BANK OF FINLAND
DISCUSSION PAPERS

5/97

Sinimaaria Ranki

Research Department
14.4.1997

Monetary Policy in the ERM: Internal Targets or External Constraints?

SUOMEN PANKIN KESKUSTELUALOITTEITA • FINLANDS BANKS DISKUSSIONUNDERLAG

Suomen Pankki
Bank of Finland
P.O.Box 160, SF-00101 HELSINKI, Finland
☎ + 358 0 1831

Sinimaaria Ranki

Research Department
14.4.1997

Monetary Policy in the ERM: Internal Targets or External Constraints?

ISBN 951-686-545-3
ISSN 0785-3572

Suomen Pankin monistuskeskus
Helsinki 1997

Monetary Policy in the ERM: Internal Targets or External Constraints?

Bank of Finland Discussion Paper 5/97

Sinimaaria Ranki
Research Department

Abstract

This study is concerned with the determinants of monetary policy in the ERM countries. We derive a monetary policy rule, an interest rate rule, from a minimization problem faced by the central bank. The loss function trades off costs of interest rate instability against benefits from successful demand management and stable exchange rate in the ERM. ERM-related considerations, particularly exogenous effects from German interest rates as well as deviations from the ERM central rates, are introduced into the analysis through the latter channel. In the empirical section of the paper, we seek to quantify the significance of the effects of the various factors on the domestic interest rate of the ERM-countries by performing regression analysis with the domestic short-term interest rate as the dependent variable. The evidence suggests that the countries can be divided into two groups. In the first group (Belgium, Denmark, France and the Netherlands) the exchange rate has deviated *more* from the central rate since the widening of the fluctuation bands than it did earlier. At the same time, the direct influence of German monetary policy has diminished, while the significance of the lags of the domestic interest rate has remained high or even increased. In the second group (Great Britain, Italy and Spain) the trade-off in monetary policy has been more a consideration of the two domestic factors than domestic and foreign components of the loss function. These results seem to be consistent with the interpretation that the EMS has become more symmetric, especially as regards the "core" countries. One could also interpret the development of the role of the EMS as a gradual introduction of an implicit coordination mechanism through which countries have sought to improve interest rate convergence by coordinating their policy targets. In this way, the role of the ERM as a constraint on achieving policy targets has decreased.

Keywords: ERM, reaction function, exchange rates, monetary policy

Tiivistelmä

Tutkimuksessa analysoidaan rahapolitiikkaan vaikuttaneita tekijöitä valuuttakurssimekanismiin (ERM) osallistuneissa maissa. Keskuspankin päätöksenteko-ongelmaa kuvaavasta mallista johdetaan korkosäännön muodossa oleva rahapolitiikkasääntö. Rahapolitiikkaan vaikuttaa kolme tekijää: kustannukset, joita rahapolitiikan välineen käyttö aiheuttaa, sekä hyödyt, joita saadaan onnistuneesta kysynnän ohjauksesta sekä vakaista valuuttakurssiodotuksista. Tätä jälkimmäistä kanavaa pitkin saadaan mallitettua myös ERM:ään osallistumisesta aiheutuvat Saksan korkomuutosten ja valuuttakurssipoikkeamien (keskuskurssista) vaikutukset. Tutkimuksen empiirisessä osassa pyritään määrittämään eri tekijöiden vaikutukset ERM-maiden korkopolitiikkaan. Tulosten perusteella maat voidaan jakaa kahteen ryhmään. Ensimmäisessä ryhmässä (Belgia, Tanska, Ranska ja Hollanti) valuuttakurssi on poikennut keskuskurssistaan laajojen vaihteluvälien aikana enemmän kuin aikaisemmin. Samalla Saksan rahapolitiikan suoranainen vaikutus on pienentynyt, kun taas kotimaisen koron oman historian merkitys on pysynyt suurena tai jopa kasvanut. Sen sijaan toisessa maaryhmässä (Iso-Britannia, Italia ja Espanja) rahapolitiikan valinnat on tehty ennemminkin kotimaisten muuttujien kuin kotimaisten ja ulkomaisten muuttujien välillä. Tulokset ovat sopusoinnussa sen tulkinnan kanssa, jonka mukaan ERM:stä on tullut symmetrisempi, etenkin ns. ydinmaiden kohdalla. Vastaavasti voidaan tulkita ERM:n vähitellen muuttuneen yhteistyötä tiivistäväksi mekanismiksi, jonka avulla maat ovat voineet saavuttaa yhtenäisen korkokehityksen koordinoimalla talouspolitiikkansa tavoitteet. Ulkoisena rajoitteena ERM:n merkitys olisi samalla vähentynyt.

Asiasanat: ERM, reaktioyhtälö, valuuttakurssit, rahapolitiikka

Contents

1 Introduction

The exchange rate mechanism (ERM) of the European Monetary System (EMS) was established in 1979 in order to promote exchange rate stability in Europe. It is a system with fixed, but adjustable, parity rates. Within the parity grid, the currencies of the participating countries have a central rate vis-à-vis each other. The currencies are then allowed to float in a band around the central rate. If long-lasting discrepancies in the underlying economies cause pressures for the exchange rate, the central rate can be realigned by a common decision of all the participating countries.

ERM functioning has evolved. The prevalent idea of the course of this evolution is breadly as follows. In the early years, domestic goals were preferred over external targets in monetary policy formulation. Inflation discrepancies were allowed, because they were readily corrected through a change of the exchange rate parity. Towards the end of the 1980s, however, exchange rate stability seems to have gained more weight in the reaction function of the central banks. Domestic inflation was forced down, and there was a reluctance to disturb the central rate. Even the exchange rate close was to be kept close to the central rate, a goal formally expressed in the Basle-Nyborg Agreement. This period of exchange rate credibility was disturbed by a Europe-wide currency crisis in autumn 1992. That turmoil led the ERM countries to widen the fluctuation margins from the original ±2.25 per cent to ±15 per cent. Measurement of the changes in policy preferences in the ERM remains an interesting issue, however.

So what does the empirical evidence tell us about the course of monetary policy in the ERM countries? To find out we construct a model based on a loss function that the central bank has to minimize. In the loss function, we have three elements. The first is the cost arising from using the policy instrument: interest rate variability. The second element is the standard short-term Phillips-curve related trade-off, ie the central bank wants to keep the inflation rate as well as the rate of output close to levels that are considered optimal. The third element introduces the ERM into the system. If the central bank targets the exchange rate, it has to react whenever the spot exchange rate deviates from the announced central rate, or whenever the interest rate of the anchor country, ie Germany, changes. The interesting question is the relative weight put to the different targets or constraints of monetary policy. In order to test this, we derive a regression equation where we have as dependent variable the domestic short-term interest rate and as explanatory variables domestic inflation rate, domestic production, the exchange rate, German short-term interest rate, and the US short-term interest rate as representing the monetary policy of the rest of the world. We analyse the entire period from the establishment of the EMS in January 1980 up to June 1996, dividing it into three subperiods. The three subperiods, in turn, are designated according to the de facto functioning of the ERM. In the early years, when there were many realignments, the system was more a crawling peg than a fixed exchange rate system. Between 1987 and 1992, no realignments occurred, making the EMS essentially a fixed exchange rate system. In the aftermath of the 1992 currency crisis, the fluctuation margins of the ERM were widened. Theoretically, at least, the system in use since August 1993 offers plenty of room for flexibility.

The evidence suggests that the role of the domestic variables for monetary policy making has been about the same throughout the full period. While they were most important in the first subperiod, they became only slightly less significant in following subperiods. On the foreign side, the German interest rate became a significant coefficient only in two countries - Belgium and the Netherlands. In the other countries, the deviation of the exchange rate from the central rate has been the significant determinant of monetary policy. It is natural that from these two variables only one is observed when making domestic monetary policy decisions. A country participating in the ERM can either follow the monetary policy of the anchor country and stabilize the exchange rate, or deviate from the monetary policy of the anchor country and let the exchange rate react to this deviation. The fact that the deviation of the spot exchange rate from the central rate yields only insignificant coefficients in the third subperiod may indicate that the EMS has become more symmetric over time in the sense that the participating economies and the policy preferences of the participants have converged. During the existence of the wide fluctuation margins, either the amount of sterilized intervention has increased, or deviations of the exchange rate from its central rate have been allowed more generously than before, or both. In any case, the exchange rate restriction originally provided by the ERM seems to have lost its direct constraining influence on domestic monetary policy making.

2 The German dominance hypothesis

The influence of the EMS on the participants' monetary policies has usually been studied in the context of the so-called German dominance hypothesis. Every fixed exchange rate system raises the question of symmetry attached to the conduct of monetary policy among the participating countries. The EMS has been called a "greater DEM area", meaning that the DEM is considered as the monetary anchor of the system. Institutionally, the EMS does not induce an asymmetric working of international adjustment. The German dominance hypothesis states that Germany is the central country in the EMS, ie Germany determines its monetary policy more or less independently of what happens in the rest of the EMS; whereas the other countries, given the bilateral DEM parities, subordinate their monetary policies to German policy.

The main approaches adopted to test the German dominance hypothesis are:

- informal description of rules and outcomes,
- formal exploration of central bank reaction functions, and
- formal testing of outcomes.

The most important empirical contributions to the research around this asymmetric interpretation of the EMS are reviewed below.[1]

Giovannini (1988) studies the behaviour of interest rates in correspondence with parity realignments. His test is based on the premise that, while in a

[1] For another literature survey on German leadership, see Gros & Thygesen (1992) and Begg & Wyplosz (1993).

symmetric regime international portfolio shifts are reflected in both countries' interest rates, in an asymmetric regime the central country's rate is unaffected. International portfolio disturbances perturb rates only in other countries. Hence, he uses a simple test of the asymmetry hypothesis, based on the observation of countries' interest rates in correspondence with observable international portfolio shifts, ie parity realignments. The data show large swings in the offshore interest rates of the other EMS countries and a strikingly stable pattern in the domestic and offshore German rates. He then constructs objective functions for the central banks and tests the hypothesis that, in the central country, the deviations of the domestic target from its desired value are white-noise errors. While his results debunk the notion of white noise significance for other countries, this is not the case for Germany. Hence, the empirical evidence in his study agrees with the German dominance hypothesis.

In their study of interventions within the EMS, Mastropasqua et al. (1988) arrive at a similar result. They estimate central bank reaction functions for four countries displaying the expected ordering of sterilization coefficient of the foreign creation of a monetary base. They claim to have find ample evidence that Germany has played the n'th country role of supplying the system with a nominal anchor.[2]

De Grauwe (1988a, b) distinguishes short- and long-term offshore and domestic interest rates. He then tests whether expected exchange rate devaluations of an EMS member country against the DEM affect short-term interest rates only in a given country or both in Germany and the depreciating country. The empirical evidence presented suggests that the EMS constrained short-term interest rates without adding significant constraints to long-run interest rates. He concludes, however, that the EMS works in a highly symmetric way and rejects the German dominance hypothesis.[3]

Giavazzi & Giovannini (1989) study the GDH by looking at evidence from foreign exchange intervention data as well as the volatility of interest rates. The foreign exchange market data show that most of the intramarginal intervention was carried out by countries other than Germany, while Germany intervened only when bilateral fluctuation margins were reached. Motivated by this empirical finding, the authors construct a theoretical "accounting" model to show that:

- in an asymmetric system, interest rates respond asymmetrically to international portfolio shocks; and

---

[2] Bini Smaghi & Micossi (1990) also look at intervention data and find that participation by Germany in ERM-related intervention operations always has been minimal, and thereby confirming the asymmetry of the ERM. Bofinger (1991), in turn, argues that the eventual leading position of the DEM is, in practice, due to the asymmetric intervention mechanism of the system. Interventions imply an asymmetric sterilization behaviour among the member countries so that the liquidity effects of interventions are unevenly distributed. As a consequence, in order to prevent major foreign exchange reserve losses, the other EMS countries have had to conform their monetary policies of the strong-currency country, ie Germany. The German authorities in turn, as the providers of the strongest and most important currency in the ECU basket, never have to face monetary pressure from other EMS countries.

[3] The statistical properties of the data used in deGrauwe (1988b) have been carefully analyzed by Beyer & Schmidt (1992). They argue that the interest rates used in deGrauwe (1988b) are cointegrated of order one and should, therefore, be estimated in a different way as that employed in the paper.

- the center country, by sterilizing foreign disturbances, attempts to control its own money supply while the "satellite" countries attempt to control their foreign exchange reserves.

The authors test their model with short-term interest rates. They obtain a result suggesting that only Germany sets monetary policy independently, while other members accommodate German monetary policies.

Table 2.1 **Studies testing the German Dominance Hypothesis**

Study	Test object(s)	German Dominance yes: +, no: -
Giovannini (1988)	interest rates and realignments	+
de Grauwe (1988a, b)	interest rates - short-term - long-term	 (+) -
Mastropasqua et al. (1988)	interventions	+
Giavazzi & Giovannini (1989)	interest rates	+
von Hagen & Fratianni (1989)	interest rates and money supply growth	(-)
Honahan & McNelis (1989)	realignments and exchange rate predictability	+
Fratianni & von Hagen (1990)	monetary base growth	-
von Hagen & Fratianni (1990)	interest rates	(-)
Karfakis & Moschos (1990)	Granger causality tests with short-term interest rates	+
MacDonald & Taylor (1990)	Granger causality tests with nominal money supply -growth rates	+
Artus et al. (1991)	- Granger causality tests with short-term and long-term interest rates - maximum likelihood estimation of a structural model describing the transmission of US monetary policy	+ +
Kirchgässner & Wolters (1991a)	Granger causality tests with short-term and long-term interest rates	+
Kutan (1991)	money growth rates	-
Beyer & Schmidt (1992)	co-integration tests and error correction model for interest rates	+
Herz & Röger (1992)	estimation of a neoclassical two-country model	+
Koedijk & Kool (1992)	interest and inflation rates	-
Loureiro (1992)	VAR estimations with domestic credit	+/-
García-Herrero & Thornton (1996)	co-integration and Granger causality tests with interest rates	+ /-

von Hagen & Fratianni (1989) focus on monetary policy actions. Their hypothesis of German dominance rests on four assumptions:

- German dominance implies that other countries do not react directly to monetary policies occurring outside the EMS.
- German dominance implies that each EMS country reacts only to Germany's, and not other members', policies.
- German dominance implies that monetary policy in a member country depends on German policy, and
- to make German dominance meaningful, Germany itself must not be influenced by the monetary policy actions of other members.

