 0.5879*	*Chow F (88.1) = 0.4071*	*Sample breakpoint (88.1) = 0.1573*	

Marginal significance levels of restrictions on coefficients: $(M\text{-}P)_{-1} = -Y_{-1}$ *(0.3229)*; $\underline{r}_{-3} = -\underline{R}_{-3}$ *(0.5299)*; $\Delta P = -1$ (0.9566).

Equation 2

C	$(M\text{-}P\text{-}Y)_{-1}$	ΔP	or_{-4}	$\underline{R}_{-2}$	$(\underline{r} - \underline{R})$	$\underline{EE\$}$	$\underline{EEDM^{1}}_{-2}$	$\Delta_3(M\text{-}P)$
-0.419	-0.119	0.936	0.015	-0.004	-0.003	-0.323	-0.469	0.167
-2.860	*-2.775*	*-8.465*	*3.863*	*-2.204*	*-2.295*	*-3.358*	*-2.437*	*3.235*

Statistical indicators and tests:

R2 adj. = 0.7713	S E R = 0.0084	DW = 2.0010	Log Likelihood = 166.4891	F = 20.81251
LM (4) = 0.8543	*Jarque-Bera = 0.1421*	*Box-Pierce = 0.8392*	*Ljung-Box = 0.7614*	*Arch (4) = 0.7777*
RESET(2) = 0.6925	*RESET(3) = 0.7753*	*Chow F (88.1) = 0.2251*	*Sample breakpoint (88.1) = 0.0694*	

Marginal significance levels of restrictions on coefficients: $(M\text{-}P)_{-1} = -Y_{-1}$ *(0.4664)*; $\Delta P = -1$ (0.5674).

Equation 3

C	$(M\text{-}P\text{-}Y)_{-1}$	ΔP	or_{-4}	$\underline{R}_{-2}$	$\underline{EE\$}$	$\underline{EEDM}_{-2}$	$\underline{EEFF}_{-1}$	$\Delta_3(M\text{-}P)$
-0.333	-0.093	-0.906	0.017	-0.004	-0.391	-0.445	-0.206	0.166
-2.744	*-2.614*	*-8.336*	*4.316*	*-2.716*	*-3.875*	*-2.543*	*-2.640*	*3.271*

Statistical indicators and tests:

R2 adj. = 0.7798	S E R = 0.0082	DW = 2.1657	Log Likelihood = 167.3947	F = 21.80034
LM (4) = 0.2799	*Jarque-Bera = 0.0388*	*Box-Pierce = 0.8007*	*Ljung-Box = 0.7359*	*Arch (4) = 0.6860*
RESET(2) = 0.4676	*RESET(3) = 0.6490*	*Chow F (88.1) = 0.2577*	*Sample breakpoint (88.1) = 0.1095*	

Marginal significance levels of restrictions on coefficients: $(M\text{-}P)_{-1} = -Y_{-1}$ *(0.4750)*; $\Delta P = -1$ (0.3927).

Equation 4

C	$(M\text{-}P\text{-}Y)_{-1}$	ΔP	or_{-4}	$\underline{R}_{-2}$	$(\underline{r}\text{-}\underline{R})_{-2}$	$\underline{EE\$}$	$\underline{EEDM}_{-3}$	$\underline{EEIT}_{-1}$	$\Delta_3(M\text{-}P)$
-0.261	-0.074	-0.911	0.015	-0.005	-0.002	-0.224	-0.397	-0.286	0.124
-2.326	*-2.237*	*-8.279*	*3.949*	*-2.944*	*-2.213*	*-2.287*	*-2.694*	*-2.467*	*2.272*

Statistical indicators and tests:

R2 adj. = 0.7861	S E R = 0.0081	DW = 2.1896	Log Likelihood = 168.7210	F = 20.19394
LM (4) = 0.2507	*Jarque-Bera = 0.5577*	*Box-Pierce = 0.7164*	*Ljung-Box = 0.6393*	*Arch (4) = 0.5038*
RESET(2) = 0.9760	*RESET(3) = 0.9971*	*Chow F (88.1) = 0.2839*	*Sample breakpoint (88.1) = 0.1843*	

Marginal significance levels of restrictions on coefficients: $(M\text{-}P)_{-1} = -Y_{-1}$ *(0.4681)*; $\Delta P = -1$ (0.4234).

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t statistics and marginal significance levels of tests are in italics. Underlined variables represent two-period moving averages.

[1] Expected rate of devaluation estimated according to the Bertola and Svensson (1993) procedure.

Table 3

Estimated demand of real balances: FRANCE

Equation 1

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔP	$(\underline{r} - \underline{R})_{-4}$	$\Delta\underline{r}$	$\Delta\underline{R}_{-2}$	$\Delta(M\text{-}P)_{-4}$	$EE\$_{-1}$	$\Delta(EEDM)^{1}$	DU 86.4
-1.370	-0.232	0.315	-0.838	0.002	0.003	0.006	-0.170	-0.060	-0.110	-0.009
-4.552	*-5.653*	*4.980*	*-7.076*	*2.178*	*3.164*	*4.430*	*-2.122*	*-2.511*	*-2.029*	*-2.190*

Statistical indicators and tests:

R2 adj. = 0.8365	S E R = 0.0039	DW = 1.8822	Log Likelihood = 204.9001	F = 25.04284
LM (4) = 0.8336	*Jarque-Bera = 0.7411*	*Box-Pierce = 0.9206*	*Ljung-Box = 0.8845*	*Arch (4) = 0.4840*
RESET(2) = 0.6950	*RESET(3) = 0.8569*	*Chow F (88.1) = 0.5309*	*Sample breakpoint (88.1) = 0.5440*	

Marginal significance levels of restrictions on coefficients: $\underline{r}_{-4} = -\underline{R}_{-4}$ *(0.6914)*; $\Delta P = -1$ (0.1782).

Equation 2

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔP	$\underline{r}_{-3}$	$\underline{R}_{-3}$	$\Delta\underline{r}$	$\Delta\underline{R}_{-2}$	$\Delta(EEDM)^{1}$	$\Delta_4(M\text{-}P)$	DU 86.4
-0.802	-0.177	0.203	-0.878	0.003	-0.003	0.004	0.005	-0.145	0.124	-0.007
-3.460	*-5.498*	*4.153*	*-7.559*	*3.842*	*-2.731*	*4.599*	*4.002*	*-2.866*	*3.545*	*-1.802*

Statistical indicators and tests:

R2 adj. = 0.8603	S E R = 0.0036	DW = 1.9323	Log Likelihood = 208.6767	F = 29.94103
LM (4) = 0.7592	*Jarque-Bera = 0.6018*	*Box-Pierce = 0.9036*	*Ljung-Box = 0.8648*	*Arch (4) = 0.1799*
RESET(2) = 0.8704	*RESET(3) = 0.9358*	*Chow F (88.1) = 0.2052*	*Sample breakpoint (88.1) = 0.1668*	

Marginal significance levels of restrictions on coefficients: $\Delta P = -1$ (0.3013).

Equation 3

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔP	or $_{-1}$	r_{-1}	$\Delta_4(M\text{-}P)$	$\Delta(\underline{r} - \underline{R})_{-1}$	$EE\$_{-2}$	$\Delta(EEDM)^{1}$	DU 86.4
-0.954	-0.166	0.219	-1.036	0.004	-0.002	0.236	-0.006	-0.058	-0.084	-0.010
-4.490	*-5.269*	*4.818*	*-11.392*	*2.442*	*-2.523*	*5.660*	*-4.313*	*-2.930*	*-1.926*	*-2.890*

Statistical indicators and tests:

R2 adj. = 0.8963	S E R = 0.0031	DW = 1.6807	Log Likelihood = 215.8202	F = 41.60389
LM (4) = 0.5821	*Jarque-Bera = 0.7125*	*Box-Pierce = 0.5940*	*Ljung-Box = 0.4841*	*Arch (4) = 0.7785*
RESET(2) = 0.8685	*RESET(3) = 0.6406*	*Chow F (88.1) = 0.3734*	*Sample breakpoint (88.1) = 0.6457*	

Marginal significance levels of restrictions on coefficients: $\Delta\underline{r}_{-1} = -\Delta R_{-1}$ *(0.8363)*; $\Delta P = -1$ (0.6926).

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t statistics and marginal significance levels of tests are in italics. Underlined variables represent two-period moving averages.

[1] Expected rate of devaluation estimated according to the Bertola and Svensson (1993) procedure.

[2] Chow tests have been obtained in equations where the value of $\Delta(M\text{-}P)$ in the fourth quarter of 1986 has been corrected by an amount equal to the coefficient of DU 86.4.

Table 4

Estimated demand of real balances: GERMANY

Equation 1

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔY_{-1}	ΔP	$(\underline{or} - \underline{r})_{-2}$	$(\underline{r} - \underline{R})_{-2}$	ΔR_{-1}	ΔR_{-3}	$\Delta(M\text{-}P)_{-1}$	$\underline{EE}^1$	$\Delta EEFF_{-3}$
-1.005	-0.122	0.213	-0.121	-1.226	0.005	0.005	-0.003	0.003	0.388	-0.204	-0.057
-4.564	*-4.380*	*4.701*	*-2.275*	*-9.882*	*3.746*	*3.719*	*-2.409*	*2.339*	*4.705*	*-3.474*	*-2.933*

Statistical indicators and tests:

R2 adj. = 0.7786	S E R = 0.0032	DW = 2.5534	Log Likelihood = 214.1048	F = 16.02929
LM (4) = 0.1152	*Jarque-Bera = 0.7807*	*Box-Pierce = 0.1195*	*Ljung-Box = 0.0689*	*Arch (4) = 0.7630*
RESET(2) = 0.2728	*RESET(3) = 0.4329*	*Chow F (88.1) = 0.4142*	*Sample breakpoint (88.1) = 0.6493*	

Marginal significance levels of restrictions on coefficients: $\underline{or}_{-2} = -\underline{r}_{-2}$ *(0.6356)*; EE\$ = EEFR, EE\$ = $EEIT_{-2}$ and EEFR = $EEIT_{-2}$ *(0.9828)*; $\Delta P = -1$ (0.0765).