They then model monetary policy actions and interactions on the basis of money market interest rates in the short-term, and the growth rate of the monetary base in the long-term. They provide empirical evidence to test for two forms of German dominance: a strong form, whereby deviations of the other members' policies from the path prescribed by the Bundesbank are not allowed either in the short- or long-term; and a weak form, which allows deviations in the short-term only. The results speak against German dominance in the EMS both in the strong and weak form. Overall, their results suggest that the system is more interactive, than hierarchical.

Honahan & McNelis (1989) test the effect of EMS realignments on the ability to forecast the exchange rate. They find no evidence for the DEM/USD rate to be affected whereas the ability to forecast the USD exchange rate against other EMS currencies is significantly affected by realignments. They conclude that the DEM serves as the dominant EMS currency.

Fratianni & von Hagen (1990) focus on the interaction of monetary policies looking at the evidence from the growth of the monetary base standardize these terms. Their tests give a strong rejection of German dominance. von Hagen & Fratianni (1990) look at the evidence from the interest rate perspective and find that Germany is a relatively strong player in the system, although its independence has diminished over time.

Karfakis & Moschos (1990) investigate, also, interest rate linkages between Germany and the other EMS countries. First, they determine if there exist long-term co-movements between German and other EMS interest rates by employing integration and cointegration techniques. Then they examine whether German interest rate changes convey information about future movements of other EMS interest rates. Their results with monthly data on short-term domestic nominal interest rates show that German interest rates heavily influence interest rate movements in other EMS countries.

MacDonald & Taylor (1990) argue that the GDH is correct when Granger causality runs from German monetary policy to the other EMS monetary policies. They use money growth rates as indicators, and test formally whether movements in the German money supply temporally precede movements in the others. The results of their Granger causality tests reveal strong evidence in favour of the GDH, ie causality runs from German money to other monies. They also find supportive evidence for the view that foreign exchange intervention to support intra-EMS parities is predominantly undertaken by non-German members, and also that interventions are sterilized in Germany more often than in other EMS

countries. Overall, based on the empirical evidence, the authors suggest that the EMS has been functioning asymmetrically with Germany as the center country.

Artus et al. (1991) analyse the transmission of US monetary policy in the EMS when evaluating the asymmetry of the EMS. They construct a small structural model of interest rates and exchange rates, run causality tests and estimate the model. The causality tests show that the main forces driving the short-term interest rate in Germany are the short-term interest rate in the US and the DEM/USD exchange rate, whereas the short-term interest rate in France depends mostly on the short-term rate in Germany and on the FRF/DEM exchange rate. The estimation of the structural model confirms these findings, ie the French short-term interest rate depends mostly on the German short-term interest rate.

Kirchgässner & Wolters (1991a) pose the question whether German interest rates dominate Euromarket rates. Their methodology differs from others in that they explicitly take into account the non-stationarity of the interest-rate time series and check for the possibility that the time series is co-integrated. This approach provides the possibility to obtain information about adjustment processes and the long-term equilibrium relations between interest rates. They formulate the German dominance hypothesis in four-assumption approach of Fratianni & von Hagen (1990), ie dependence on Germany, German independence, EMS insularity and world insularity. In terms of Granger causality, dependence on Germany implies Granger causal relations between German interest rates and those of other member countries and/or instantaneous causal relations between Germany and other countries. German independence is defined as the non-existence of Granger causal relations between the interest rates of other member countries and German interest rates. EMS insularity means that besides the relations with Germany, there are no Granger causal or instantaneously causal relations between the other member countries of the EMS. Finally, world insularity implies that if German interest rates are included in the information set, there are no Granger causal or instantaneous relations between countries outside the EMS and the interest rates of other member countries. German dominance implies that all four conditions hold. For the long-term, the authors reformulate their hypotheses slightly so that dependence on Germany means that German interest rates are included in the error-correction terms of the equations of other member countries of the EMS. German independence implies that the interest rates of other member countries are not included in the error correction terms of the German equation. EMS insularity means that interest rates of third countries in the EMS are not included in the error-correction terms of the equations of other EMS member countries, and finally, world insularity is defined so that the interest rates of countries outside the EMS are not included in the error-correction terms of the equations of EMS member countries other than Germany. The true importance of Germany in Europe can be seen in the fact that its observed dominance in the long-term is not restricted to countries in the EMS. The authors note, however, that because of capital controls, their findings concerning German long-term dominance do not necessarily imply German policy dominance in the sense that other European central banks cannot follow an independent monetary policy and choose their own

preferred rate of inflation. This is because the EMS allows realignments of exchange rates.[4]

Kutan (1991) looks at the evidence from the growth in the monetary base and interest rates. He assumes that central banks in the EMS peg short-term interest rates and that the leading country is Germany, which sets its money supply target independently. The rest of the EMS countries fix their exchange rates at a given level and intervene in the foreign exchange market to keep them in place. A reduced form of the model is estimated using block-exogenity tests[5]. The results suggest that monetary policies in the EMS are relatively interactive. Yet, since the EMS has not caused a greater co-movement in money demand functions between the participating countries in the "hierarchical" structure claimed by German dominance, the author rejects this hypothesis.

Beyer & Schmidt (1992) employ the interest rate parity in order to test the asymmetry of the EMS. Use three-months interest rates in their empirical test, they carefully investigate the statistical properties of the data. The authors show that the parameters are not stable over time, and that, according to cointegration tests, there is a long-run relationship between the German and other EMS interest rates. They then employ an error correction model to test for functional symmetry of the EMS. The results allow the authors to conclude that there is functional asymmetry. However, they note that their results cannot be used to draw any conclusions concerning causal relationships between interest rate links.

Koedijk & Kool (1992) assess the timing and speed of monetary convergence between the EMS countries, focusing on bilateral interest and inflation differentials. Their study differs from most of the others in that they do not use Germany as the benchmark country. Hence, if other EMS countries passively follow Germany's lead, inflation rates should converge, and given the integration of financial markets, so too should interest rates. For comparison, they select British variables, for as an outsider to the ERM, Great Britain is expected to have had more freedom in determining an independent monetary policy. Additionally, instead of VAR regressions, the authors apply a modified version of principal component analysis. Their conclusion is that the most important differences within the EMS are between Germany, the Netherlands and Great Britain on the one hand, and Belgium, France and Italy on the other. The results indicate that France and Italy may have been able to avoid part of the negative consequences of their deflationary policies because of the borrowed credibility of their exchange rate commitment, but since large differences in independent interest rate and inflation differentials with Germany have persisted, they reject the German dominance hypothesis.

Loureiro (1992) assesses monetary autonomy in EMS countries by focusing on the domestic credit. He argues that, in an asymmetric fixed exchange regime, monetary authorities in small countries cannot discretionarily use domestic credit

---

[4] Also see the work of Kirchgässner & Wolters (1991a), which investigates interest rate linkages between the US and Europe and within the EMS between 1974-1989. The study shows a strong German influence on the development of other European countries. The authors conclude that while Germany does not dominate other countries totally, there are significant relations between EMS countries which are not influenced by Germany.

[5] A block-exogenity test has the null hypothesis that the lags of one set of variables do not enter the equations in a system for the remaining variables.

to achieve domestic objectives. Consequently, innovations in the domestic credit should mostly be the result of innovations in exchange market variables. The degree of the use of domestic credit as a policy instrument is then assessed empirically through the forecast variance decomposition technique. The results indicate that the asymmetry of the EMS is not proven for France and Italy, whereas the GDH is accepted for the Netherlands. Denmark and Belgium remain intermediate cases.

Biltoft & Boersch (1992) test the GDH with three-month interest rates by running Granger causality tests. If the EMS has been functioning asymmetrically, causality should run unidirectionally from Germany to other EMS countries. Notably, these researchers use daily observations of interest rates, and divide the data into two sub-periods, with the break following the Basel-Nyborg Agreement of September 1987. They find that, for the first sub-period, the GDH must be rejected, but that the EMS has become asymmetric in the second period. Moreover, the asymmetry has been toward the countries with few or no capital controls. Unidirectional interest rate linkages were reported for Belgium, Denmark, France and the Netherlands, whereas Italy has consistently been isolated from German monetary policy. This could, according to the authors, be due to capital controls and a wider exchange rate band.

Herz & Röger (1992) analyse the GDH in a framework different from that commonly used. Instead of constructing a reaction function for the central bank, they construct a neoclassical two-country version of the standard Mundell-Fleming framework. They concentrate on the explanation of inflation rates under different exchange rate regimes. In their model, they have equations for the supply side of the domestic and foreign economy, and for the money market in the respective economies. They apply uncovered interest rate parity and assume perfect capital mobility within the EMS. Finally, they define a parameter determining the burden of intervention for each of the central banks. In the case of German dominance, Germany does not intervene, rather it determines monetary growth in a fixed exchange rate block. The results of their empirical tests clearly indicate German dominance in the monetary policies of other EMS countries.

García-Herrera & Thornton (1996) employ cointegration and Granger-causality techniques to investigate the existence of long-run comovements between German and other EMS members' interest rates. They also examine whether short-run changes in German interest rates convey information about future movements in other EMS interest rates. They also include US interest rates in their analysis in order to evaluate the role of the rest-of-the-world monetary policy in EMS interest rate linkages. They use one-month data and find evidence of Granger-causality stemming from German interest rates to interest rates in Belgium, France, Spain, and the UK. Bidirectional causality was found between German and Italian, German and Danish, and German and Dutch interest rates. For the interest rates in Germany and Ireland, they report no causality. The authors also find that the inclusion of US interest rates shifts the balance of the Granger causality test towards bidirectional causality. This, they say, is consistent with the level of arbitrage activity to be expected from efficient capital markets.

There is also the view of eg Bini Smaghi & Micossi (1990) and Weber (1991), that, after a short initial transitional phase, the EMS has functioned as a bipolar system with a "hard currency" option offered by the Bundesbank and a "soft currency" option supplied by the Banque de France. Even though the bipolar

working was supported by empirical results, they also indicated that the French commitment towards the "hard" option has increased in the latter half of the 1980s, pulling other currencies along and making the "soft" bloc around the FRF shift towards the "hard currency" standard. At the end of the 1980s, this rendered the fixed parities more credible and prevented inflation from emerging as strongly as it did outside the system.

To date, no consensus in the literature exists about whether the EMS has been working asymmetrically or symmetrically. There are studies that find a rich structure of cross-country policy interactions, so that even though Germany exerts a significant influence on many EMS countries, it is not immune to influences from others. Further, other EMS countries are found to transmit their policy impulses to each other. This suggests an almost symmetric functioning of the EMS. Hence, the effect of EMS membership on monetary policy-making remains, scientifically, a controversial issue. As stated in eg Bini Smaghi & Micossi (1990), Cohen & Wyplosz (1991), and Begg & Wyplosz (1993), few doubt that the EMS entails a tightening of the external constraints. This interpretation of the EMS as an asymmetric system dominated by Germany emerged due to increasingly vocal observations by policy-makers and implicitly recognized in the Basel-Nyborg agreement from September, 1987. Yet how this tightening of the external constraints actually operates is never fully elucidated. Thus, the failure to confirm the asymmetric model of coordination empirically, casts doubt on the specification and testing of the hypothesis " not the hypothesis itself. Even here, the debate over the German dominance hypothesis still revolves around the effects of interdependence and the channels through which this interdependence operates.

3 Theoretical and empirical analysis of monetary policy

3.1 Central bank loss functions

The analysis of optimal monetary policy has a long tradition in economic policy research. Generally, the central bank has an objective function which involves increasing output and decreasing inflation, the latter being under the control of the monetary authority. Besides the policymaker, there is the wage setter who contracts in advance, usually for fixed periods of time. In such a framework, whenever the actual unemployment diverges from its natural rate and the policymaker is concerned with the growth of output, the optimal solution becomes time-inconsistent, as was shown by Kydland & Prescott (1977) and Calvo (1987). In such a situation, a credibility problem arises when, after announcing the monetary policy, the policymaker is tempted to introduce inflation surprises. It is simply not credible to announce a monetary policy that leaves room for surprise inflation. The game between the policymaker and the wage setters, therefore, must lead to an equilibrium solution where the expectations of wage setters are fulfilled. The only credible monetary policy then, is one which affects output growth. As long as the public is aware of the central bank's temptation to deviate from its announced monetary commitment, any government's attempt to affect output

growth will fail. In the resulting, consistent, equilibrium, output will remain the same while inflation becomes unnecessarily high. The lower the weight that monetary authorities give to inflation in the utility function, the higher the consistent equilibrium inflation.