Equation 2

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔY_{-1}	ΔP	$\underline{or}_{-2}$	$\underline{R}_{-2}$	ΔR_{-1}	ΔR_{-3}	$\Delta(M\text{-}P)_{-1}$	$\underline{EE}^1$	$\Delta EEFF_{-3}$
-1.028	-0.127	0.219	-0.124	-1.228	0.004	-0.005	-0.003	0.003	0.399	-0.216	-0.057
-4.713	*-4.423*	*4.826*	*-2.353*	*-10.086*	*2.381*	*-3.757*	*-2.618*	*2.342*	*4.838*	*-3.510*	*-2.947*

Statistical indicators and tests:

R2 adj. = 0.7810	S E R = 0.0032	DW = 2.5739	Log Likelihood = 214.3667	F = 16.24108
LM (4) = 0.0821	*Jarque-Bera = 0.7855*	*Box-Pierce = 0.0805*	*Ljung-Box = 0.0426*	*Arch (4) = 0.7853*
RESET(2) = 0.2792	*RESET(3) = 0.4210*	*Chow F (88.1) = 0.4334*	*Sample breakpoint (88.1) = 0.7201*	

Marginal significance levels of restrictions on coefficients: EE\$ = EEFR *(0.8822)*; EE\$ = $EEIT_{-2}$ *(0.9035)*; EEFR = $EEIT_{-2}$ *(0.6163)*; $\Delta P = -1$ (0.0696).

Equation 3

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔY_{-1}	ΔP	$(\underline{or} - \underline{R})_{-2}$	ΔR_{-1}	$\Delta(M\text{-}P)_{-1}$	EE\$	EEFF	$\Delta EEFF_{-1}$
-0.911	-0.119	0.197	-0.109	-1.254	0.005	-0.004	0.347	-0.113	-0.067	-0.055
-4.929	*-4.970*	*5.180*	*-2.036*	*-9.706*	*3.495*	*-3.268*	*3.891*	*-2.470*	*-3.015*	*2.668*

Statistical indicators and tests:

R2 adj. = 0.7357	S E R = 0.0035	DW = 2.2280	Log Likelihood = 209.1911	F = 14.08190
LM (4) = 0.4052	*Jarque-Bera = 0.8713*	*Box-Pierce = 0.1658*	*Ljung-Box = 0.0868*	*Arch (4) = 0.4027*
RESET(2) = 0.6246	*RESET(3) = 0.8056*	*Chow F (88.1) = 0.4263*	*Sample breakpoint (88.1) = 0.2394*	

Marginal significance levels of restrictions on coefficients: $\underline{or}_{-2} = \underline{R}_{-2}$ *(0.2811)*; $\Delta P = -1$ (0.0569).

Equation 4

C	$(M\text{-}P)_{-1}$	Y_{-1}	ΔY_{-1}	ΔP	$(\underline{or} - \underline{R})_{-3}$	ΔR_{-1}	$\Delta(M\text{-}P)_{-1}$	EE\$	EEFF	$EEIT_{-2}$
-1.012	-0.116	0.211	-0.131	-1.227	0.004	-0.004	0.341	-0.110	-0.051	-0.062
-4.746	*-4.630*	*4.981*	*-2.337*	*-9.063*	*3.203*	*-2.572*	*3.699*	*-2.282*	*-2.278*	*-2.290*

Statistical indicators and tests:

R2 adj. = 0.7111	S E R = 0.0037	DW = 2.4215	Log Likelihood = 207.0601	F = 12.57108
LM (4) = 0.3008	*Jarque-Bera = 0.9602*	*Box-Pierce = 0.3181*	*Ljung-Box = 0.2075*	*Arch (4) = 0.4239*
RESET(2) = 0.2692	*RESET(3) = 0.4257*	*Chow F (88.1) = 0.7042*	*Sample breakpoint (88.1) = 0.4976*	

Marginal significance levels of restrictions on coefficients: $\underline{or}_{-3} = \underline{R}_{-3}$ *(0.4173)*; $\Delta P = -1$ (0.1023).

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t statistics and marginal significance levels of tests are in italics. Underlined variables represent two-period moving averages.

[1] $\underline{EE}$ = EE\$ + EEFF + $EEIT_{-2}$

Table 5

Estimated demand of real balances: ITALY

Equation 1

C	$(M-P)_{-1}$	Y_{-1}	ΔY_{-1}	ΔP	$(\underline{or} - \underline{r})_{-1}$	$\Delta(\underline{or} - \underline{r})_{-3}$	$\Delta \underline{r}$	LT[2]	$\Delta_3(M-P)_{-1}$	$\underline{EE}_{-1}$[1,3]	DU 89.1
1.486	-0.483	0.218	-0.978	-0.901	0.004	-0.005	-0.005	0.995	0.258	-0.155	-0.015
4.284	*-6.789*	*4.628*	*-5.488*	*-5.377*	*2.391*	*-2.580*	*-2.940*	*5.471*	*5.233*	*-2.392*	-2.330

Statistical indicators and tests:

R2 adj. = 0.8257	S E R = 0.0058	DW = 2.2496	Log Likelihood = 185.8844	F = 21.23915
LM (4) = 0.2813	*Jarque-Bera = 0.8333*	*Box-Pierce = 0.6553*	*Ljung-Box = 0.6215*	*Arch (4) = 0.2747*
RESET(2) = 0.9400	*RESET(3) = 0.7045*	*Chow F (88.1) = 0.9093*[4]	*Sample breakpoint (88.1) = 0.7117*[4]	

Marginal significance levels of restrictions on coefficients: $\underline{or}_{-1} = -\underline{r}_{-1}$ *(0.3557)*; $\Delta\underline{or}_{-3} = -\Delta\underline{r}_{-3}$ *(0.2503)*; $\underline{EE\$} = \underline{EEDM}$[1] *(0.7806)*; $\Delta P = -1$ (0.5584).

Equation 2

C	$(M-P)_{-1}$	Y_{-1}	ΔY	ΔY_{-1}	ΔP	$(\underline{or} - \underline{R})_{-2}$	$\Delta(\underline{or} - \underline{r})_{-3}$	$\Delta \underline{r}$	LT[2]	$\Delta_3(M-P)_{-1}$	$\underline{EE}$[1,3]	DU 89.1
1.645	-0.671	0.335	-0.315	-0.921	-0.832	0.006	-0.005	-0.004	1.001	0.324	-0.173	-0.012
4.978	*-6.555*	*4.940*	*-1.833*	*-5.999*	*-4.949*	*4.010*	*-2.935*	*-2.622*	*6.608*	*6.797*	*-2.420*	-2.031

Statistical indicators and tests:

R2 adj. = 0.8563	S E R = 0.0052	DW = 2.1439	Log Likelihood = 191.1923	F = 24.33564
LM (4) = 0.4969	*Jarque-Bera = 0.3746*	*Box-Pierce = 0.6213*	*Ljung-Box = 0.5795*	*Arch (4) = 0.6504*
RESET(2) = 0.3429	*RESET(3) = 0.4559*	*Chow F (88.1) = 0.7467*[4]	*Sample breakpoint (88.1) = 0.5457*[4]	

Marginal significance levels of restrictions on coefficients: $\underline{or}_{-2} = -\underline{R}_{-2}$ *(0.4040)*; $\Delta\underline{or}_{-3} = -\Delta\underline{r}_{-3}$ *(0.2634)*; EEFF = EEDM[1] *(0.5063)*; $\Delta P = -1$ (0.3242).

Equation 3

C	$(M-P)_{-1}$	Y_{-1}	ΔY	ΔY_{-1}	ΔP	$(or-r)_{-2}$	$\Delta(\underline{or}-\underline{r})_{-3}$	$\Delta \underline{r}$	LT[2]	$\Delta_3(M-P)_{-1}$	Δ(EEFF)	$EE\$_{-1}$	DU 89.1
1.306	-0.429	0.195	-0.489	-1.013	-1.005	0.004	-0.005	-0.007	0.997	0.254	-0.119	-0.119	-0.014
5.260	*-6.903*	*4.593*	*-2.755*	*-6.212*	*-6.737*	*2.863*	*-2.532*	*-3.870*	*5.670*	*5.838*	*-2.621*	*-3.408*	-2.424

Statistical indicators and tests:

R2 adj. = 0.8571	S E R = 0.0053	DW = 2.1002	Log Likelihood = 192.0235	F = 22.68298
LM (4) = 0.5506	*Jarque-Bera = 0.6272*	*Box-Pierce = 0.6114*	*Ljung-Box = 0.5084*	*Arch (4) = 0.3831*
RESET(2) = 0.8101	*RESET(3) = 0.5337*	*Chow F (88.1) = 0.3041*[4]	*Sample breakpoint (88.1) = 0.1996*[4]	

Marginal significance levels of restrictions on coefficients: $o\underline{r}_{-2} = -r_{-2}$ *(0.0739)*; $\Delta\underline{or}_{-3} = -\Delta\underline{r}_{-3}$ *(0.0570)*; $\Delta P = -1$ (0.9724).

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t statistics and marginal significance levels of tests are in italics. Underlined variables represent two-period moving averages.

[1] Expected rate of devaluation estimated according to the Bertola and Svensson (1993) procedure.

[2] LT = exp (a + bT)/1 + exp (a + bT). The values of the coefficients a and b have been estimated using non-linear least squares and are as follows: equation 1 (a = -2.2110; b = -0.1647); equation 2 (a = -1.8592; b = -0.1697) equation 3 (a = -2.2434; b = -0.1829)

[3] $\underline{EE}$ are arithmetic averages of the expected rate of devaluation:
$\underline{EE} = (\underline{EE\$} + \underline{EEDM}$[1]$)$ / 2 for equation 1 and EE = (EEFF + EEDM[1]) / 2 for equation 2.

[4] Chow F tests have been obtained using equations where the value of Δ(M-P) in the first quarter of 1989 has been corrected, in each equation, by an amount equal to the estimated coefficient of DU 89.1.

<u>Table 6</u>

Estimated demand of real balances: NETHERLANDS

Equation 1

C	$(M-P)_{-1}$	Y_{-1}	ΔP	or_{-1}	$\underline{R}_{-3}$	Δr_{-1}	EE$	$\underline{EEDM}_{-1}$[1]	$\Delta_2(M-P)$
-1.227	-0.128	0.293	-0.857	0.005	-0.003	-0.006	-0.168	-0.677	0.141
-3.343	*-3.202*	*3.373*	*-7.438*	*2.082*	*-2.801*	*-3.965*	*-2.729*	*-3.703*	*2.127*

Statistical indicators and tests:

R2 adj. = 0.8120	S E R = 0.0057	DW = 2.0573	Log Likelihood = 185.5441	F = 23.55577
LM (4) = 0.9892	*Jarque-Bera = 0.3259*	*Box-Pierce = 0.8584*	*Ljung-Box = 0.7749*	*Arch (4) = 0.9415*
RESET(2) = 0.1435	*RESET(3) = 0.2630*	*Chow F (88.1) = 0.4637*	*Sample breakpoint (88.1) = 0.2313*	

Marginal significance levels of restrictions on coefficients: ΔP = -1 (0.2208).

Equation 2

C	$(M-P)_{-1}$	Y_{-1}	ΔP	or_{-1}	$\underline{R}_{-3}$	Δr_{-1}	EE$	$EEFF_{-1}$	$\Delta_2(M-P)$	T
-1.282	-0.251	0.315	-0.686	0.011	-0.003	-0.004	-0.148	-0.133	0.205	0.002
-3.598	*-4.435*	*3.783*	*-6.182*	*4.168*	*-3.072*	*-3.337*	*-2.632*	*-3.143*	*3.371*	*3.480*

Statistical indicators and tests:

R2 adj. = 0.8386	S E R = 0.0053	DW = 2.0420	Log Likelihood = 189.8496	F = 25.42535
LM (4) = 0.9014	*Jarque-Bera = 0.5528*	*Box-Pierce = 0.8011*	*Ljung-Box = 0.7065*	*Arch (4) = 0.9777*
RESET(2) = 0.3986	*RESET(3) = 0.5689*	*Chow F (88.1) = 0.2959*	*Sample breakpoint (88.1) = 0.1959*	

Marginal significance levels of restrictions on coefficients: ΔP = -1 (0.0074).

Equation 3

C	$(M-P)_{-1}$	Y_{-1}	ΔP	or_{-1}	$\underline{R}_{-3}$	Δr_{-1}	EE$	EEDM[1] $_{-1}$	$\underline{EEFF}_{-1}$	$\Delta_2(M-P)$
-1.400	-0.125	0.327	-0.837	0.008	-0.005	-0.006	-0.148	-0.317	-0.140	0.144
-3.249	*-2.965*	*3.258*	*-7.026*	*2.860*	*-3.125*	*-3.592*	*-2.340*	*-2.072*	*-2.281*	*2.098*

Statistical indicators and tests:

R2 adj. = 0.7982	S E R = 0.0059	DW = 1.9260	Log Likelihood = 184.4812	F = 19.58774
LM (4) = 0.9796	*Jarque-Bera = 0.3815*	*Box-Pierce = 0.2182*	*Ljung-Box = 0.1120*	*Arch (4) = 0.8514*
RESET(2) = 0.2148	*RESET(3) = 0.3739*	*Chow F (88.1) = 0.6904*	*Sample breakpoint (88.1) = 0.5172*	

Marginal significance levels of restrictions on coefficients: ΔP = -1 (0.1780).

Equation 4

C	$(M-P)_{-1}$	Y_{-1}	ΔP	$(r-R)_{-1}$	$\Delta(r-R)_{-1}$	EEDM[1] $_{-1}$	EE$	$\Delta_2(M-P)$	T
-0.662	-0.199	0.178	-0.777	0.005	-0.007	-0.426	-0.174	0.159	0.002
-2.114	*-3.513*	*2.418*	*-6.531*	*3.111*	*-3.662*	*-2.987*	*-2.725*	*2.387*	*3.127*

Statistical indicators and tests:

R2 adj. = 0.8087	S E R = 0.0057	DW = 2.1752	Log Likelihood = 185.1311	F = 23.08180
LM (4) = 0.9474	*Jarque-Bera = 0.6815*	*Box-Pierce = 0.5940*	*Ljung-Box = 0.4730*	*Arch (4) = 0.7019*
RESET(2) = 0.2102	*RESET(3) = 0.3663*	*Chow F (88.1) = 0.1029*	*Sample breakpoint (88.1) = 0.0265*	

Marginal significance levels of restrictions on coefficients: $r_{-1} = -R_{-1}$ (*0.4868*); ΔP = -1 (0.0680).

---

t statistics and marginal significance levels of tests are in italics. Underlined variables represent two-period moving averages.

[1] Expected rate of devaluation estimated according to the Bertola and Svensson (1993) procedure.

Table 7

Estimated demand of real balances: UNITED KINGDOM

Equation 1

C	$(M-P)_{-1}$	Y_{-1}	ΔY_{-2}	ΔP	$\underline{or}_{-3}$	$\underline{R}_{-3}$	$\Delta_4(M-P)$	$\underline{EE\$}_{-2}$	T	DU 88.3
-2.276	-0.338	0.544	-0.246	-0.812	0.004	-0.002	0.074	-0.089	0.003	0.012
-7.959	*-6.458*	*8.068*	*-2.728*	*-6.622*	*4.455*	*-2.178*	2.668	*-2.444*	*3.796*	2.867

Statistical indicators and tests:

R2 adj. = 0.9039	S E R = 0.0038	DW = 1.8842	Log Likelihood = 205.9201	F = 45.20285
LM (4) = 0.3631	*Jarque-Bera = 0.2569*	*Box-Pierce = 0.4141*	*Ljung-Box = 0.3085*	*Arch (4) = 0.9008*
RESET(2) = 0.6164	*RESET(3) = 0.4243*	*Chow F (88.1) = 0.5595*	*Sample breakpoint (88.1) = 0.4675*	

Marginal significance levels of restrictions on coefficients: $\Delta P = -1$ (0.1326).

Equation 2

C	$(M-P)_{-1}$	Y_{-1}	ΔY_{-2}	ΔP	$(\underline{r}-\underline{R})_{-3}$	$\Delta_4(M-P)$	$EE\$_{-2}$	T	DU 88.3
-2.097	-0.313	0.504	-0.254	-0.858	0.003	0.064	-0.076	0.002	0.012
-7.361	*-5.606*	*7.348*	*-2.641*	*-6.605*	*3.982*	2.193	*-2.004*	*3.249*	*2.847*

Statistical indicators and tests:

R2 adj. = 0.8905	S E R = 0.0040	DW = 1.7532	Log Likelihood = 202.1425	F = 43.45559
LM (4) = 0.1918	*Jarque-Bera = 0.2212*	*Box-Pierce = 0.2370*	*Ljung-Box = 0.1532*	*Arch (4) = 0.7808*
RESET(2) = 0.7396	*RESET(3) = 0.3010*	*Chow F (88.1) = 0.6320*	*Sample breakpoint (88.1) = 0.4005*	

Marginal significance levels of restrictions on coefficients: $\underline{r}_{-3} = -\underline{R}_{-3}$ (0.1202); $\Delta P = -1$ (*0.2817*).

---

t statistics and marginal significance levels of tests are in italics. Underlined variables represent two-period moving averages.

[1] Chow tests have been obtained in equations where the value of $\Delta(M-P)$ in the third quarter of 1988 has been corrected by an amount equal to the coefficient of DU 88.3.

Table 8

Long-run elasticities of money demand

Countries	Eq.no.	Price level	Real income	Interest rates			Devaluation expectations			
				Own	Short-term	Long-term	$	DM	FF	Lit.
Belgium	1	1	1	-	0.020	-0.020	-0.026	-0.046	-	-
	2	1	1	0.126	-0.025	-0.008	-0.027	-0.039	-	-
	3	1	1	0.183		-0.043	-0.042	-0.048	-0.022	-
	4	1	1	0.203	-0.027	-0.041	-0.030	-0.054	-	-0.039
France	1	1	1.358		0.009	-0.009	-0.003	-	-	-
	2	1	1.147		0.017	-0.017	-	-	-	-
	3	1	1.319	0.024	-0.012		-0.003	-	-	-
Germany	1	1	1.746	0.041	-	-0.041	-0.017	-	-0.017	-0.017
	2	1	1.724	0.031		-0.039	-0.017	-	-0.017	-0.017
	3	1	1.655	0.042		-0.042	-0.009	-	-0.006	-
	4	1	1.819	0.034		-0.034	-0.009	-	-0.004	-0.005
Italy	1	1	0.451	0.008	-0.008		-0.003	-0.003	-	-
	2	1	0.499	0.009		-0.009	-	-0.003	-0.003	-
	3	1	0.455	0.009	-0.009		-0.003			
Netherlands	1	1	2.289	0.039	-	-0.023	-0.013	-0.053	-	-
	2	1	1.255	0.044	-	-0.012	-0.006	-	-0.005	-
	3	1	2.616	0.064	-	-0.040	-0.012	-0.025	-0.011	-
	4	1	0.894	-	0.025	-0.025	-0.009	-0.021	-	-
United Kingdom	1	1	1.609	0.012	-	-0.006	-0.003	-	-	-
	2	1	1.610	-	0.010	-0.010	-0.002	-	-	-

<u>Chart 1</u>

Velocity levels and deviations from trend (logarithmic scale)