A suggestion for the removal of the inflation bias implied by the inconsistency was made in Barro & Gordon (1983). Using the traditional inflation-output trade-off in an intertemporal framework, they compared the costs from conducting discretionary monetary policy with following a rule. They showed that the best enforceable rule is a weighted average of the ideal rule and discretion, meaning that the building up of an anti-inflationary reputation by the public sector was crucial for surrounding the time-inconsistency problem. This, in turn, raised the question of central bank credibility, ie How could the reputation of an inflation-prone central bank be improved so that the public's inflation expectations would decrease?

When the credibility argument is applied to a fixed exchange rate system, the real exchange rate appreciation due to the existence of inflation differentials is taken into account in the game between the policymaker and the wage setters. Apart from taking the central bank's inflationary temptations into account, rational private agents also take into account the restrictions that a fixed exchange system imposes on the authorities' incentives. Giavazzi & Pagano (1988) provided an extension of the Barro-Gordon model, where the EMS was included in the loss function of the central bank. Their argument was that participation in the EMS helps inflation-prone countries to overcome their inefficiency stemming from the public's mistrust of the authorities and, thus, brings potentially large credibility gains to the central bank. Assuming the EMS (or any fixed exchange rate system) works asymmetrically, this gain is possible when one central bank sets monetary policy for the entire region, while another surrenders its monetary autonomy and passively pegs the exchange rate. The result is that both countries will end up with the inflation rate that would prevail in the center country if it were a closed economy. If the center country is less inflation-prone than its partner, the latter can gain by credibly pegging. The participation in the EMS, does not, however, remove the policy choices altogether. This is evidenced by the different monetary policy performance of the European countries, a fact which calls for analysing their policy preferences more closely.

3.2 Reaction function literature

Traditionally, empirical studies of monetary policy have employed a reduced-form reaction function methodology. In this framework, the measure of policy action is related to a set of potential policy targets or information variables:

Policy Instrument = f (Intermediate targets, Information variables) (1)

This relationship can be viewed formally as part of a feedback control mechanism or rule in which the policy instrument is adjusted systematically when actual values of the intermediate target differ from desired values, or if actual values of the information variables deviate from expected values.

Empirical studies using the reaction function approach differ in terms of the choice of dependent and independent variables, data frequency, and methods for evaluating the success of the model. For the dependent variable, a money or reserve aggregate, or the short-term interest rate have been used. For the independent variables, three classes of information variables have been employed: monetary aggregates, measures of real economic activity, and measures of inflation. In the next section, we make a brief survey of the reaction function literature, concentrating on methodological issues.

3.2.1 Survey of previous studies

Levy (1981) develops a money supply-reaction function and estimates it within the context of an IS-LM framework. In that study, particular emphasis is placed on measuring the responsiveness of the Federal Reserve to budget deficit and the government borrowing requirement. The author argues that only a handful of studies have estimated money supply reaction functions by including a deficit or public debt measure as an independent variable. Hence, the author constructs an IS-LM framework with an endogenous monetary sector, and then chooses the monetary base equation to be tested as the reaction function. In his reaction function equation, the monetary base is expressed as a function of variables describing the economy including indicators of fiscal policy. From a methodological point of view, the equation is transformed into a first-difference equation and then estimated using quarterly data. The empirical results show that the monetary base has been extended in response to increases in inflationary expectations and government deficits. In addition, the Federal Reserve has tended to accommodate its own previous actions rather than abruptly change policy.

Bradley & Potter (1985) investigate the responsiveness of monetary and fiscal policies to the state of the economy. They account for the possibility that monetary and fiscal policy authorities consider each others' actions when setting policy. Policymaker reaction functions are, thus, derived in their model using an optimization procedure in which a loss function is minimized with respect to the policy instrument, subject to a constraint reflecting the policymakers' view of the structure of the economy. The policymaker then selects values for the policy instrument that minimize deviations of inflation and unemployment from a prespecified target. These authors, especially, want to find out whether monetary and fiscal authorities consider each other's actions when setting policy. Their method of testing the reaction functions empirically involves running two-stage least squares estimations.

Hamada & Hayashi (1985) investigate the reaction function of the Bank of Japan. They specify the money supply rule by referring to empirical results from previous studies analysing the behaviour of the central bank in the US and in Japan. They argue that, against the previous evidence, it is reasonable to suppose that the growth of the money supply depends on the inflation rate, on changes in the industrial production, and on the stock of foreign currency reserves. In their empirical analysis, they use a lag length of eight months to capture eventual long-lasting effects of the explanatory variables on money supply. They divide their sample period into subperiods because the reaction function is not expected to

remain stable over the whole period. Hence, the empirical results differ depending on the period under study.

Mastropasqua et al. (1988) construct a simple central bank reaction function that focuses the monetary coordination in the ERM. They relate monetary base creation through domestic channels to changes in the foreign component of the monetary base and to variables representing the domestic objectives of monetary policy. As domestic objectives, they select inflation and growth. They argue that, to the extent that monetary base growth is determined in the light of domestic objectives, changes in the foreign component must be offset by equal and opposite changes in the domestic component. However, there is the problem of endogenity: changes in the domestic component are liable to affect interest rates in domestic markets and, through this channel, the foreign component. The authors solve this problem by employing two-stage least-squares and seemingly unrelated regressions techniques to take full account of the possible correlations between the residuals of the estimated reaction functions.

Artus et al. (1991) analyse the transmission of interest rate changes from the US to Europe and the asymmetry of the EMS. In that context, they construct a structural model of interest rates and exchange rates. The model also comprises two equations describing the policy reactions of the (French and German) monetary authorities. The dependent variables are the respective short-term interest rates. As the authors state, a number of possible variables can appear in the interest rate equations. They choose as explanatory variables such potentially affecting the policy objectives of the authorities: capacity utilization rate, trade deficit, foreign interest rates, and exchange rate. In order to select the relevant variables for the final test of their model, the authors run causality tests between the interest rates and the explanatory variables. In their estimation of the structural model, they only introduce those variables which significantly affect (short-term) interest rates.

Since we assume Germany is the center country of the EMS here and, consequently, German variables are exogenous, we only examine the results for French short-term interest rates. The period under analysis extends from 1979 to mid-1988. The causality tests show that in the formation of the French short-term interest rate, the French long-term interest rate, inflation, German rates, US rates and exchange rates all seem to play a role. However, German variables outweigh US variables. Moreover, the authors point out that the desire of the central bank to stabilize the exchange rate has intensified over the years.

The authors then estimate the structural model using the maximum likelihood method. They treat US rates and the administratively set FRF/DEM exchange rate as exogenous. In the reaction function on the short-term interest rate, changes in financial variables are decisive, whereas real variables do not matter. The French short-term rate clearly responds to changes in the German short-term rate, as well as to inflation and the FRF/DEM exchange rate[6]. This result is interpreted as supporting the view that the EMS has functioned asymmetrically.

Hakkio & Sellon (1994) model the behaviour of the Federal Reserve. They attempt to determine which variables were influential in monetary policy decisions and whether policy responded systematically to these variables. The authors adopt

---

[6] The German short-term interest rate, by contrast, depends on the US short-term rate, the DEM/USD exchange rate and the central bank's foreign exchange reserves.

a traditional reduced-form reaction function. The equation is not derived from a formal model. It includes as explanatory variables monetary aggregates (M1,M2), different inflation rate induces, measures of economic activity (industrial production, unemployment), exchange rates vis-à-vis the major world currencies, and indicators of financial market activity. They find that monetary policy has depended most clearly on the inflation rate, measured by a variety of contemporaneous and leading indicators.

Neumann (1996) provides an exhaustive analysis of the reaction function of the German Bundesbank. The Bundesbank's concept of monetary targeting is an intermediate approach to securing internal value of money. Its focus is on providing the monetary frame for zero or low trend in inflation through:

- attempting to anchor the public's expectations as regards medium to long-run inflation by setting a consistent target rate for monetary growth, and
- systematic short-run deviation from the mid-point target for the purpose of counteracting unanticipated shocks to prices and the exchange rate and for accommodating shocks to money demand.

The author uses the quantity theory background of monetary targeting in constructing the reaction function of the Bundesbank. The quantity theory of money implies that providing stable money for the medium to long run requires selecting the appropriate money expansion path, for given trends of real growth and velocity. By announcing the target path to the public and by explaining its derivation the public's inflation expectations will be anchored, provided the Bank enjoys credibility. Thus, the reaction function derived on this theoretical basis implies that the Bundesbank counteracts excessive inflation, leans against the wind of real exchange rate appreciation and accommodates shocks to money demand. Empirical estimation of this equation with only four explanatory variables yields the result that adding a proxy for money demand shocks as an independent variable improves the estimation results considerably.

Ueda (1996) analyses the behaviour of the Bank of Japan by testing a reaction function adopted from reaction function literature. Thus, neither in this study is the reaction function derived formally from, say, the maximization of an objective function of the central bank. The author estimates several reaction functions and admits that those are not necessarily the best equations one can find. The set of independent variables consists of GDP and business cycle indicators, the exchange rate vis-à-vis the USD, current account balance, money growth rate, and the inflation rate. Of these, the interest rate has responded most saliently in countercyclical fashion to real GDP. The monetary authority has also paid close attention to exchange rate and current account developments.

Obviously, most of the issues of how policy should react to shocks are really questions about alternative policy rules which describe how policy makers should react to different contingencies. Summarizing the empirical results surveyed above, the US monetary authority appears to prefer nominal-income targeting or a mixture of real-GNP and inflation-rate targeting. In contrast, Germany and Japan prefer more mixed regimes - sometimes exchange rate targeting is employed, other times they use income targets. This finding may be explained by the theoretical result referred to in Bryant et al. (1993a) that money targeting or

exchange-rate targeting could be the preferred regime under at least one of the following conditions:

- productivity or the supply shocks are the most prevalent disturbances to economies,
- policymakers loss functions place great weight on stabilization of the inflation rate or the price level, and place little or no weight on stabilization of output or employment, or
- policymakers' loss functions give significant weight to the stabilization of financial variables such as interest rates and exchange rates.

3.3 The model

We construct a regression equation to be tested empirically. Referring to the empirical literature analysing the German Dominance Hypothesis (GDH), we assume that Germany is the monetary policy leader in the ERM so that German monetary policy is fixed by the Bundesbank with no constraints from the monetary policies of the other countries. Here, we are interested in the relations of the other EMS countries with Germany on a bilateral basis.[7] More specifically, we are interested in how German monetary policy affects the monetary policy of the partner countries, so we abstract from any feedback between the countries. These assumptions do not rule out German strategic reactions to other EMS monetary policies. Nor do they rule out independence from Germany for other EMS countries (both within parity limits and through parity changes).

As the typical theoretical model in the literature sets up the monetary policy problem as the minimization of a hypothetical social loss function, we start with a general formulation of a loss function for the central bank.[8] In doing this, we want to distinguish between internal and ERM-related aspects in the monetary policy formulation:

$$\mathcal{L} = \frac{1}{2} r^2 + \theta D + \lambda F \qquad (1)$$

The first term on the right-hand side describes that the central bank faces a cost from operating with its instrument, r. For example, policymakers believe that changing interest rates imposes costs on private sector behaviour. More generally, as Bryant et al. (1993b) note, policymakers may believe that volatility in a variety of variables can impose costs on the economy. D is a function of domestic variables that the central bank is concerned for, and similarly, F is a set of foreign, or in this case, EMS-related variables. θ and λ are the weights that the central bank

[7] Excellent discussions of multilateral monetary relations between EMS countries have been made by Basevi & Calzolari (1984) and Schulstad & Serrat (1995).

[8] We assume that the central bank is the sole relevant decision-making unit in monetary policy matters, so that we abstract from issues arising from different preferences over output and inflation between the government and the central bank.

places on each group of variables. The loss function further operationalizes the assumption that the central bank is concerned about the stability of its target values. We can assume that the stability of the target variables is an intermediate economic policy target serving some ultimate longer-run policy target such as stable economic growth.

Following the standard specification of the loss function in a closed-economy context in the literature, we suppose that on the domestic side, the monetary authorities minimize the expected squared deviations of output and inflation from their target levels:

$$D=\tfrac{1}{2}[(y-\bar{y})^2+\sigma(\pi-\bar{\pi})^2] \qquad (2)$$

where y is actual output, $\bar{y}$ is the target level for output level, π is the inflation rate and $\bar{\pi}$ is the target inflation rate. The parameter σ represents the relative social importance assigned to inflation: a higher σ places a greater weight on inflation deviations and a lesser weight on output. Generally $\bar{y}$ is different from equilibrium employment because of distortions in the labour market. $\bar{\pi}$ is set by the monetary authority. The central bank wants to keep π as close to $\bar{\pi}$ as possible, because inflation or inflation surprises implies a cost and is, therefore, not desirable.[9]

The foreign component in the loss function describes the role of the ERM in the domestic monetary policy conduct. In the ERM, the currencies are pegged to a central rate, and around this central rate they have a fluctuation band.

The influence of the ERM on monetary policy may reflect simply the constraint of keeping the exchange rate within the band or, alternatively, trying to shadow the monetary policy of the anchor country (Germany) even within the band. These aspects are operationalized in the following loss function.

$$F=\frac{1}{2}(\delta^2+\tau(r-r^*)^2) \qquad (3)$$

Here, τ stands for the weight put on following German monetary policy, where r and r* are the domestic and foreign interest rate, respectively, and δ denotes the devaluation expectation.

The foreign component of the central bank's loss function in (3) includes, on the basis of the above discussion, devaluation expectations concerning the central rate (ie realignment expectations), and the interest rate differential vis-à-vis Germany. Of these two terms, the former is intended to capture the influence the ERM membership as such has on monetary policy. Clearly, if ERM membership has a guiding influence on monetary policy, this must imply that expected realignments are avoided. The other, stronger, dimension of ERM influence, harmonization of monetary policy with the anchor country, is captured by the interest rate differential term.