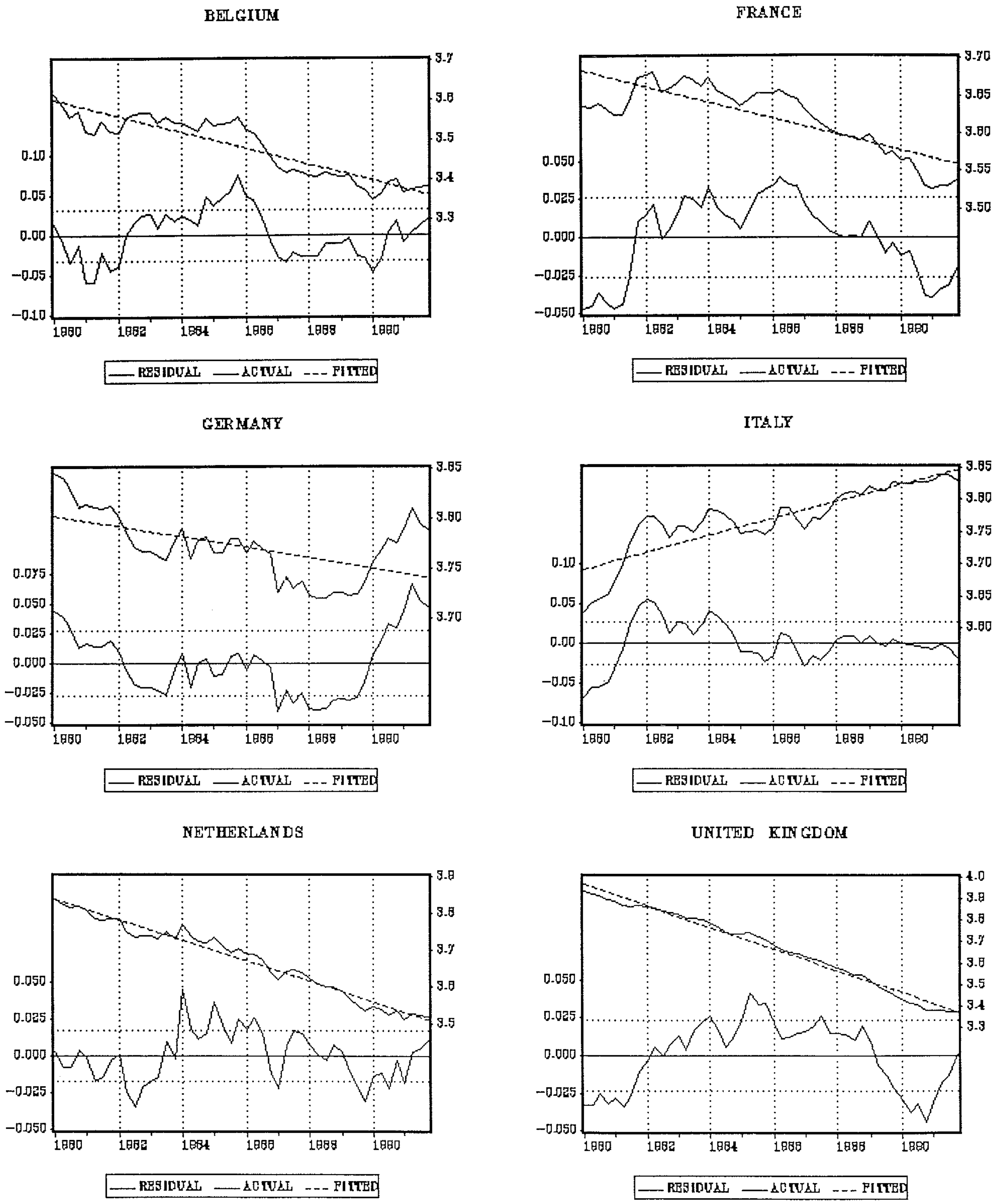
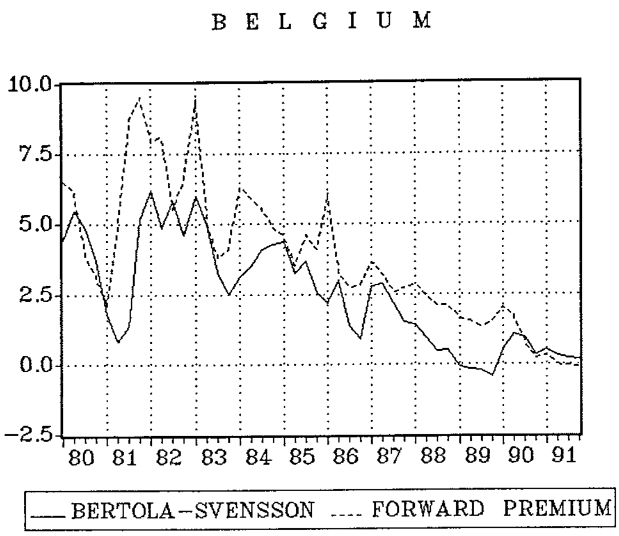
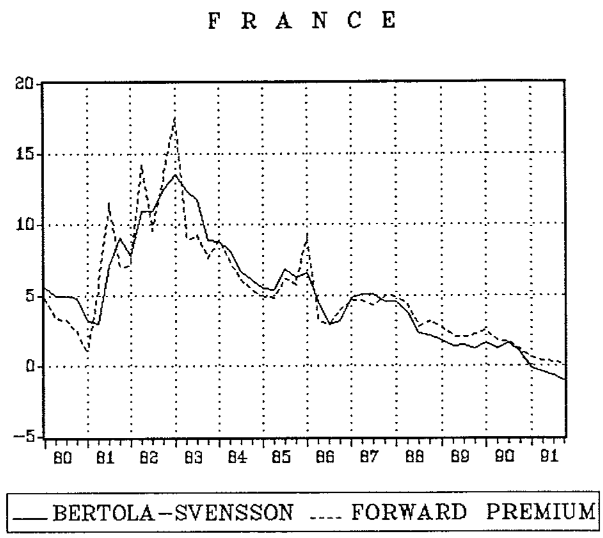
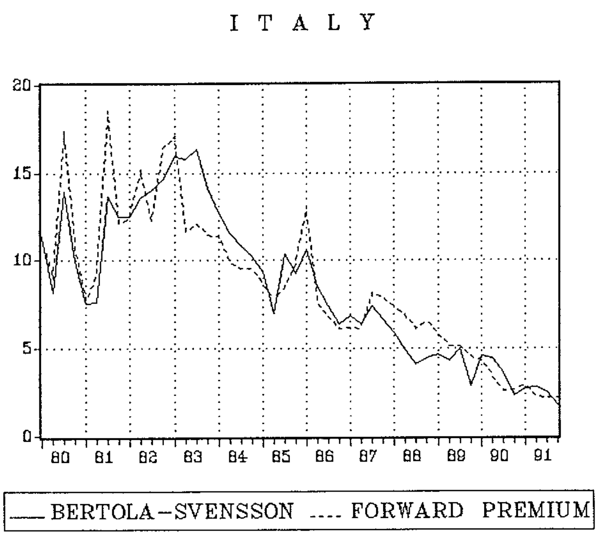


Chart 2

Devaluation expectations vis-à-vis the Deutsche Mark







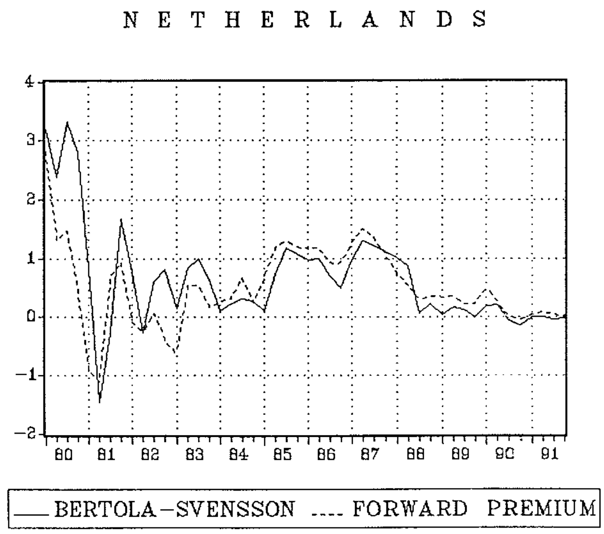
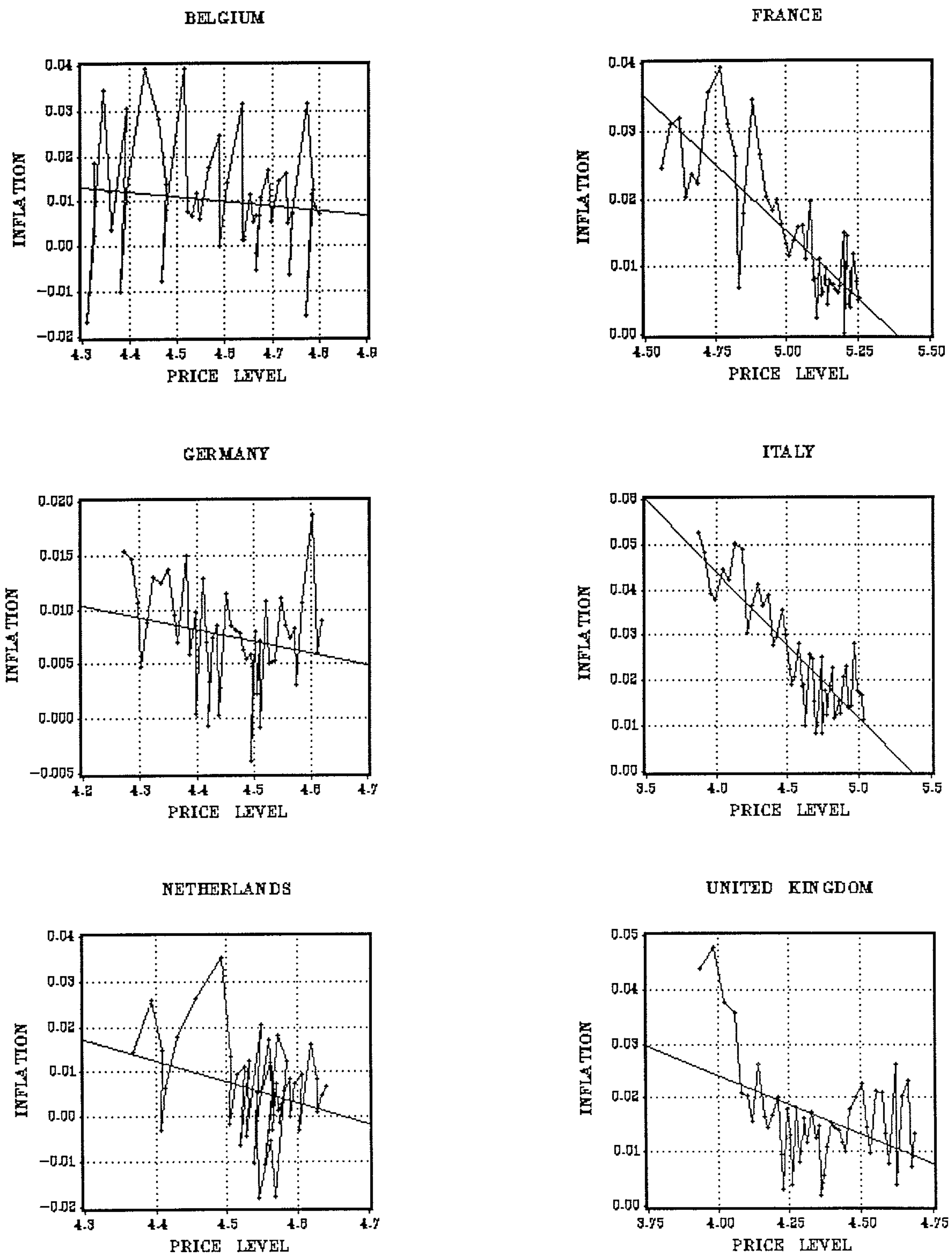


Chart 3

Quarterly rate of inflation and price level (lagged one quarter) underlying the ADF test

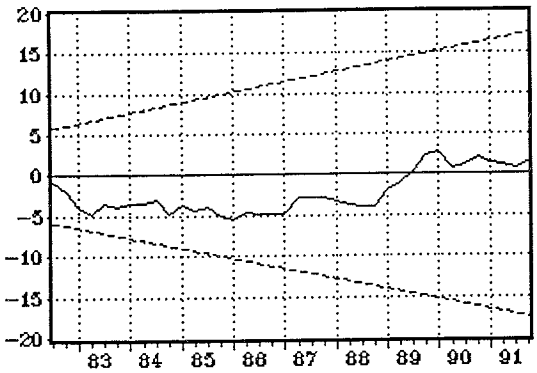


Note: The price index is the GDP deflator.

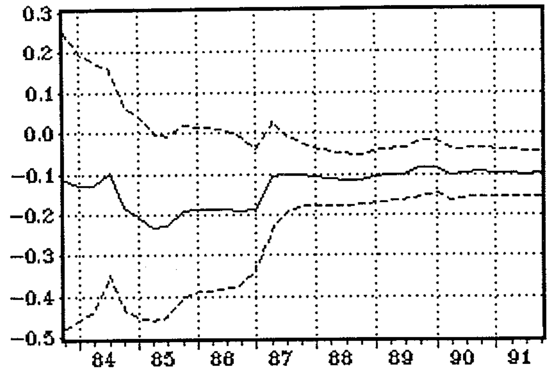
Chart 4

BELGIUM

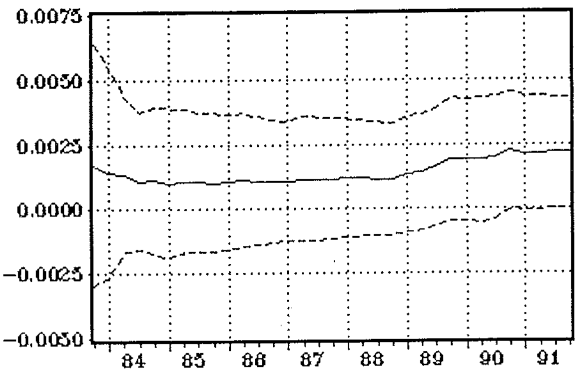
Cusum test and recursive coefficients' estimates



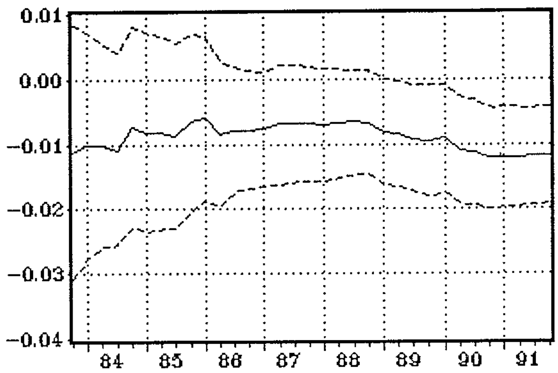
—— CUSUM --- 5% significance



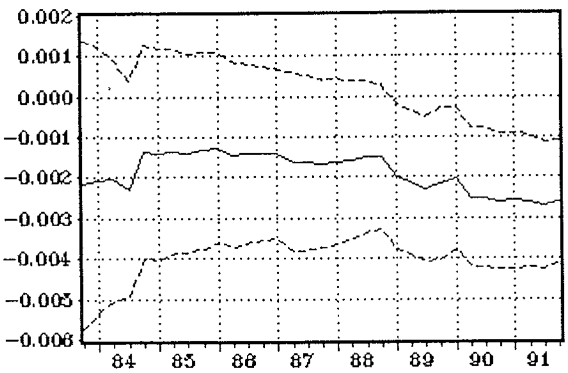
—— Recursive (M-P-Y)(-1) Estimates --- +- 2 S.E.



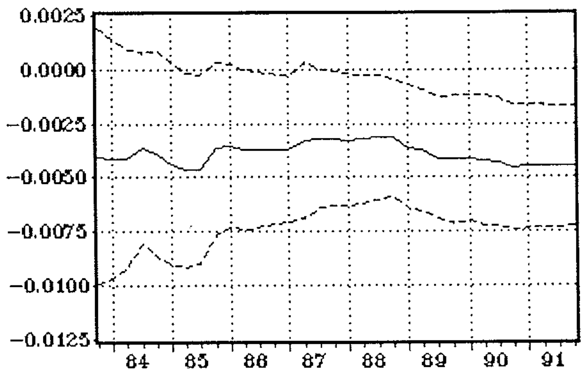
—— Recursive (r-R)(-3) Estimates --- +- 2 S.E.



—— Recursive D(R(-1)) Estimates --- +- 2 S.E.



—— Recursive EE$ Estimates --- +- 2 S.E.



—— Recursive EEDM(-2) Estimates --- +- 2 S.E.

Chart 5

FRANCE

Cusum test and recursive coefficients' estimates

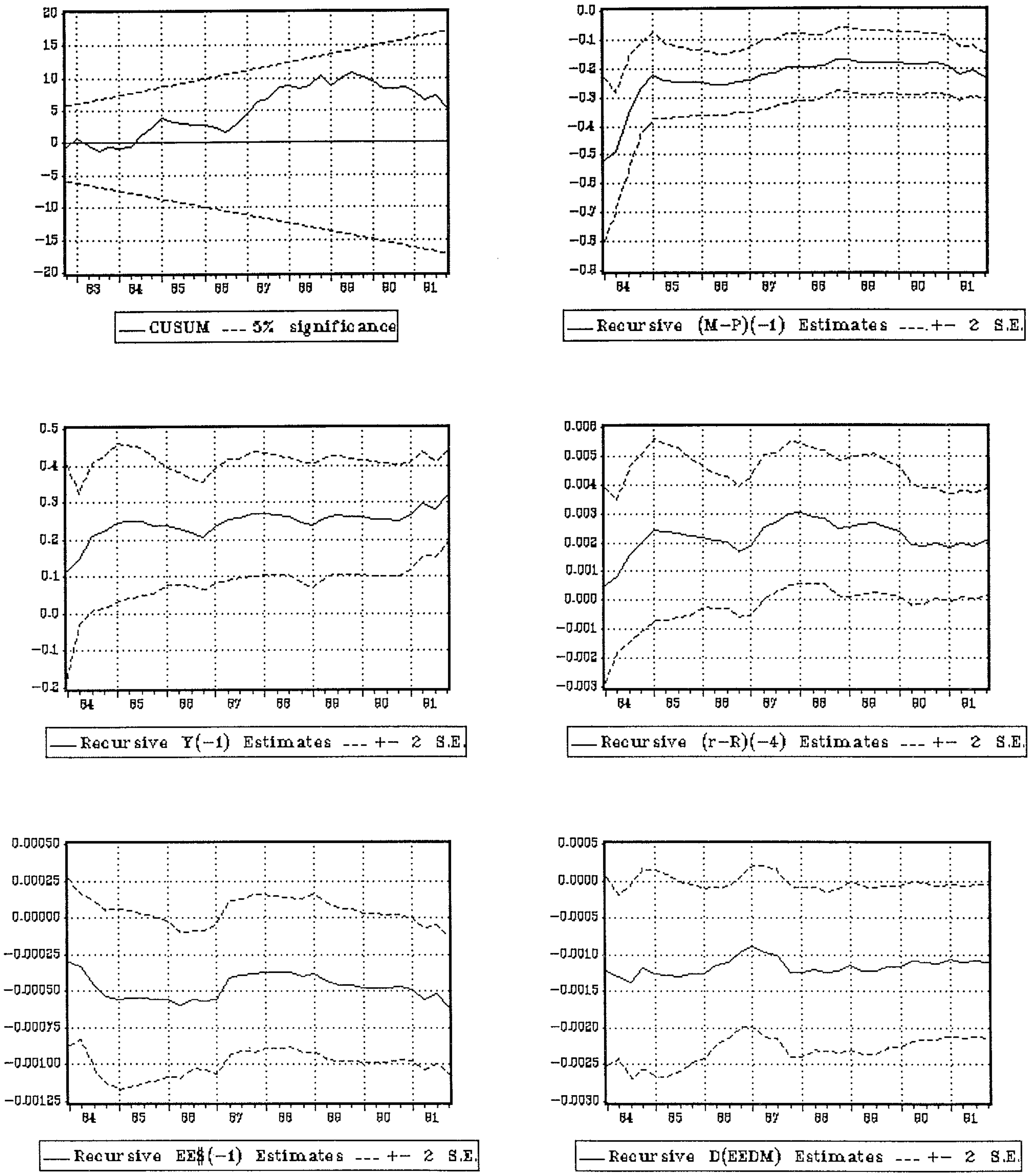


Chart 6

GERMANY

Cusum test and recursive coefficients' estimates

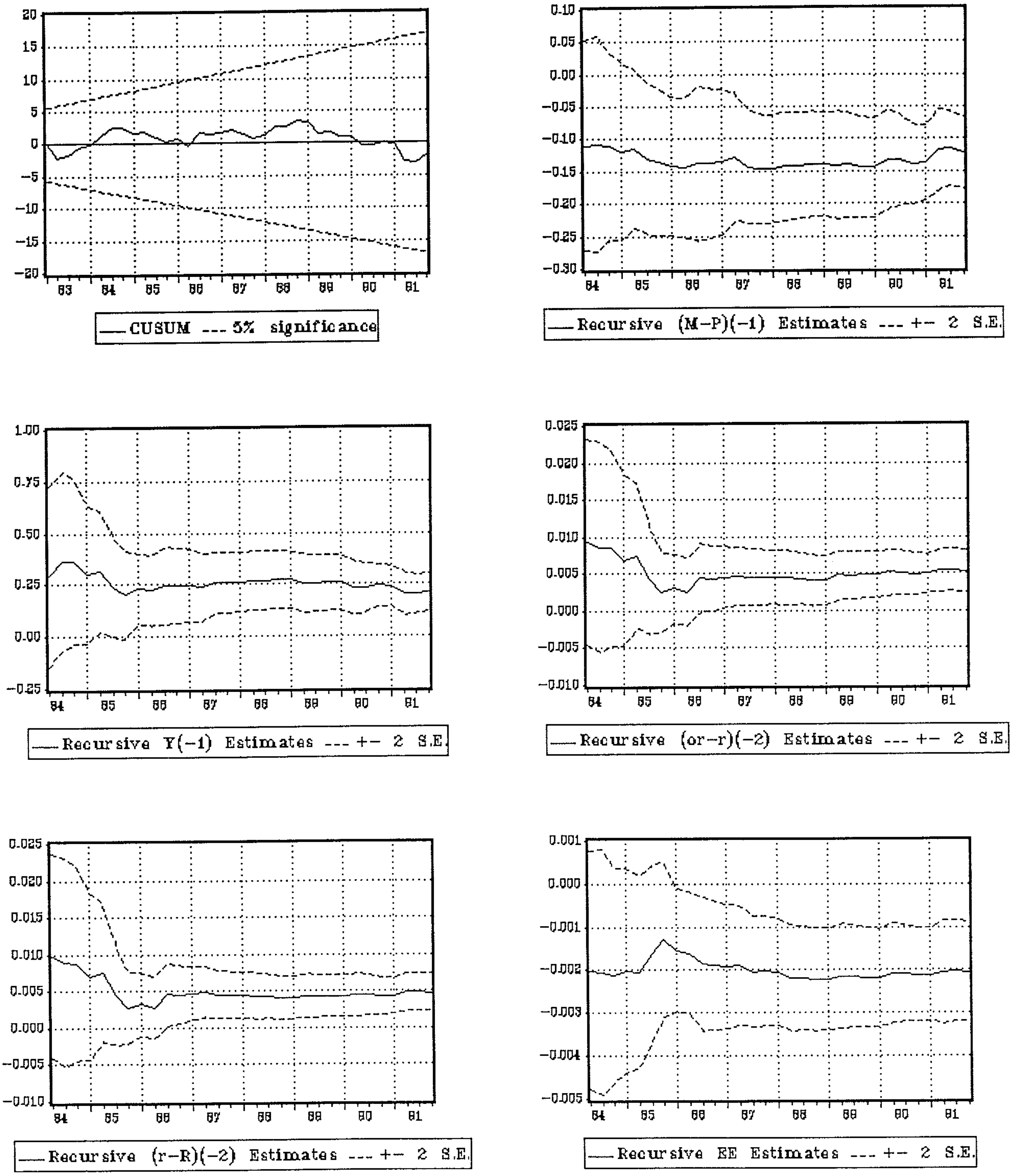
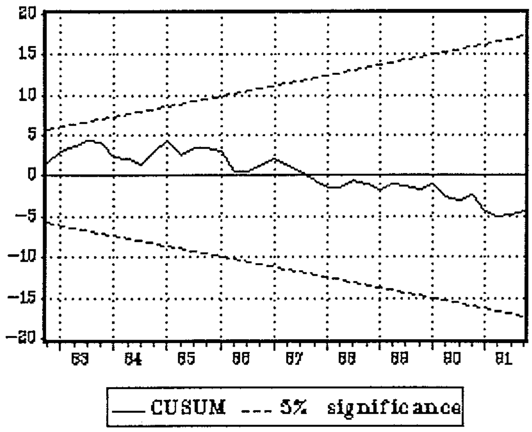
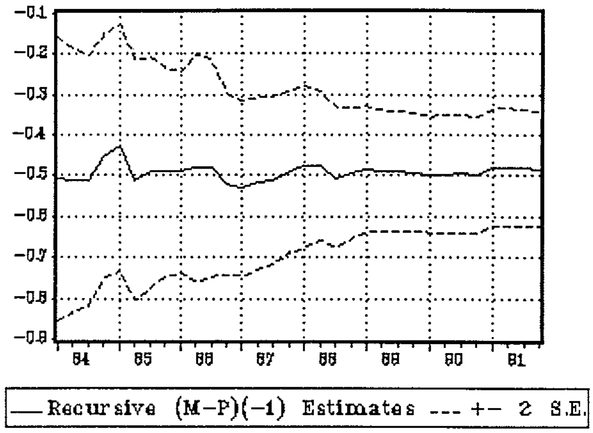