Inserting expressions (2) and (3) into the loss function in equation (1) yields

---

[9] On the cost of inflation, see eg Gale (1982).

$$\mathcal{L}=\frac{1}{2}r^2+\frac{\theta}{2}[(y-\bar{y})^2+\sigma(\pi-\bar{\pi})^2]+\frac{\lambda}{2}[\delta^2+\tau(r-r^*)^2] \quad (4)$$

The task of the central bank is to choose interest rate that minimize this loss. In terms of participation in the ERM, this reflects two aspects. First, the central bank may want to minimize devaluation expectations, ie to maximize the credibility of the central rate. Second, the central bank may want to minimize exchange rate fluctuations, ie maximize exchange rate stability in a credible ERM regime. The alternative strategy in the latter case is to utilize the credibility of the central rate through allowing fluctuations of the exchange rate within the band and instead stabilizing the domestic interest rate.

In order to minimize the loss equation, we need the first-order condition. Deriving equation (4) with respect to r gives

$$\mathcal{L}': r+\theta[a(y-\bar{y})+\sigma b(\pi-\bar{\pi})]+\lambda[d\delta+\tau(r-r^*)] \quad (5)$$

$-a$, $-b$ and d are the partial derivatives of $(y-\bar{y})$, $(\pi-\bar{\pi})$ and δ, respectively, with respect to the interest rate r. They are all negative (a and b positive) constants indicating that an increase of the interest rate has a dampening effect on all of these variables.[10]

From the target zone theory[11] we know that in a system with fluctuation bands, any interest rate differential reflects the sum of the expected rate of depreciation of the exchange rate within the band, and the expected rate of devaluation of the central rate:

$$r-r^*=k(s-c)+\delta \qquad (k<0) \quad (6a)$$

where r and r* are the domestic and foreign interest rate, respectively, s denotes the (log of the) spot exchange rate and c is the (log of the) central rate, k is a parameter reflecting the mean reversion in the spot rates, and δ denotes the devaluation expectation. This means that the expected rate of depreciation can be written as

$$\delta=r-r^*-k(s-c) \quad (6b)$$

Hence, replacing δ in equation (5) with the expression obtained in equation (6b) gives the following first-order condition

$$\mathcal{L}': r-\theta[a(y-\bar{y})+\sigma b(\pi-\bar{\pi})]+\lambda[(r-r^*-k(s-c))d+\tau(r-r^*)]=0 \quad (7a)$$

---

[10] A positive value of d is valid for a crisis situation, where an increase of the domestic interest rate increases devaluation expectations.

[11] For a survey of target zone theory, see eg Ranki (1996).

By rearranging all terms with the domestic interest rate on the left-hand side, we obtain an equation that describes the determination of the interest rate, namely

$$r+\lambda dr+\lambda\tau r=\theta[a(y-\bar{y})+\sigma b(\pi-\bar{\pi})]+\lambda dr^{*}+\lambda\tau r^{*}+\lambda kd(s-c) \tag{7b}$$

$$\Rightarrow [1+\lambda(d+\tau)]r=\theta[a(y-\bar{y})+\sigma b(\pi-\bar{\pi})b]+[\lambda(d+\tau)]r^{*}+\lambda kd(s-c) \tag{7c}$$

$$\Rightarrow r=\frac{\theta}{1+\lambda(d+\tau)}[a(y-\bar{y})+\sigma b(\pi-\bar{\pi})]+\frac{\lambda(d+\tau)}{1+\lambda(d+\tau)}r^{*}+\frac{\lambda kd}{1+\lambda(d+\tau)}(s-c) \tag{7d}$$

If $\lambda=0$ reflects that the central bank is only concerned about domestic factors, then - trivially - only the domestic variables matter, as r* and (s-c) disappear. Assuming that $|\lambda(d+\tau)| < 1$, the domestic variables y and π always have a positive effect on the domestic interest rate. If $\lambda\neq 0$ so that the foreign variables r* and s-c affect domestic monetary policy, s-c also always has a positive effect on the interest rate since k and d are both negative.

The effect, of r* depends on the relative size of d and τ. If $d > -\tau$, then the sum $d+\tau$ is negative, which makes the coefficient negative, and vice versa, if $d < -\tau$. In the special case where $d = -\tau$, the term with the German interest rate disappears. In other words, the effect of an interest rate change on devaluation expectations has to be smaller than or equal to the weight put on following German monetary policy in order to obtain sensible results.

4 Empirical analysis

We are looking for empirical evidence that the EMS has actually played a central role in the monetary policy conduct of the participating countries. Given general consensus on the development of the EMS, we should expect to observe the weight of the exchange rate restriction provided by the ERM to have increased, especially during the "hard" EMS period of 1987-1992. The approach is essentially that employed in the large reaction function literature, consisting of a large number of studies.

We now turn to an empirical application of the framework developed in the previous section, with the aim of evaluating the weights given by central banks to the various determinants of monetary policy. Most deal with the reaction function of a large economy such as the US, Japan or Germany. In these cases, the role of foreign variables has been very limited. Only a few cases include some form of the exchange rate in the reaction function. In the current study, however, we analyse the behaviour of the central bank in small, open economy. Since a small, open economy is largely affected by the continuous interaction with other countries, this evidently affects the conduct of monetary policy. Thus, we formulate the problem as a trade-off between internal targets and external constraints.

4.1 Operationalization of the model

The model is based on the theory given in the previous section. The dependent variable is the domestic short-term (one-month) interest rate.[12] Monetary policy is assumed to be conducted through either using the short-term interest rate directly, or through open market operations, which then affect the interest rate indirectly.

The set of explanatory variables consists of two kinds of variables. First, we have indicators of the domestic economy: the inflation rate and industrial production. Second, we have variables reflecting exchange rate changes: movements of the spot exchange rate, and deviations of the spot exchange rate from the central parity. As exogenous variables, we use the German and US interest rate. If Germany is the monetary leader in the system, then German interest rates should affect the interest rates of the other countries, but not vice versa. Moreover, if the primary goal of the other EMS countries is to stabilize the exchange rate (vis-à-vis the DEM), they should not care about the monetary policy of the rest of the world (here represented by the USA). In that case, the center country alone reacts to external shocks, and these are then transferred into the system via the monetary policy of the center country.

Taking this together and considering the time-series properties of the data (see Appendix for details), we obtain a regression equation such as

$$\Delta r = \alpha + \beta_1 \Delta \pi + \beta_2 \Delta y + \gamma_1 (s-c) + \gamma_2 \Delta r^{*} + \gamma_3 \Delta r^{**} + \varepsilon \qquad (7)$$

where

Δr = change in the domestic interest rate
$\Delta \pi$ = change in inflation
Δy = change in output
$(s-c)$ = deviation of the spot rate from the central rate
Δr^{*} = change in the German interest rate
Δr^{**} = change in the US interest rate
ϵ = error term

In those cases when a currency is floating and has, thus, no central parity, we use the change of the spot exchange rate instead of the deviation of the spot rate from the central rate. In the regression, we have used in level form those variables which do not seem to have a unit root for the remaining variables, first differences have been used.

---

[12] Another commonly used indicator of the conduct of central bank policy has been the money base growth rate. As Taylor (1996) notes, there is a similarity between money supply rules and interest rates. If money growth is fixed then the money demand function can be viewed as a relationship between three variables: the price level or its percentage change the inflation rate, real GDP and the short term interest rate. If the interest rate is isolated as one variable, it is seen that the interest rate depends on the inflation rate and real GDP. Hence, analysing the interest rate as indicator of monetary policy is as valid as looking at the money supply.

When estimating the model, we introduce dynamics by using vector autoregression (VAR). A VAR system is a reduced form of a linear dynamic simultaneous equation model in which all endogenous variables obtain an equation where the dependent variable is explained by lagged values of itself and by lagged values of all the other variables in the system. Here, we use three lags for the endogenous variables. All other variables except German and US interest rates are treated as endogenous.

For the purpose of describing the dynamic interaction of the time series, we employ the impulse-response function. In order to analyse the effects of a shock in one or more variables, we derive the moving-average presentation of the system. There, each variable is described as a function of the innovations, which are uncorrelated both across equations and over time. With the moving-average representation, one can analyse the effects of an innovation in one variable ea a policy variable in isolation. A typical shock is commonly understood as one standard error in an equation. The system's response is traced in the impulse-response functions which show the effects of an innovation in one variable on subsequent values of all variables in the model. In the current study, we have calculated the cumulative impulse response functions in order to see the effect of the innovations on the levels of the variables. However, there is one drawback with the impulse functions due to the tendency of VAR models to be over-parametrized. When confidence intervals are calculated taking into proper account VAR parameters uncertainty, very large confidence intervals around the calculated impulse responses are very usual. Here, we calculated the confidence intervals, but because of their negligible informative value, for the sake of space, they are not reported.

Since the German interest rate is exogenous in the VAR model, we do not directly obtain the impulse responses of the endogenous variables to changes in the German interest rate. The exogenous variable can, however, be treated as a deterministic part of the error term and its impact can be calculated from the usual impulse responses. Since the German interest rate appears in all the equations in the system, the impulse response of a specific variable to a one per cent increase in the German interest rate is a weighted sum of its impulse responses to all the endogenous variables. The weights are the coefficients of the German interest rate in the respective equations.

The data under investigation spans the period from January 1980 to June 1996, which covering almost the entire existence of the EMS. We use monthly data because of the non-availability of production data at higher frequencies. The period is divided into three subperiods: January 1980 - January 1987, April 1987 - September 1992, and December 1992 - June 1996. This division reflects the changing character of the EMS. During its early years, the economies of the participating countries differed remarkably, and realignments were frequent. The second subperiod[13] represents the years of the "hard" EMS: nominal convergence of the economies was substantial and no realignments occurred. The last period

[13] The starting dates for the second subperiod are different for the ESP and the GBP. In these cases, the starting date is the same as the date of entry of these currencies into the ERM. The ESP joined the ERM in June 1989, and the GBP in October 1990.

starts when the GBP and the ITL were allowed to float, which was the start for the "new" EMS with the currently wider bands.[14]

The data is compiled as follows: the interest rates are those reported by the Bank for International Settlements (BIS); the central rates are those reported in the *Beihefte zu den Monatsberichten: Reihe 4, Devisenstatistik* published by the Deutsche Bundesbank; all the other variables, ie the exchange rates, industrial production, and inflation rates were collected from the International Financial Statistics published by the IMF. All other data except the interest rates have been transformed by taking logarithms. Standard tests for the properties of the data have been performed, and their results are presented in the Appendix.

4.2 Results

A variety of methods can be used for evaluating the model. The most basic criteria are a theoretically correct sign of a response coefficient and statistical significance. Thus, if the coefficient on an information variable is correctly signed and statistically significant, it is taken as evidence that policymakers responded to this variable. Here we concentrate on the relative weightings of domestic versus foreign variables. Tables 4.1 and 4.2 summarize the results obtained for the regression with equation 6. Table 4.1 displays the t statistics for the coefficients, and Table 4.2 shows the F statistics for the respective groups of the lags of each variable. The unit shock impulse response functions are plotted in Figures 4.1-4.7.

The estimated VAR fits the data relatively well. The residuals do not appear to be autocorrelated nor heteroscedastic, and the model is capable of explaining up to 88.6 % of the observed interest rate changes. The proportion explained by the estimated VAR is fairly high in other equations as well, perhaps with the exception of the inflation equations. Great Britain appears to deviate from the general pattern in that the estimated VAR accounts for most of the observed variation in the inflation rate, but the explanatory power of the interest rate equation remains modest. Overall, the estimated VAR performs generally better in the second and/or third subperiod than in the first subperiod. The reason may be the higher global interest rate volatility in the first subperiod. The impulse response functions displayed in Figures 4.2-4.8 show that in the first subperiod, the interest rate often "overshoots" its new level after an innovation in the interest rate before it again starts to converge. The estimated lag structure remains fairly stable across subperiods and indicates that, generally, the first lag is the most significant. The estimated dynamics of the deviation of the spot exchange rate from the central rate suggests a different pattern in that slightly more lagged effects occur in the second subperiod in four of the seven cases. In sections 4.3.1-4.3.7 we present the results country by country.

[14] An analysis of the history of the EMS is provided in eg Gros & Thygesen (1992).