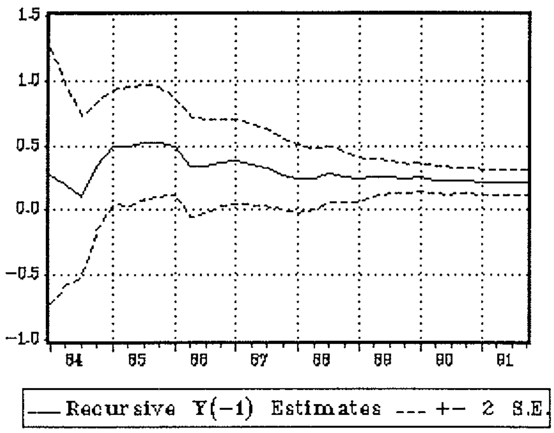
Chart 7

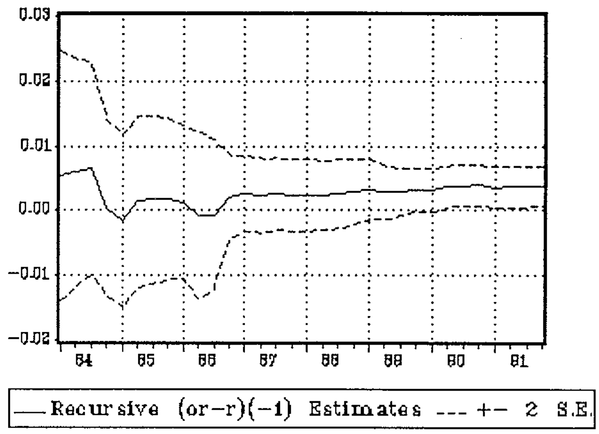
ITALY

Cusum test and recursive coefficients' estimates









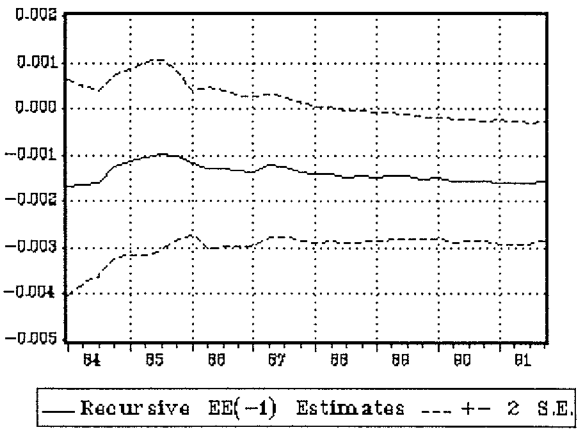


Chart 8

NETHERLANDS

Cusum test and recursive coefficients' estimates

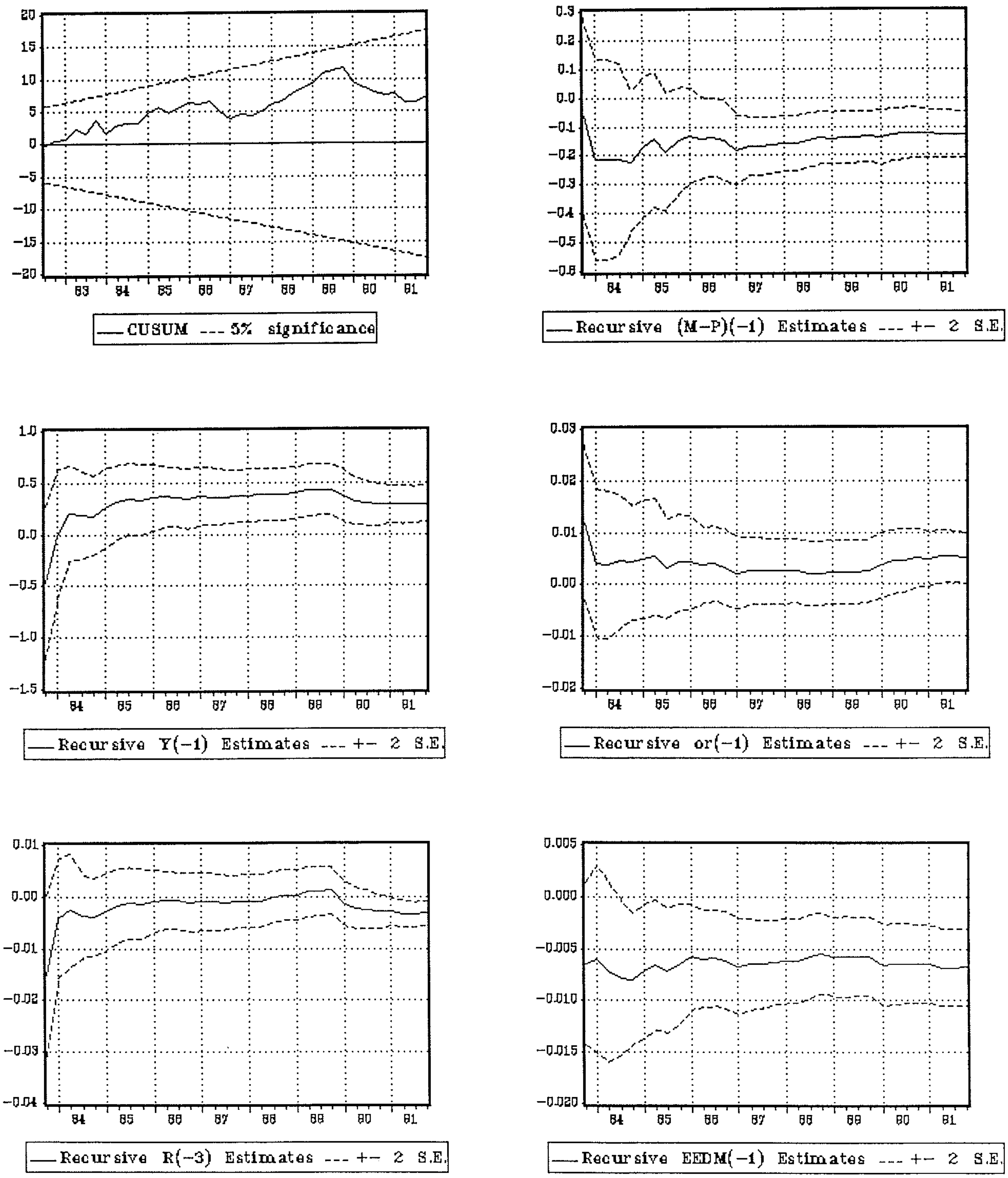


Chart 9

UNITED KINGDOM

Cusum test and recursive coefficients' estimates