Table 4.1

t-values		Domestic interest rate	Domestic inflation	Domestic production	Deviation from central rate	German interest rate	US interest rate	Constant	Dummy
Belgium	I	-0.94	.34	**2.73**	**3.26**	**3.68**	**1.79**	-2.26	
		-0.61	-.42	**3.10**	**-1.84**				
		-2.24	1.69	**3.03**	1.44				
	II	0.38	-1.53	1.21	1.48	**10.16**	-.21	-1.51	
		-.36	-.26	1.17	.42				
		2.92	.49	.89	**-2.38**				
	III	**2.25**	-1.59	-.16	-1.11	-1.31	.20	-1.20	
		-1.04	-.20	-.13	1.09				
		-.54	-.17	-.38	-1.20				
Denmark	I	**-2.30**	1.28	.04	**2.24**	-0.39	.52	-0.17	
		-1.46	.14	.49	-.94				
		-1.52	**2.20**	.16	-.97				
	II	1.08	0.38	-0.32	0.76	0.76	-0.30	-0.68	**2.85**
		-0.01	**1.71**	0.93	0.39				
		0.16	-0.63	-0.08	-0.97				
	III	**3.17**	0.23	0.93	-1.09	0.67	-0.35	0.09	**11.67**
		0.86	-0.65	0.51	0.67				
		-1.08	0.14	1.27	-0.19				
France	I	-1.42	0.85	-0.383	**2.81**	1.40	0.82	0.06	**6.98**
		-0.35	-0.13	-0.60	-0.94				
		0.07	-1.31	0.08	-1.26				
	II	**1.75**	0.62	0.26	**1.73**	0.40	-1.17	0.30	**4.41**
		-0.35	**-2.08**	0.14	**-2.86**				
		-0.32	0.39	-0.08	**1.88**				
	III	**2.62**	-0.80	0.18	-1.47	1.16	-1.56	0.65	**3.01**
		-1.35	-0.25	-0.42	1.32				
		0.18	-1.01	0.84	-0.83				

Significant values (at 10 % level) are bold.
* no ERM

Table 4.1 continued

t-values		Domestic interest rate	Domestic inflation	Domestic production	Deviation from central rate	German interest rate	US interest rate	Constant	Dummy
Great Britain	I*	**2.78**	1.24	-0.24	**-1.85**	0.28	0.27	1.40	
		-0.58	-0.93	-0.13	0.24				
		-0.76	-0.80	-1.34	-0.56				
	II	0.45	0.86	**-2.28**	-0.11	1.15	**-1.92**	0.37	
		-1.63	-1.38	**-1.92**	**1.77**				
		-0.02	-0.12	**-2.28**	**-2.22**				
	III*	0.70	**1.91**	**-1.82**	-0.50	0.62	-0.35	1.03	
		0.12	-1.37	-0.90	-1.05				
		1.85	-0.28	-0.26	-1.09				
Italy	I	-1.09	**-1.74**	0.67	-0.21	-0.28	0.45	-1.06	
		1.34	0.21	**3.56**	-1.45				
		-0.46	0.23	**1.99**	0.03				
	II	**-2.44**	-0.54	-0.56	0.11	0.81	-0.36	0.60	
		0.66	0.34	-0.15	1.43				
		0.54	-0.58	0.79	**-2.33**				
	III*	1.69	0.01	-0.97	1.08	0.06	1.71	-0.89	
		1.06	-0.80	0.47	0.19				
		0.45	1.55	**2.25**	-1.08				
The Netherlands	I	**-2.63**	-0.44	0.47	**3.45**	**6.10**	0.80	-0.11	
		-0.23	0.48	0.51	-1.09				
		0.51	-1.14	0.66	-0.13				
	II	**2.79**	-1.26	0.39	1.19	**11.57**	0.92	-0.64	
		-1.26	-0.89	-0.69	1.02				
		0.46	0.74	-0.80	-1.30				
	III	0.74	0.36	0.04	0.30	**4.90**	**1.85**	-1.46	
		0.17	-0.24	1.09	-0.10				
		-0.47	0.08	0.78	-0.59				

Significant values (at 10 % level) are bold.
* no ERM

Table 4.1 continued

t-values		Domestic interest rate	Domestic inflation	Domestic production	Deviation from central rate	German interest rate	US interest rate	Constant	Dummy
Spain	I*	**-4.74**	-0.21	0.04	0.43	0.05	0.56	-1.07	**9.99**
		-4.99	-0.73	0.15	-1.24				
		-1.55	-0.73	-0.59	0.83				
	II	-0.76	-0.61	0.48	0.48	0.23	0.16	-0.40	
		-0.20	0.98	0.36	-0.77				
		-1.69	0.80	0.76	0.58				
	III	**-6.64**	-0.70	-1.46	**3.41**	0.24	-1.54	**-3.92**	
		-1.93	**-2.06**	**-2.19**	**-4.51**				
		-0.69	-0.20	-0.68	**6.38**				

Significant values (at 10 % level) are bold.
* no ERM

Table 4.2

F-values		Domestic interest rate	Domestic inflation	Domestic production	Deviation from central rate	German interest rate	US interest rate
Belgium	I	1.93	0.95	**3.58**	**4.27**	**13.54**	**3.19**
	II	**2.97**	1.22	0.62	2.55	**103.31**	0.05
	III	2.47	0.91	0.19	1.97	1.81	0.03
Denmark	I	2.57	2.13	0.09	2.17	0.16	0.27
	II	0.08	0.75	0.10	1.69	1.33	0.12
	III	1.85	0.26	0.66	0.79	0.21	0.24
France	I	0.76	0.76	0.20	**3.39**	1.97	0.67
	II	1.48	1.45	0.41	**2.77**	0.16	1.38
	III	2.49	0.51	0.35	0.74	1.33	2.42
Great Britain	I*	**2.86**	1.95	0.67	1.33	0.08	0.71
	II	1.38	**6.43**	2.33	1.96	0.91	**3.98**
	III*	**3.23**	1.82	1.13	0.62	0.38	0.12
Italy	I	1.42	1.04	**5.35**	0.88	0.08	0.20
	II	**2.82**	0.21	0.60	2.03	0.65	0.13
	III*	2.76	1.20	**3.51**	1.11	0.004	**2.93**
The Netherlands	I	2.49	0.63	0.18	**4.67**	**37.23**	0.64
	II	2.65	1.04	0.54	1.23	**133.80**	0.84
	III	0.14	0.04	2.06	0.05	**22.90**	**3.60**
Spain	I*	**55.63**	**35.75**	**103.89**	**35.79**	**100.90**	**99.80**
	II	0.68	0.12	**2.80**	0.41	2.07	0.86
	III	**18.59**	2.07	**5.02**	**15.49**	0.06	2.38

Critical values at 10 % level: I: > 2.7, II: > 2.8, III:> 2.99.
Significant values (at 10 % level) are bold.
* no ERM

4.2.1 Belgium

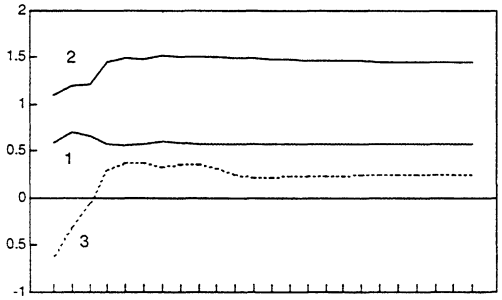
In Belgium, production has been the only domestic variable affecting the domestic interest rate, and it has been of importance for the domestic interest rate changes only in the first subperiod. An increase in production has resulted in a rise in the domestic short-term interest rates indicating that the monetary authority has acted to prevent an overheating of the domestic economy. The significant coefficient for production might reflect the contradictory economic situation in Belgium: in order to dampen inflation the country had to satisfy with relatively low levels of activity. In the two later subperiods, domestic variables have not played a significant role for monetary policy making. Instead, the role of the history of the domestic interest rate itself is significant throughout all the subperiods.

Of the foreign variables, the US interest rate appears in the equation with a significant coefficient in the first subperiod. This might be explained by the fact that, as pointed out by Gros & Thygesen (1992), in the early years of the EMS, monetary policy in the US was tightened at the same time as financial flows were liberalized. This increased interest rate variability as a tool to achieve intermediate monetary policy targets. As a consequence, EMS countries faced the challenge of responding to changes in the US interest rates and the ensuing international financial shocks. As the US interest rates rose to high levels, European countries had either to accept a depreciation of their currencies or to follow US interest rate changes.

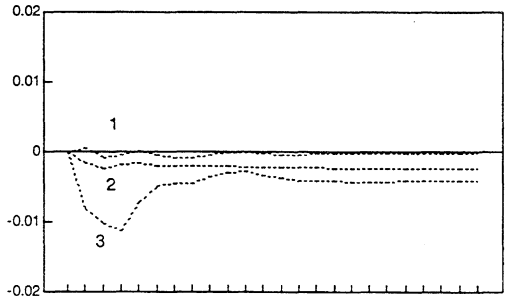
The German interest rate and the deviation of the spot exchange rate from the central rate, in turn, have gained importance during the second subperiod as compared with the first. This is particularly well illustrated in Figure 4.1 where the effect of a one per cent point rise in the German interest rate results in a larger than one-to-one permanent positive effect in the Belgian interest rate. In the first subperiod, this effect was only around half a percentage point. The exchange rate also has had a remarkable effect on the domestic interest rate during the first subperiod. At that time, Belgium aimed for a stable position near the central rate, but because of the pressure from the US monetary policy, and because Belgium was still recovering from the inflation crisis induced by the oil shock, it suffered from a persistent inflation differential vis-à-vis Germany. The currency depreciated, and interventions were needed to keep the BEF from its upper limit. It is also interesting to note that in the third subperiod, we do not find significant effects of either of the German interest rate or the deviation of the spot rate from the central rate.

Figure 4.1 **Cumulative impulse response functions of the Belgian short-term interest rate to innovations in domestic and foreign variables.**

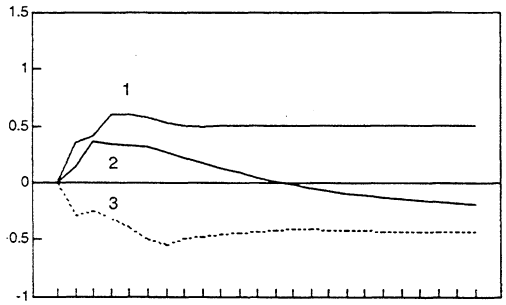
German interest rate



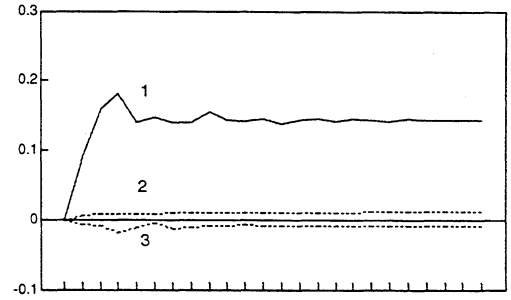
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

4.2.2 Denmark

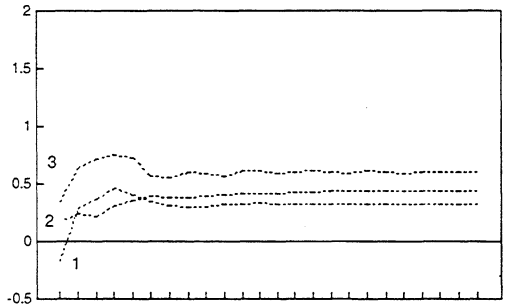
In Denmark, we observe that the inflation rate has been the significant domestic variable affecting monetary policy, whereas production has not been decisive for domestic interest rate changes. A rise in inflation has led to a rise of the domestic interest rate, which indicates that the monetary authority has tried to control inflation. This link was less pronounced in the second subperiod and disappears in the third subperiod. Denmark's story here is very similar to that of Belgium's: in the first subperiod, Denmark suffered from the inflation shock induced by the oil price hike. Monetary policy was not effective in depressing inflation, and, as described in Gros & Thygesen (1992), Denmark requested realignments in order to maintain competitiveness. The level of economic activity remained relatively low. The domestic interest rate itself affects future interest rate changes in the first subperiod, and then again in the third subperiod. The third subperiod also includes

a dummy in order to capture turbulence during the exchange rate crisis in August 1993.

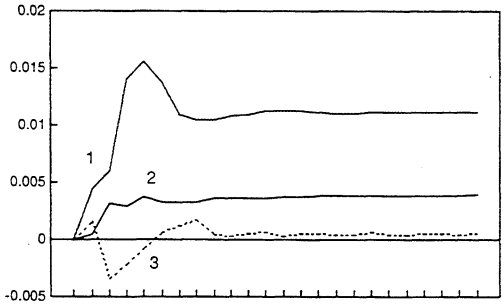
On the foreign side, the deviation of the spot exchange rate from the central rate has a significant coefficient only in the first subperiod. As Figure 4.2 illustrates, the effect of the German interest rate seems to increase over time so that the permanent positive effect is about twice as large in the third subperiod as in the first subperiod. However, the coefficient for the German interest rate is not statistically significant in any of the subperiods.

Figure 4.2 **Cumulative impulse response functions of the Danish short-term interest rate to innovations in domestic and foreign variables.**

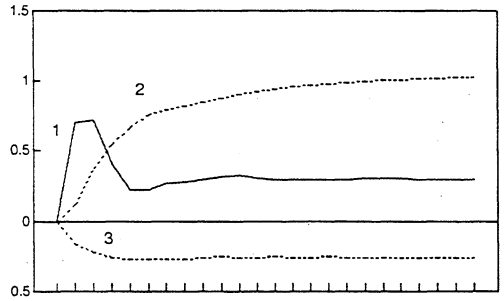
German interest rate



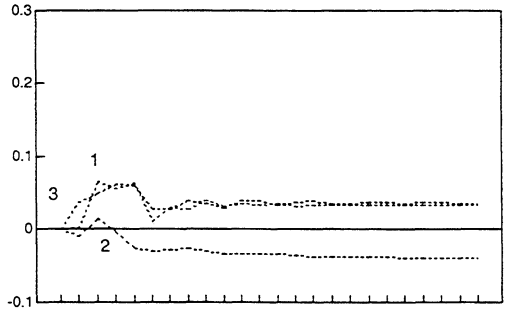
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

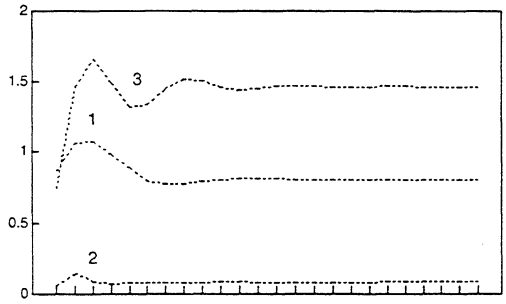
4.2.3 France

In France, we find no significant coefficients for the domestic variables. Only the inflation rate gets a significant coefficient during the second subperiod. It has a perverse negative sign indicating that the monetary authority reacts by lowering the interest rate when the inflation rate increases. The impulse response of the interest rate to inflation innovations, as displayed in Figure 4.3, however, is very close to zero. The negative effect might be explained by the change in the course of the French monetary policy from 1983. Since then France has pursued a tough monetary policy. To bring about convergence of inflation with the anchor country, the money supply in France was tightened more than in Germany so that by 1990 the two countries' inflation rates were the same. This change of regime most certainly affected inflation expectations. The VAR methodology, based on lagged values of a variable, cannot capture such a change in expectations. Hence, since we are facing a problem of simultanity, we can question the direction of causality between the interest rate and the inflation rate. The significance of the past values of the domestic interest rate itself, in turn, increases towards the third subperiod.

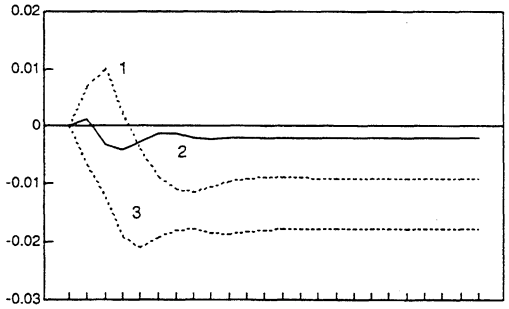
From the foreign variables, deviation of the spot exchange rate from the central rate was a significant determinant of the monetary policy during the first and second subperiods. In the first subperiod, the FRF was unstable because of the divergence between the domestic and the German economies. As Gros &Thygesen (1992) report, the consequent tensions in the foreign exchange markets had to be controlled by interventions. These are mostly sterilized interventions, as found in eg Mastropasqua et al. (1988) or Loureiro (1992), so the effect of the spot exchange rate on the domestic interest rate has been only temporary during the first subperiod. The coefficient for the German interest rate is not significant, but as Figure 4.3 illustrates, the influence of the German interest rate seems to have been the least during the "hard" EMS period, ie the second subperiod. In the first subperiod, the response of the French interest rate to changes in the German interest rate were close to one, and are larger than one in the third subperiod. However, because the insignificance of the coefficient, we may not conclude with any certainty that the role of the German interest rate for the French monetary policy would have increased.

Figure 4.3 **Cumulative impulse response functions of the French short-term interest rate to innovations in domestic and foreign variables.**

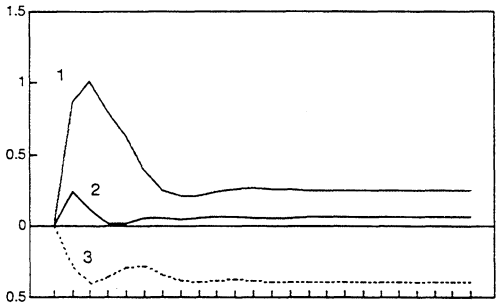
German interest rate



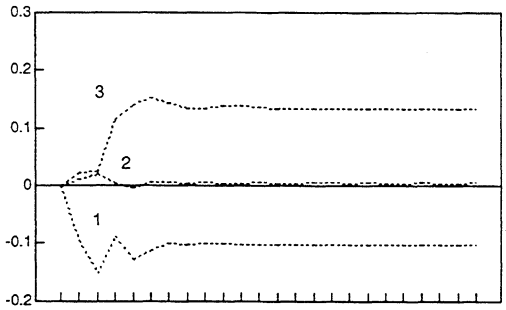
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

4.2.4 Great Britain

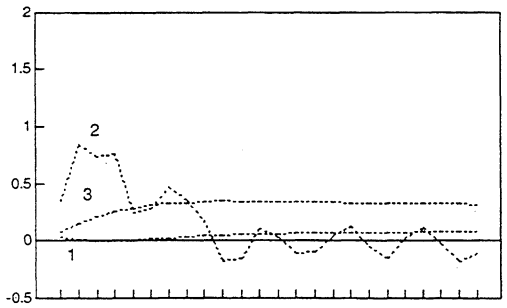
The periods for Great Britain are divided according to the exchange rate regime of the GBP. The first and third subperiods represent British monetary policy under a floating GBP, whereas the second subperiod includes GBP's very brief participation in the ERM. Due to the lack of observations, therefore, the empirical results for the second subperiod cannot be interpreted reliably. The impulse responses in Figure 4.4 illustrate clearly the odd response of the interest rate to all variables.

In the British case, the domestic variables gain significance over time. Both the inflation rate and production get significant coefficients in the second and third subperiods. The role of the domestic interest rate itself disappears in the second subperiod, but is crucial again in the third subperiod.

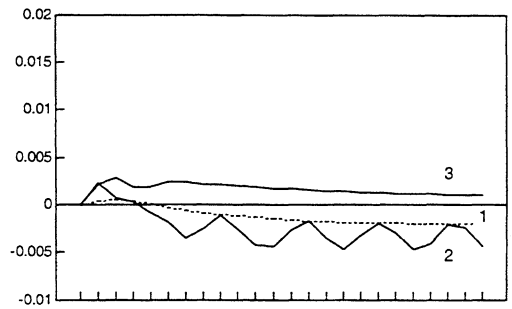
Of the foreign variables, the change of the (floating) exchange rate had a significant negative effect on the domestic interest rate, meaning that a depreciation of the GBP vis-à-vis the DEM resulted in a decrease in the domestic interest rate. This might reflect the relative importance of the GBP/USD exchange rate, so that in times of a strong DEM, the USD has been relatively weak. During such periods, capital flows have been such that the Bank of England has preferred to lower interest rates. The fact that Great Britain is, financially, more closely related to the US than to Germany, is perhaps reflected in the fact that in the second subperiod, US interest rates become a significant coefficient. We know from elsewhere, as eg Gros & Thygesen (1992) have claimed, that during the ERM period, movements of the GBP vis-à-vis the DEM constrained British monetary policy at times. Unfortunately the shortness of the period prevents us from making any conclusions on that issue.

Figure 4.4 **Cumulative impulse response functions of the British short-term interest rate to innovations in domestic and foreign variables.**

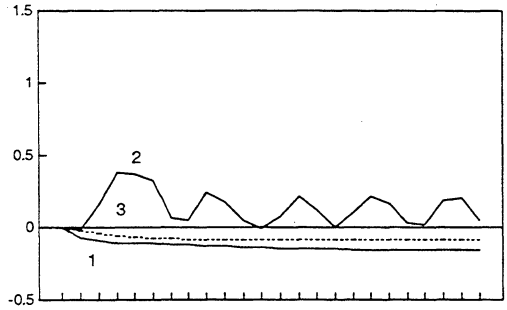
German interest rate



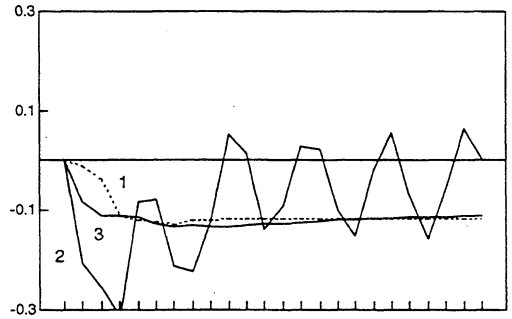
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

4.2.5 Italy

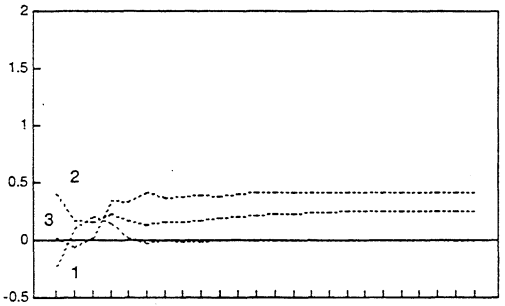
In the case of Italy, we also have one subperiod, namely the third, with a floating exchange rate. Hence, we could expect to see a difference in the reaction pattern of the domestic interest rate in the third subperiod as compared to the two prior subperiods with the ITL participating in the ERM.

First, we can observe that the domestic variables have both a significant coefficient in the first subperiod. This is not surprising since we know that Italy has pursued monetary policy that has systematically and substantially generated more inflation than in Germany. The growing inflation differential was compensated for with realignments rather than depressed with domestic monetary policy actions. This is seen in Figure 4.5. Domestic inflation affects domestic short-term interest rates only temporarily, and the magnitude of the effect is negligible. Because of the very small magnitude of the effect, we can ignore the negative sign of the impulse response function. In the second subperiod, the domestic variables loose their power to explain changes in the domestic interest rate. In the third subperiod, again, production has an influence on the domestic interest rate, but it is only slightly different from zero. The history of the domestic interest rate, in contrast, gains explanatory power towards the end of the period.

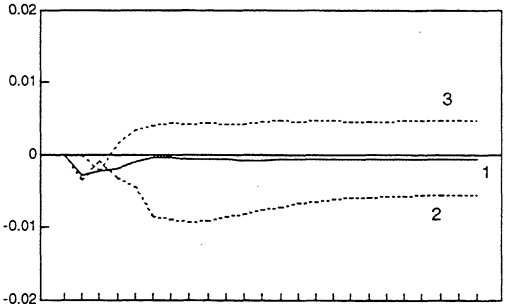
On the foreign side, we observe that the deviation of the spot exchange rate from the central rate has a significant coefficient only during the "hard" EMS subperiod. The German interest rate remains insignificant throughout the entire period, but the impulse response shows that its influence increased from practically zero to almost half a percentage point towards the third subperiod.

Figure 4.5 **Cumulative impulse response functions of the Italian short-term interest rate to innovations in domestic and foreign variables.**

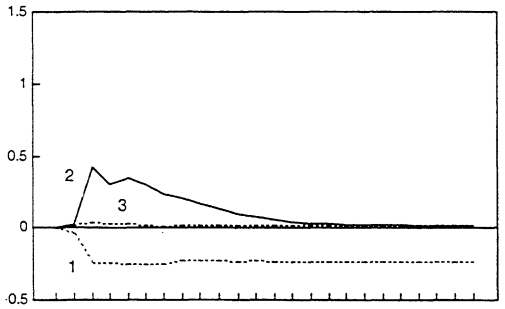
German interest rate



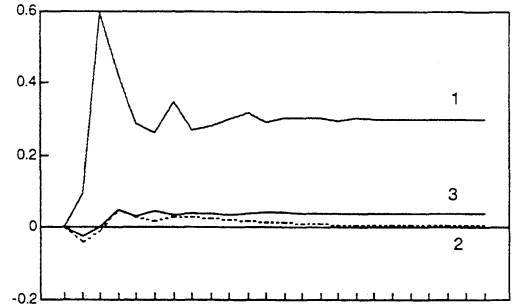
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

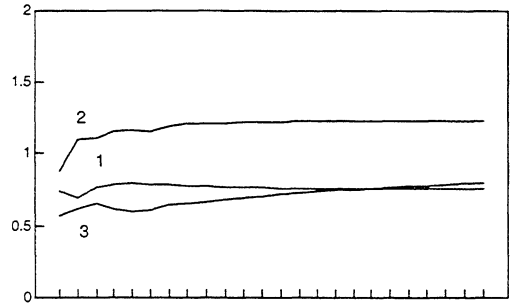
Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

4.2.6 The Netherlands

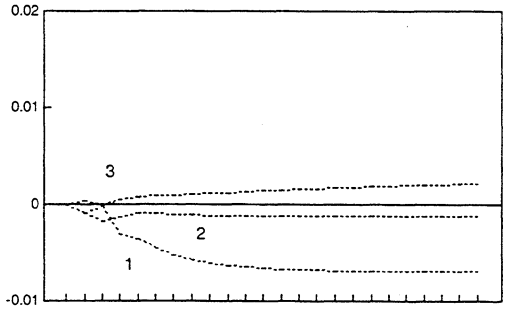
The Dutch case is the most clear of all. The role of Germany is fully evident throughout the entire period. The domestic variables play no role in monetary policy making. Only the foreign variables matter so that the role of the German interest rate, in particular, has been strong. Its effect was most pronounced in the second subperiod. The deviation of the spot rate from the central rate, in turn, is decisive only in the first subperiod. In contrast to all other countries, the history of the domestic interest rate itself loses meaning for the Netherlands as we move to the third subperiod. This reflects the fact that, in terms of equation (6), all weight has been put on τ, ie on following German monetary policy.

Figure 4.6 **Cumulative impulse response functions of the Dutch short-term interest rate to innovations in domestic and foreign variables.**

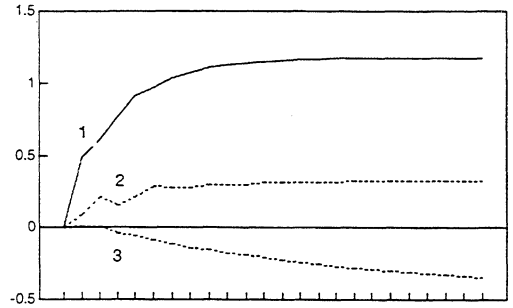
German interest rate



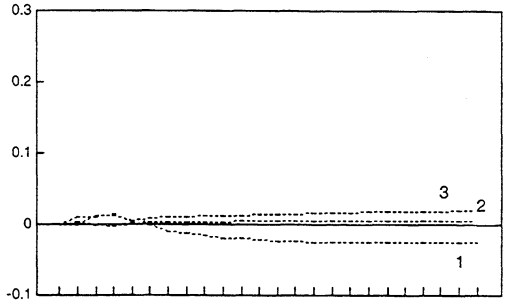
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

4.2.7 Spain

In the Spanish case, the subperiods are divided so that the first covers the time when the ESP was floating, and the second and third subperiods represent the participation of the ESP in the ERM. The third subperiod ends at December 1994, because of the January 1995 shift in monetary policy when the Banco de España announced a direct inflation target for the medium term and, shortly thereafter, raised its key interest rate in three steps. This happened at a time when the ESP was weak, and there was confusion in the markets over the new policy. Due to this abrupt shift in regime, we prefer to cut the subperiod for Spain before this event.