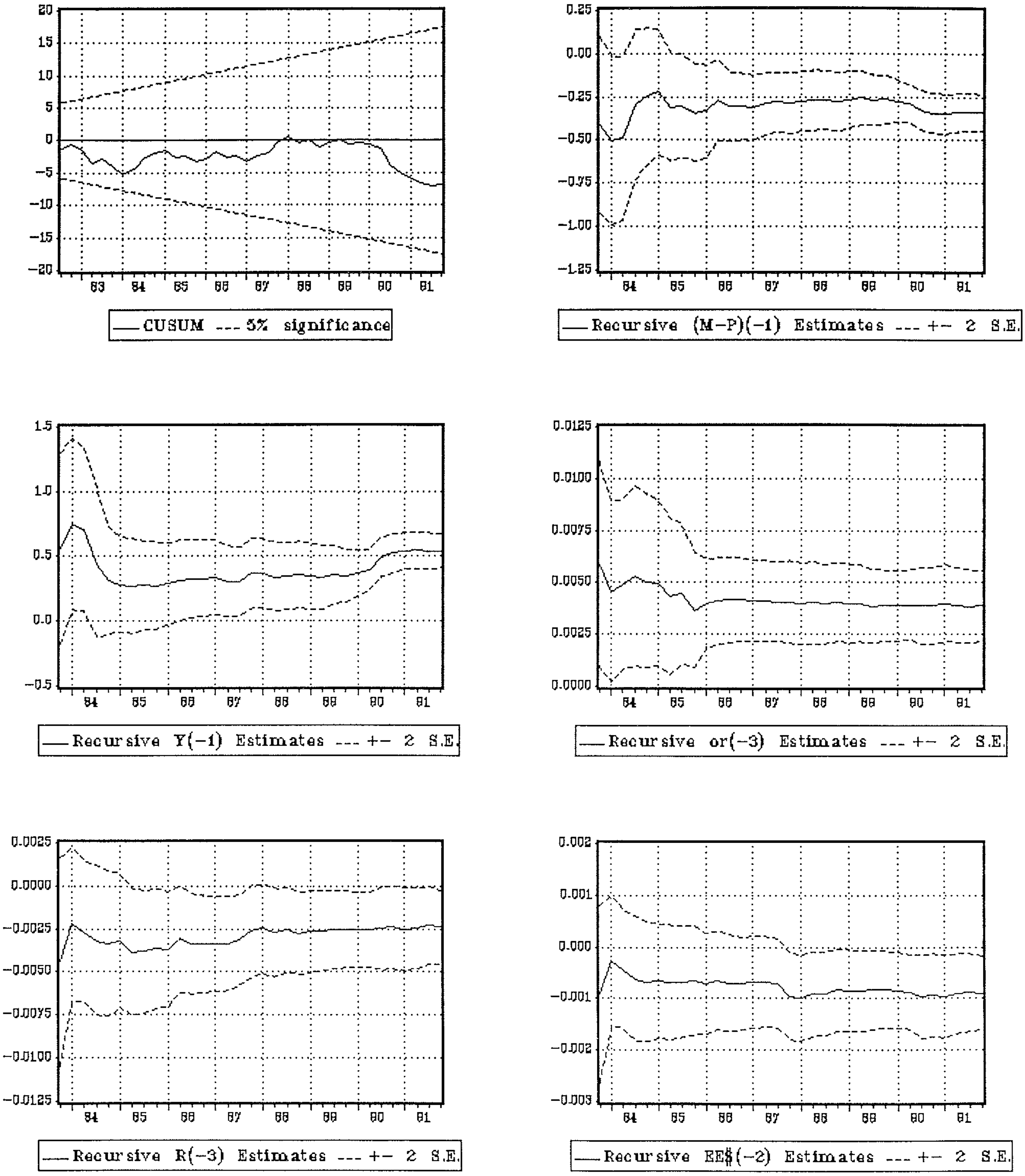
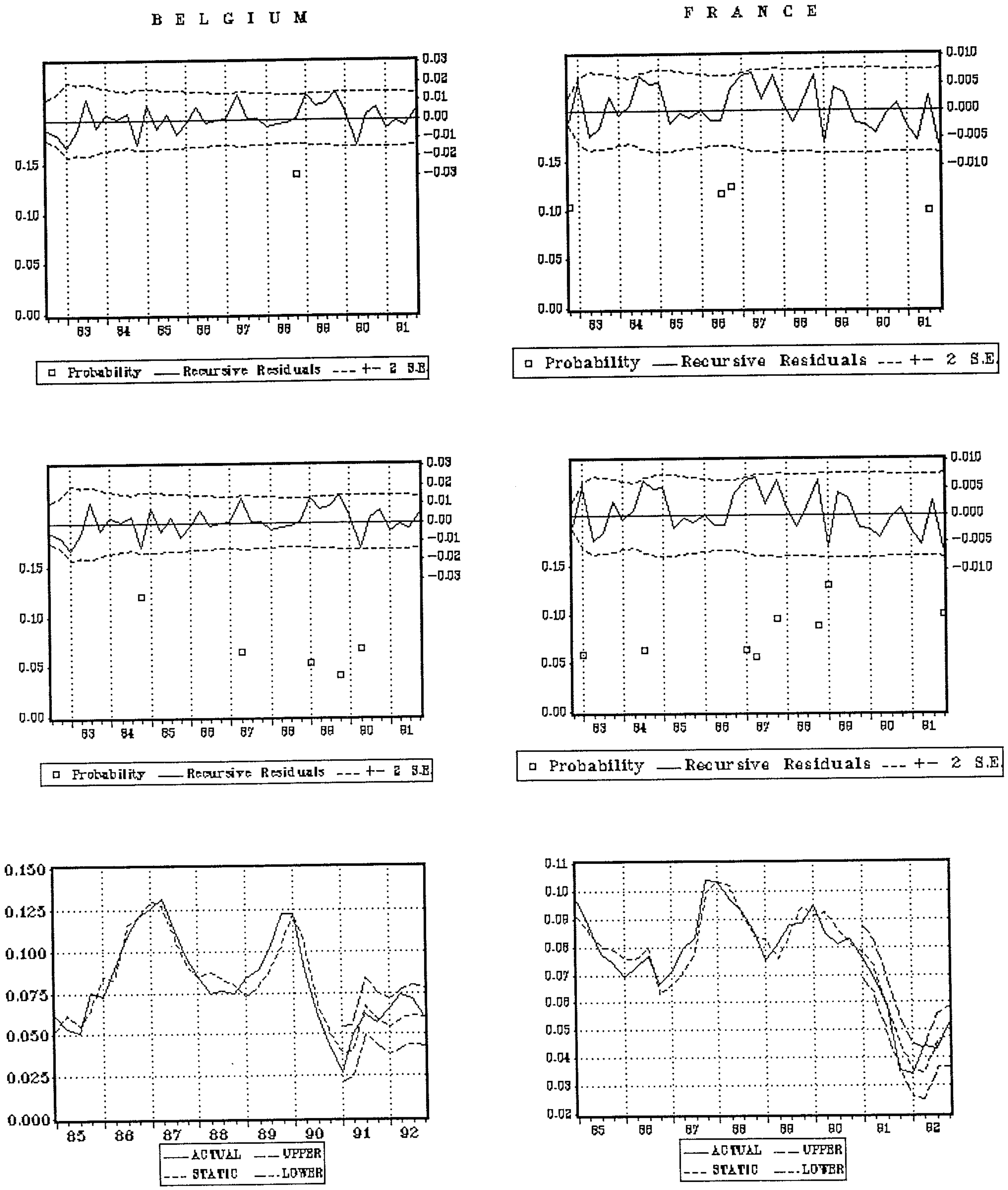


Chart 10

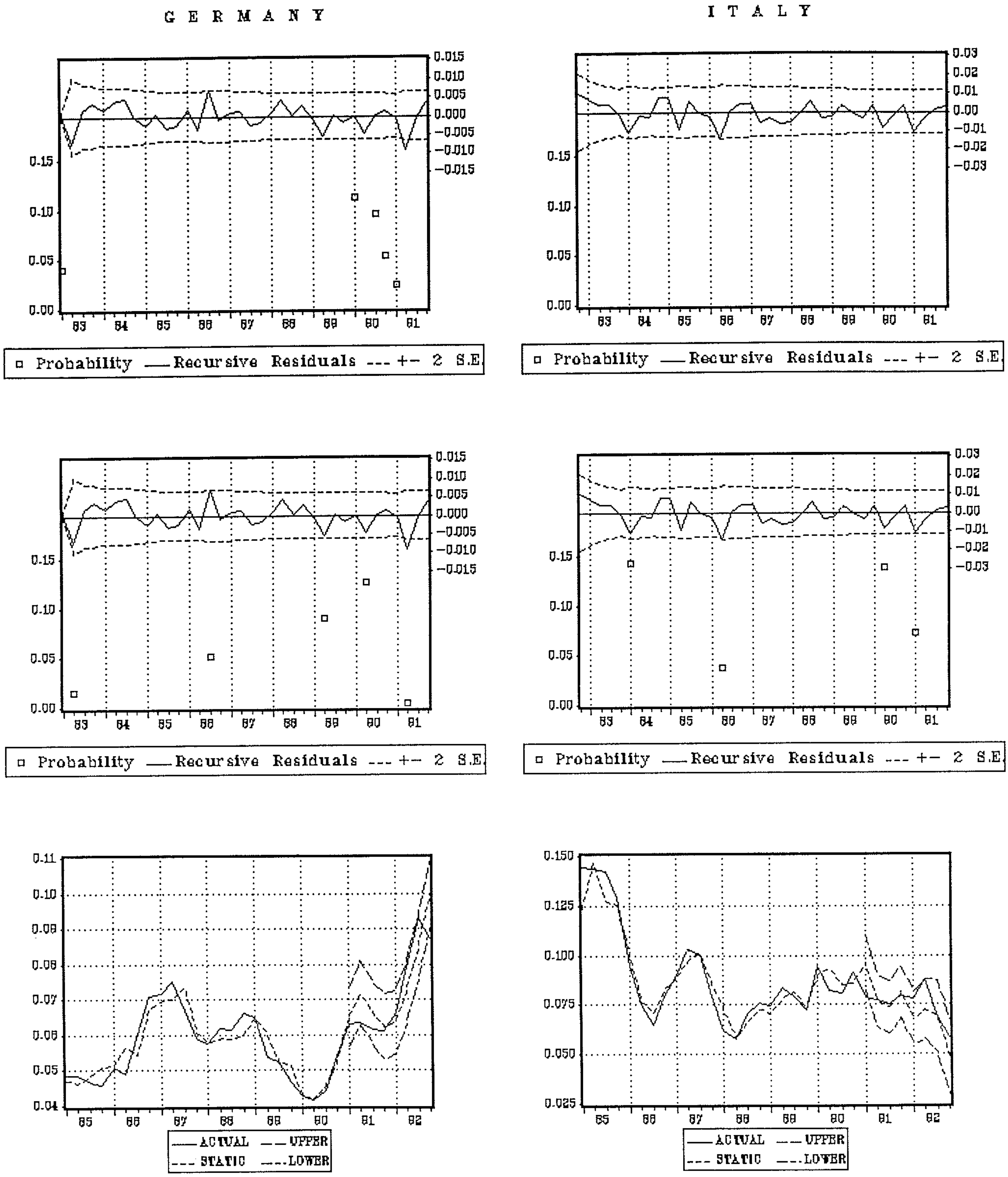
Forecast Tests



N-step Forecast F Tests are reported in the upper panels of the chart. 1-step Forecast F Tests are in the middle panels and out-of-sample static predictions are shown in the lower panels.