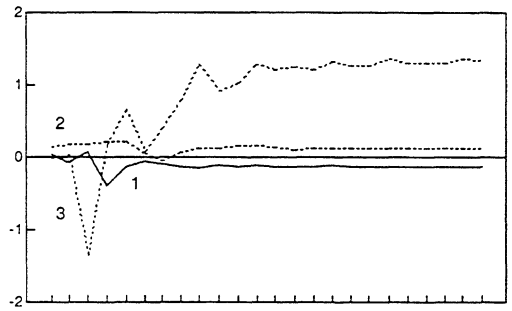
Domestic variables have been significant determinants of Spanish monetary policy during the first and third subperiods. The impact of both inflation and production are more pronounced in the third subperiod than in the first. The negative effect of the inflation rate on the interest rate may be explained by the

instability in the Spanish financial markets in 1993-1994. As reported in the EMI 1994 Annual Report, cross-border capital flows were liberalized in early 1992, resulting in the introduction of new financial instruments as well as frequent portfolio switching by the public. This made it difficult for the central bank to control monetary conditions.

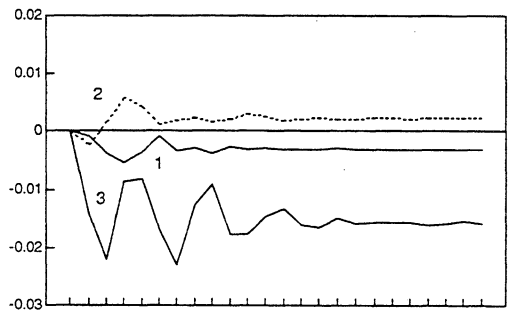
On the foreign side, the German interest rate has a significant coefficient throughout the entire period, while the exchange rate has been decisive only during the first and third subperiods. In the first subperiod, this means that the change of the (floating) exchange rate has had a slightly positive effect on the domestic interest rate, ie monetary policy has reacted to weakening of the ESP with an interest rate hike. In the third subperiod, this positive effect is much more pronounced. When the ESP has deviated from its central rate, monetary authorities have reacted by raising the interest rate in case of a positive deviation, and vice versa in the case of a negative deviation. It might be surprising that the deviation of the spot rate from the central rate does not show in the second subperiod, although the ESP entered the ERM at a central rate that was considered ambitious given Spain's competitiveness, external position and underlying inflation rate. It is also apparent that the Spanish authorities had difficulties keeping the ESP within the band. The high interest rates required to dampen strong domestic demand also caused capital inflows. The extent to which domestic production dominated monetary policy decisions can also be seen in the impulse response functions displayed in Figure 4.7.

Figure 4.7 **Cumulative impulse response functions of the Spanish short-term interest rate to innovations in domestic and foreign variables.**

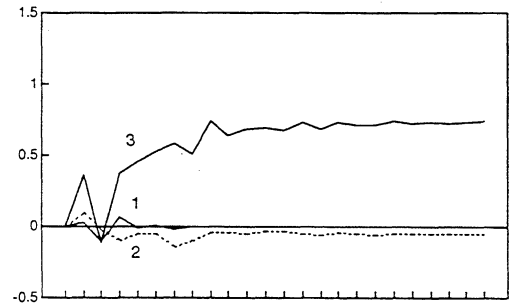
German interest rate



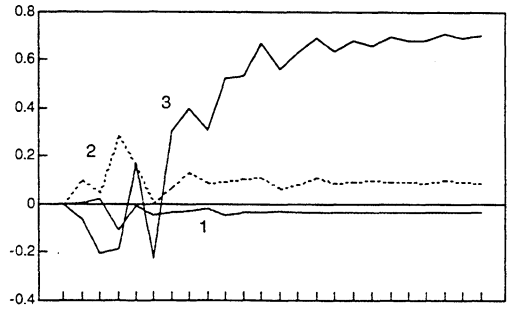
Inflation rate



Deviation of spot rate from central rate



Production



1 Period I
2 Period II
3 Period III

Continuous lines indicate cases where the variable in question has a significant (at 10 % level) coefficient.

5 Summary of the results

5.1 Domestic variables

Taking the country-by-country results together, we can make the overall observation that the inflation rate has had surprisingly little effect on domestic monetary policy during the first subperiod. At that time, Europe suffered from the inflation shock induced by the oil shock, so one might expect more anti-inflationary monetary policies. On the other hand, at that time inflation was counteracted by actions other than monetary policy such as modifying wage-indexation, and further that inflation differentials were often compensated for, at least partly, with devaluations. In any case, the role of monetary policy in

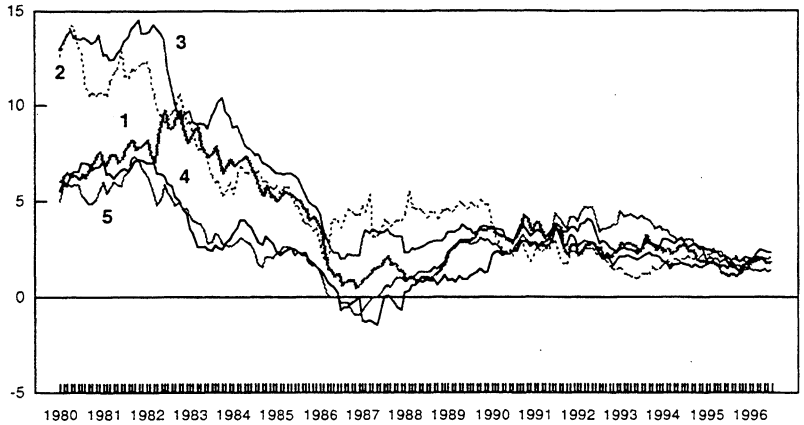
controlling inflation gains in importance only after the mid-1980s. This is seen especially in the increased inflation convergence towards the low level of the anchor country, Germany, as displayed in Figure 5.1, and in the consequently diminished need to adjust the exchange rates. But despite of the change in the orientation of monetary policy, the role of the inflation rate has decreased in the third subperiod. This can probably be explained by the fact that, in the 1990s, inflation rates in the ERM countries have strongly converged, as Figure 4.8 illustrates. We see that the range of domestic inflation rates narrowed and virtually disappeared, when the German inflation rate crept up after the unification. The convergence together with the fact that the level of the inflation rates has stabilized has diminished the need of monetary policy to react. Production, in turn, loses of significance for monetary policy in the second subperiod. This, again, can be explained by the fact that during the second subperiod, especially in the end of the 1980s, the business cycles in the ERM countries were both synchronized and favourable for growth. Therefore, as long as there was no danger of overheating, there was no pressure for monetary policy to react. Taking this together would conform with the conclusion that the role of the domestic variables for monetary policy making has been about the same throughout the entire period.

One observation is the persistence of interest rates. Interest rates have been influenced by their own history clearly throughout the period, but the pattern of the dynamic response to domestic interest rate innovations seems to have undergone a change towards the third subperiod. In general, the estimated impulse response function suggests that the interest rates converges to the new level within six months after the innovation in the first and second subperiod. The estimated reaction is also monotonous. In the third subperiod, however, there is some "overshooting" right after the initial shock in interest rates in Belgium, Denmark and France. In these cases, it also takes longer than six months before the interest rate finds its new level. In the other countries, on the contrary, there is no "overshooting" and the interest rate settles at the new level within a few months.

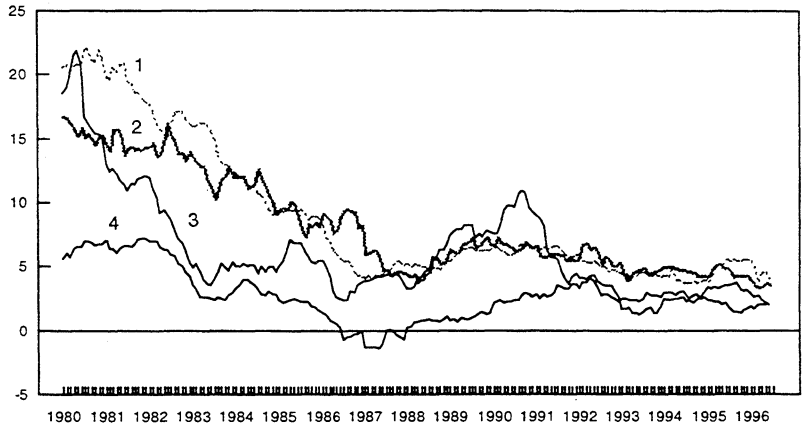
5.2 Foreign variables

On the foreign side, the German interest rate has a significant coefficient only in two countries, Belgium and the Netherlands. In the other countries, the deviation of the exchange rate from the central rate has been the significant determinant of monetary policy. This indicates that all countries, with the exception of Great Britain and Spain, have tried to follow German monetary policy at the same time as they have tried to minimize devaluation expectations. In all these cases, the effect of depreciation of the spot exchange rate on the domestic interest rate is positive. If German monetary policy had no influence, then the effect should be negative, because in equation (7d), as λ grows, the coefficient for the exchange rate term approaches k, a negative constant. Thus, the countries have followed Germany directly to some extent during the first and second subperiods. The absence of the German interest rate in the empirical results indicates that the effect of domestic interest changes on devaluation expectations has been of the

Figure 5.1 **Inflation rate in ERM countries**



1 Belgium
2 Denmark
3 France
4 The Netherlands
5 Germany



1 Italy
2 Spain
3 Great Britain
4 Germany

same size as the weight put on following Germany.[15] If we look at the impulse response functions for the first subperiod in Figures 4.1-4.7 we note that in all other countries except the Netherlands and Belgium, the effect of the exchange rate on the interest rate is only temporary. This is in accordance with Loureiro's 1992 finding that, during the period, the Netherlands was the only ERM country where the management of interest rates was a feasible instrument for counteracting exchange rate movements. Other countries followed a sterilized intervention policy which was unable to counter depreciation trends. In Figures 4.1-4.7, this can be seen as a temporary increase of the interest rate resulting from a depreciation of the exchange rate. Such behaviour, in turn, indicates that during the first subperiod, the EMS would not have been as asymmetric as has often been claimed.

In the third subperiod, the foreign variables show up only for the Netherlands and Spain. In the Netherlands, the German interest rate is the only decisive variable, which is reflected in the fact that θ is zero in the Netherlands, but all weight is on stabilizing the participation in the ERM. Moreover, there are practically no devaluation expectations, ie $\delta = 0$, and τ has a large value indicating that German monetary policy has been strictly followed. In Spain, by contrast, the exchange rate has a positive influence on the domestic interest rate. It seems that the reaction function in Spain works in the third subperiod in the fashion that was characteristic for the other countries during the first or second subperiods. Because of the late entrance of the ESP into the ERM, this makes sense.

The other cases where neither the German interest rate nor the exchange rate shows a significant effect on the domestic interest rate, this might reflect two completely different situations. One explanation could be that $\lambda=0$, ie that only domestic factors matter. However, none of the domestic variables show up, either. Thus, it seems more likely that we have a situation where devaluation expectations are so small that the term disappears. At the same time, German monetary policy is not strictly followed by the other countries. This indicates that the EMS has become even more symmetric over time. During the existence of the wide fluctuation margins, either the amount of sterilized intervention has increased, or deviations of the exchange rate from its central rate have been allowed more generously than before, or both. In any case, the exchange rate restriction originally provided by the ERM seems to have lost constraining power on domestic monetary policy making. Interest rate policies have converged, but not because of "strait-jacket" effects but because of similar domestic preferences.

Interestingly, the overall role of the foreign variables has clearly decreased over time. In the first subperiod, the effect was clear, while in the third subperiod it seems to be very small. Of course, the fluctuation bands of the ERM have been wider in the third subperiod than in the first two. and clearly margins of 15 per cent give more room for monetary policy than narrow bands.

[15] In terms of equation (7d), in these cases $|d| = |\tau|$.

6 The changing role of the ERM

The EMS is a supplement to domestic monetary systems. How it has worked has depended on the countries involved and changes in their policy preferences over time. The results of this study show three features:

- the relatively stable role of the domestic variables,
- the declining importance of the foreign variables, and that
- the history of the domestic interest rate itself has become more decisive for monetary policy decisions.

6.1 The disinflation process

The first part of the interpretation of the empirical results concerns the weighting of domestic targets. The results indicate that there has been a stabilization process going on in Denmark and France in the 1980s, and then also in Great Britain and Spain in the 1990s. Belgian and Dutch monetary policies have not reacted to changes in the domestic inflation rate. In the Netherlands' case, this is explained by the fact that the NLG has long been a currency that retains its value. In Belgium, in turn, the central bank has controlled inflation through dampening any overheating of the economy. In the traditionally inflation-prone countries (Great Britain, Italy and Spain), the monetary policy trade-off has been more a question of balancing the two domestic factors than domestic and foreign components of the loss function.[16]

The reason for the disinflation process might be found, as suggested in other studies, in the monetary cooperation practiced within the EMS. For example, Fratianni & vonHagen (1990) show that the conditional variance of inflation, as well as its trend, has fallen in EMS countries. This fall is matched in non-EMS countries, but between the EMS countries they find greater covariance than outside the EMS, suggesting policy coordination within the EMS countries. Also Bell (1995) notes that the main benefit of the ERM of lowering the inflation rates in the participating countries is not due to the (quasi-) fixity of the exchange rates, but to the monetary policy conducted in the individual countries as participants in the system.