Chart 11

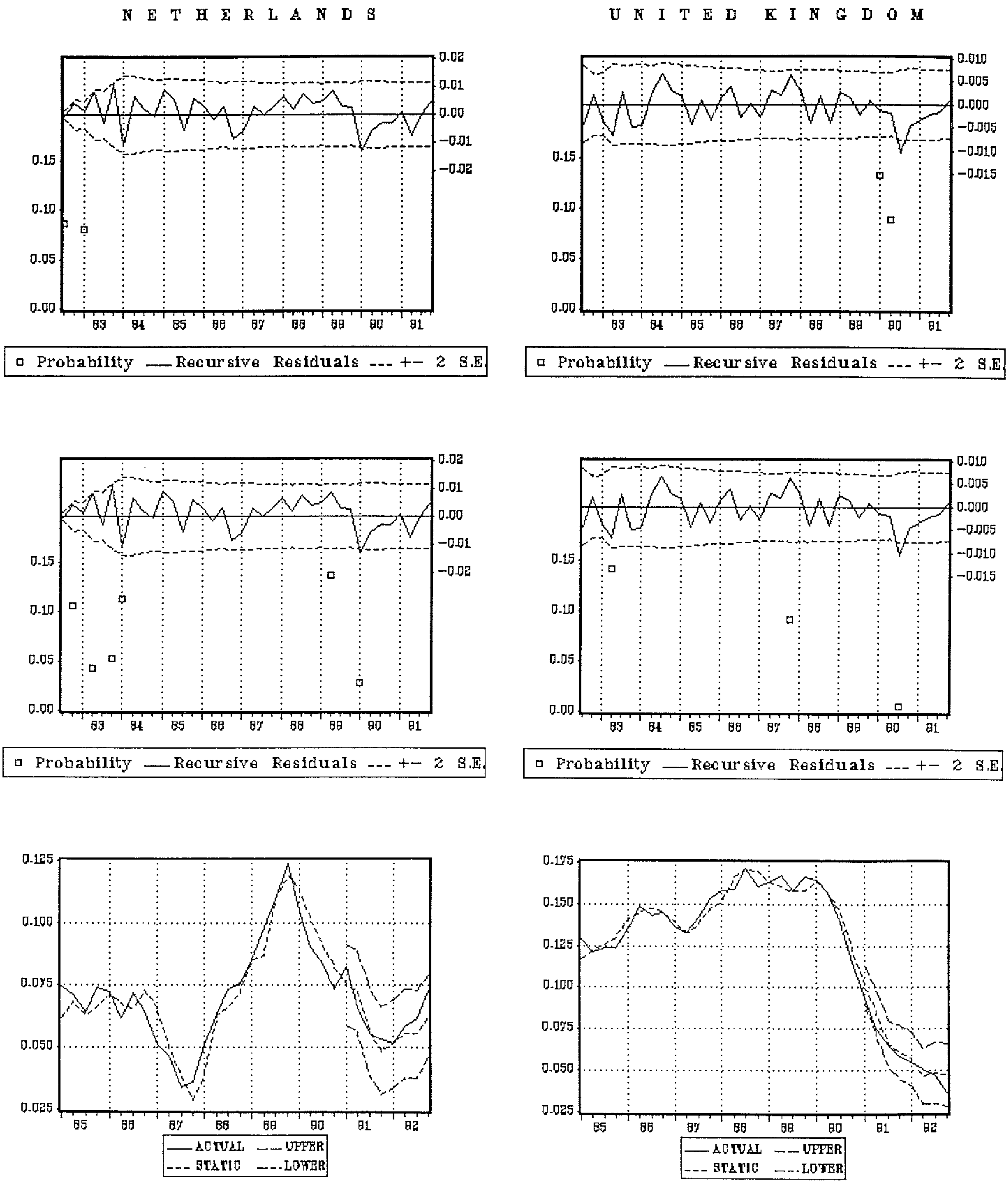
Forecast Tests



N-step Forecast F Tests are reported in the upper panels of the chart. 1-step Forecast F Tests are in the middle panels and out-of-sample static predictions are shown in the lower panels.

Chart 12

Forecast Tests



N-step Forecast F Tests are reported in the upper panels of the chart. 1-step Forecast F Tests are in the middle panels and out-of-sample static predictions are shown in the lower panels.

Appendix

Data definitions

Belgium

Broad Money	M	M3H; SA, EQ
Real Income	(Y)	Real GDP; 1985 prices; SA[1]
Price Index	(P)	GDP deflator, 1985 = 100[1]
Short-term interest rate	(r)	3-month interbank rate; AEM
Long-term interest rate	(R)	Government bonds with over 5 years to maturity; AEM

Own rate is calculated as the weighted average of interest rates which are relevant for various components of Broad Money

Money component	Relevant interest rate
Notes and coins and private demand deposits	Zero interest rate
Term and notice deposits	3-month interbank rate
Savings deposits	Ordinary savings deposits with public credit institutions
Foreign currency deposits	Simple average of German 3-month interbank loans and 10-year federal Government bonds
Savings bonds and other components	Simple average of 1-year rate on cash certificates and 5-year rate on bonds of public credit institutions

France

Broad Money	M	M3N; SA
Real Income	(Y)	Real GDP; 1980 prices; SA
Price Index	(P)	GDP deflator, 1980 = 100 - geometric link at December 1990; SA
Short-term interest rate	(r)	3-month interbank offer rate; AD
Long-term interest rate	(R)	Government bonds rate: over 7-year (1980-November 1986) and 7-10 years (December 1980 onwards - arithmetic link); AEM

Own rate is calculated as the weighted average of interest rates which are relevant for various components of Broad Money

Money component	Relevant interest rate
M1N	Zero interest rate
Savings books deposits	Basic rate on savings books deposits at savings banks
Savings books deposits for housing purchases and industrial developments	Minimum rate, including premium on housings savings plans
Domestic liquid placements	3-month interbank offer rate
Foreign currency deposits	Simple average of German 3-month interbank loans and 10-year federal Government bonds

[1] Quarterly data obtained by interpolation using as reference indicators industrial production index (SA) and producer prices (finished manufactures) (NSA) for real GDP and GDP deflator respectively.

Germany

Broad Money	M	M3N; SA; data prior to December 1985 adjusted upward by a geometric link (2.5%); data prior to January 1991 adjusted upward by a geometric link (12.7%)
Real Income	(Y)	Real GDP; 1991 prices; western Germany; SA
Price Index	(P)	GDP deflator, 1991 = 100; western Germany; SA
Short-term interest rate	(r)	3-month interbank rate; AD
Long-term interest rate	(R)	10-year Federal Government bonds rate; AEM

Own rate is calculated as the weighted average of interest rates which are relevant for various components of Broad Money

Money component	Relevant interest rate
M1N	Zero interest rate
Time deposits of domestic non-banks at up to 4 years	3-month time rate of between DM 1 and 5 million
Savings deposits of non-banks at statutory notice	Savings deposit rate at 3 months' notice

Italy

Broad Money	M	M3H; SA; data prior to 1985 adjusted downward by a geometric link (-2.8%)
Real Income	(Y)	Real GDP; 1985 prices; SA
Price Index	(P)	GDP deflator, 1985 = 100; SA
Short-term interest rate	(r)	Maximum interbank demand deposit rate; AD
Long-term interest rate	(R)	BTP rate (net of tax); AD

The own return on money is constructed as a weighted average of the net yields of the various components of Broad Money: the after-tax yields on T.bills, on Treasury bonds and on floating rate Credit Certificates. (Angelini, P., D.F. Hendry and R. Rinaldi (1994): p. 46.)

Netherlands

Broad Money	M	M3H; SA; adjusted for various breaks by geometric links
Real Income	(Y)	Real GDP; 1990 prices; SA
Price Index	(P)	GDP deflator, 1990 = 100; SA
Short-term interest rate	(r)	3-month loans to local authorities; AD
Long-term interest rate	(R)	5 to 8-year central government bonds; AD

Own rate is calculated as the weighted average of interest rates which are relevant for various components of Broad Money

Money component	Relevant interest rate
Notes and coins	Zero interest rate
Demand deposits	Ordinary demand deposits rate
Short-term time deposits	3-month interbank offer rate
Foreign currency deposits	Simple average of German 3-month rate of between DM 1 and 5 million on time deposits
Short-term savings	Ordinary savings deposits rate

United Kingdom

Broad Money	M	M4N; SA; adjusted for various breaks
Real Income	(Y)	Real GDP (average of estimates), 1990 prices; SA
Price Index	(P)	GDP deflator (average of estimates), 1990 = 100; SA
Short-term interest rate	(r)	3-month interbank deposits; AEM
Long-term interest rate	(R)	10-year Government stocks; AEM

Own rate is calculated as the weighted average of interest rates which are relevant for various components of Broad Money

Money component	Relevant interest rate
Notes and coins and non-interest-bearing retail deposits	Zero interest rate
Interest-bearing retail (sight) deposits and building society retail shares and deposits	3-month time CDs rate
Bank sterling wholesale deposits (incl. CDs)	Savings deposits with 4 clearing banks, gross of tax
Building society sterling wholesale deposits (incl. CDs)	Savings deposits with 5 major building societies, gross of tax

Note: Forward premium (discount) were calculated as (F-S/S)*400 where F and S are the 3-month forward and spot exchange rate respectively (domestic currency per unit of foreign currency). Bertola and Svensson indicators of devaluation expectation vis-à-vis the Deutsche Mark are calculated as described in Section 4 using 12-month interest rates.

Notation:

AD	=	average of daily data
AEM	=	average of end-month data
EQ	=	end of quarter
N, H	=	national, harmonised definition
SA	=	seasonally adjusted
NSA	=	seasonally unadjusted

Appendix to Table 1

Unit root tests

[equations specifications]

Series	Belgium		France		Germany		Italy		Netherlands		United Kingdom	
	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)	ADF(L)	ADF(D)
M	T,1	C,0	C,0	T,0	T,1	C,0	C,0	C,0	T,2	C,0	C,0	T,0
P	C,2	T,1	T,0	T,0	T,1	C,0	T,0	T,0	C,1	C,0	T,0	T,0
M-P	T,1	C,0	T,0	C,0	T,1	C,0	T,0	C,0	T,0	C,0	T,0	C,0
Y	T,0	C,0	T,2	C,0	C,2	C,0	T,2	C,0	T,0	C,0	T,2	C,0
or	T,0	C,0	C,1	C,0	C,2	C,0	T,1	C,0	C,1	C,0	C,1	C,0
r	T,1	C,0	T,1	C,1	C,1	C,0	T,0	C,0	C,1	C,1	C,2	C,0
R	T,2	C,0	T,1	C,0	C,1	C,0	T,2	C,0	T,1	C,0	T,1	C,0
or-r	T,1	C,0	T,1	C,0	C,2	C,0	T,0	C,0	C,1	T,1	T,0	C,0
or-R	T,2	C,0	T,1	C,0	C,1	C,0	T,1	C,0	T,1	C,0	T,1	C,0
r-R	C,1	C,0	T,1	T,1	C,2	C,0	C,1	C,0	T,1	T,1	T,2	C,0
EE$	C,1	C,1	C,0	C,0	T,0	C,1	C,0	C,0	T,1	C,1	T,1	C,0
EEDM	T,1	C,0	T,1	C,0	-	-	T,0	C,0	C,2	C,1	C,1	C,0
EEFF	C,0	C,0	-	-	T,0	C,0	C,0	C,0	C,0	T,0	T,0	C,0
EEIT	T,0	C,0	T,0	C,0	T,0	C,0	-	-	T,0	C,0	T,0	C,0

Note: ADF(L) and ADF(D) refer to Augmented Dickey-Fuller tests on levels and first differences respectively of the dependent variables. When T (or C) are reported, the equations include the constant and a time trend (or the constant only); the values after the comma indicate the number of lags. For the definitions of the series, see Table 1.

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