A further finding of close monetary policy coordination between the EMS countries is presented in Hughes-Hallet et al. (1993). They argue that the joint challenges to EMS members posed by the system's potential instability seem to have forced their central banks to abandon independence and to cooperate to a degree never originally foreseen. Hence, all EMS countries have adopted the target of the anchor country, namely monetary stability. In that sense, it could be argued that the domestic targets have not been independent of the existence of the EMS. – On the other hand, the willingness to participate in the EMS may be interpreted as evidence of the convergence of internal targets of the countries in question.

---

[16] See also Gros & Thygesen (1992) for an analysis of the disinflation in the EMS.

6.2 Lesser external constraint

The second part of the interpretation concerns the role of the ERM. In earlier research, eg Loureiro (1992) has analysed the symmetry of the EMS using VAR estimations on domestic credit. His results showed that especially France and Italy enjoyed relatively large monetary independence during the first subperiod. Only the Netherlands followed strictly German monetary policy, whereas Denmark and Belgium were "intermediate cases". Similar results are presented in Bini Smaghi & Micossi (1990), who have analysed a period corresponding the second subperiod of this study. They found evidence for that especially after 1987, monetary policies in ERM countries responded more readily to the requirements of exchange rate stability in the traditionally inflation-prone countries. The impulse response functions obtained in this study give a similar indication - the exchange rate variable has the strongest effect during the second subperiod in Italy. Its coefficient is significant also for France and Belgium, but the impulse response functions show that the effect is smaller during the second subperiod, than the first. In the Netherlands, the exchange rate has no effect on monetary policy after the first subperiod.

Page 35 of the 1994 Annual Report of the European Monetary Institute (EMI) states, "After the widening of the fluctuation bands in the ERM... the central banks of the participating countries had in principle the opportunity to use the increased room for manoeuvre to set monetary policies with less emphasis on the exchange rate. ...The solution of downgrading the exchange rate as a nominal anchor was, however, not generally pursued, thereby confirming that the ERM continued to function as a coordinating framework for national monetary policies. .. What has not changed is the final objective of monetary policy, namely price stability..." The following year, EMI writes on page 16 of its 1995 Annual Report, "... monetary policy responses to exchange rate tensions followed two broad strategies: the majority of ERM countries continued to give priority to stable nominal exchange rates vis-à-vis the strongest ERM currencies in their formulation of monetary policy; other countries found it more appropriate to allow more exchange rate flexibility, as evidenced by the increased use of the +/- 15 % fluctuation bands within the ERM." Apparently, the deviations of the spot exchange rate from the central rate have diminished and are, therefore, so negligible that they do not affect domestic monetary policy. This should not be surprising considering that during the first subperiod, and even more so during the second, the variability of nominal exchange rates in the EMS diminished greatly.[17] Moreover, since the widening of the fluctuation bands in August 1993, EU central banks have underscored their intention to stabilize exchange rates as close to central rates as possible. Of course, we can also draw the opposite conclusion here that the constraining power of the ERM disappeared in the latter period. This sounds logical as we know the fluctuation margins of the ERM were widened at that time to 15 per cent.

It should be noted that at least in favourable circumstances, a fixed central rate per se can serve as an intermediate monetary policy target without being in contradiction with the final, inflation target. Considering that the strongest attitude the monetary authority can take vis-à-vis the public is to commit themselves to the

[17] See eg Gros & Thygesen (1992).

achievement of an announced target, aiming at stabilising the exchange rate provides an objective way to hold them accountable. Independent of the width of fluctuation margins around the fixed parity, the central rate itself still is an instantly observable market price whose meaning is clear for the public. In other words, it still bears the positive properties of the nominal exchange rate serving as intermediate target.[18] Thus, if monetary policy is successful in stabilising the exchange rate, it clearly mirrors the successful restraining of domestic price increases to a level close to that one in the reference currency country (or countries).

Based on this argument and the evidence in Figure 5.2 (a plot of the deviations of the spot rates from the central rates and the interest rate changes), the countries can be divided into two groups. In the first group, we have the "core" countries Belgium, Denmark, France and the Netherlands. In the second group, we have Great Britain, Italy and Spain.

In monetary policy of the "core" countries, the exchange rate deviates *more* from the central rate during the third period than earlier.[19] At the same time, the variability of the interest rate has diminished. In the second group, which includes countries with traditionally looser exchange rate arrangements, we do not observe such a change. This leads us to the results of Svensson (1994) and Bernanke & Mishkin (1992). The theoretical analysis of Svensson (1994) shows that there is a trade-off between the exchange rate and interest rate variability, ie a wider exchange rate band that allows the central bank to reduce domestic interest rate variability. This monetary independence gained by (wide) fluctuation margins can only be used to steer short-term interest rate - the ones we have measured in the empirical part of this study. And more importantly, the central bank cannot benefit from a wide fluctuation band as long as there are persistent realignment expectations. Svensson (1994) points out that if realignment expectations increase in the exchange rate's deviation from the central rate, the desired movement in the domestic interest rate is not achieved. Instead, the outcome is the opposite interest rate movement, caused by increasing realignment expectations. Bernanke & Mishkin (1992), in turn, find evidence that successful central banks have long-term credibility in the form that monetary variables are always expected to return to their target value. This long-term credibility gives such central banks considerable short-term discretion.

---

[18] For a discussion of various targets of monetary policy, see eg Chouraqui (1989).

[19] Canzoneri et al. (1996) note that, since the widening of the ERM bands, France, the Netherlands, Austria, Belgium and Denmark seem to have clung to their old policies of pegging to the DEM, while the others have looked elsewhere for a means of determining monetary policy and achieving inflation credibility.

Figure 5.2 **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in Belgium**

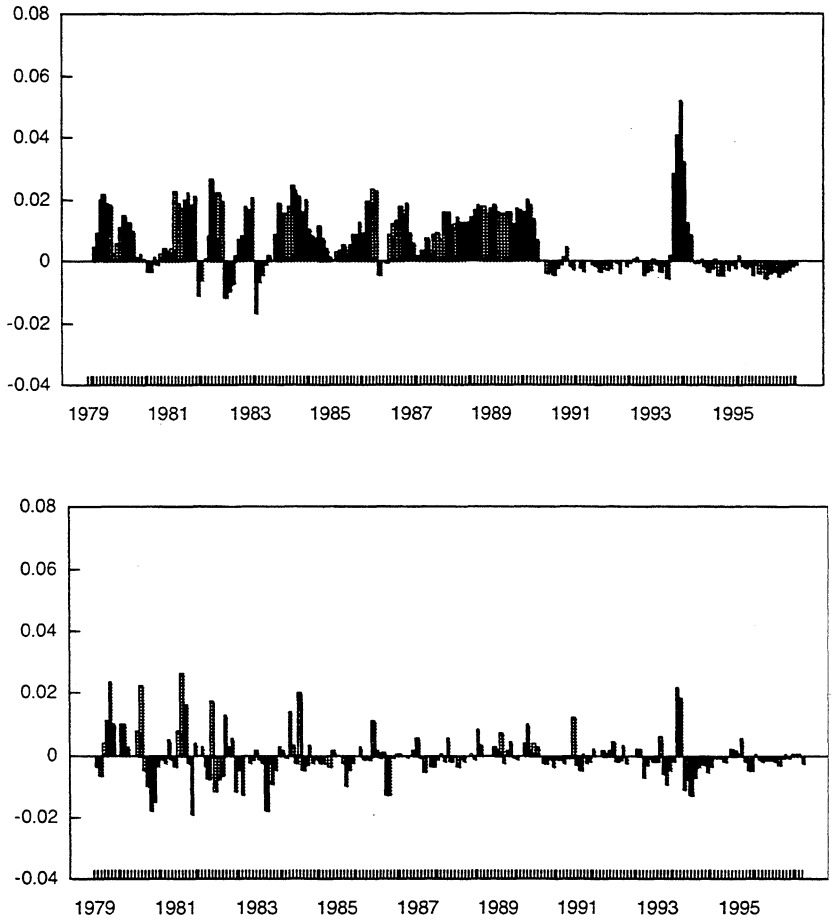


Figure 5.2 continued **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in Denmark**

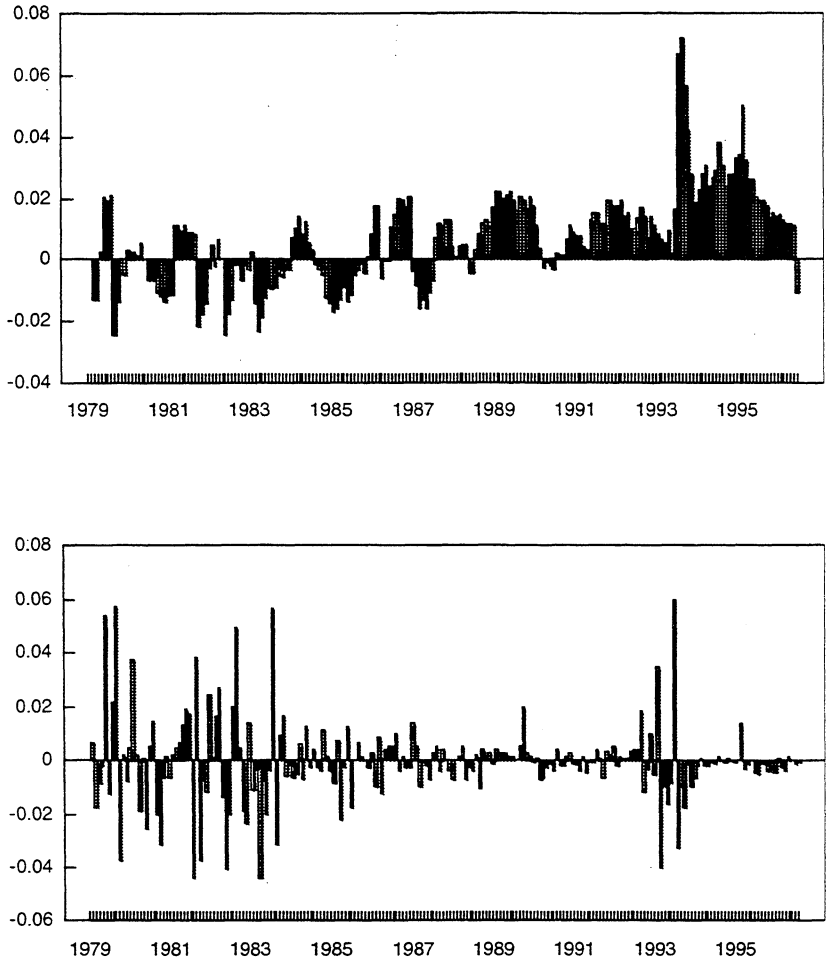


Figure 5.2 continued **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in France**

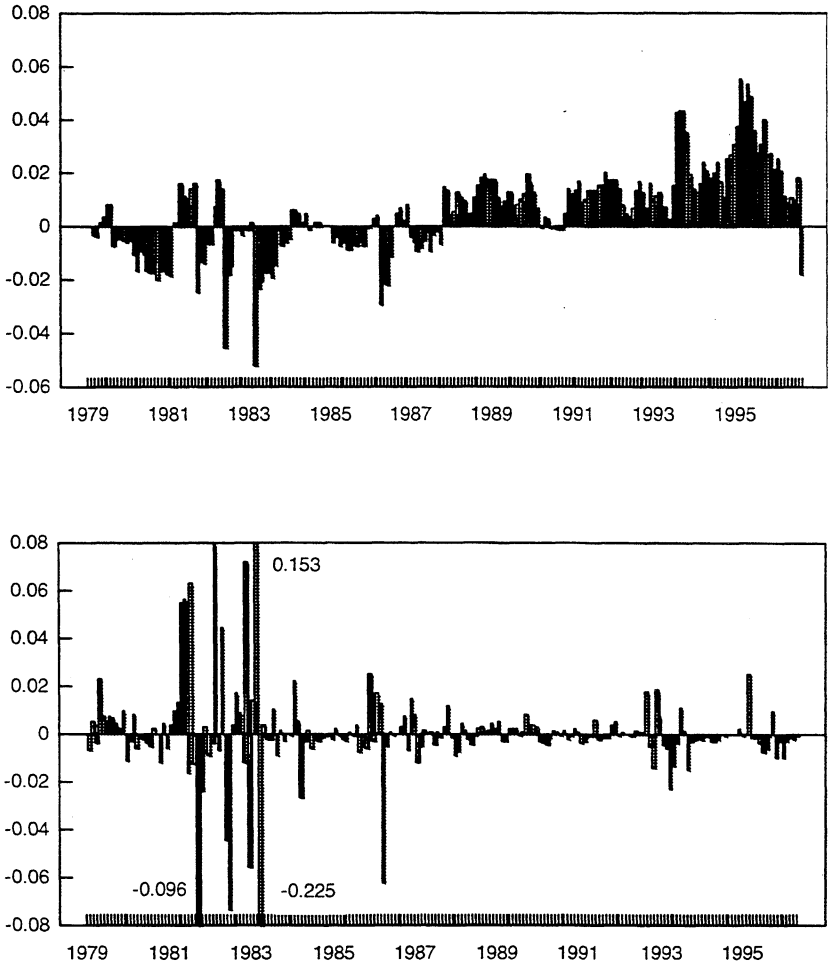


Figure 5.2 continued **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in Great Britain**

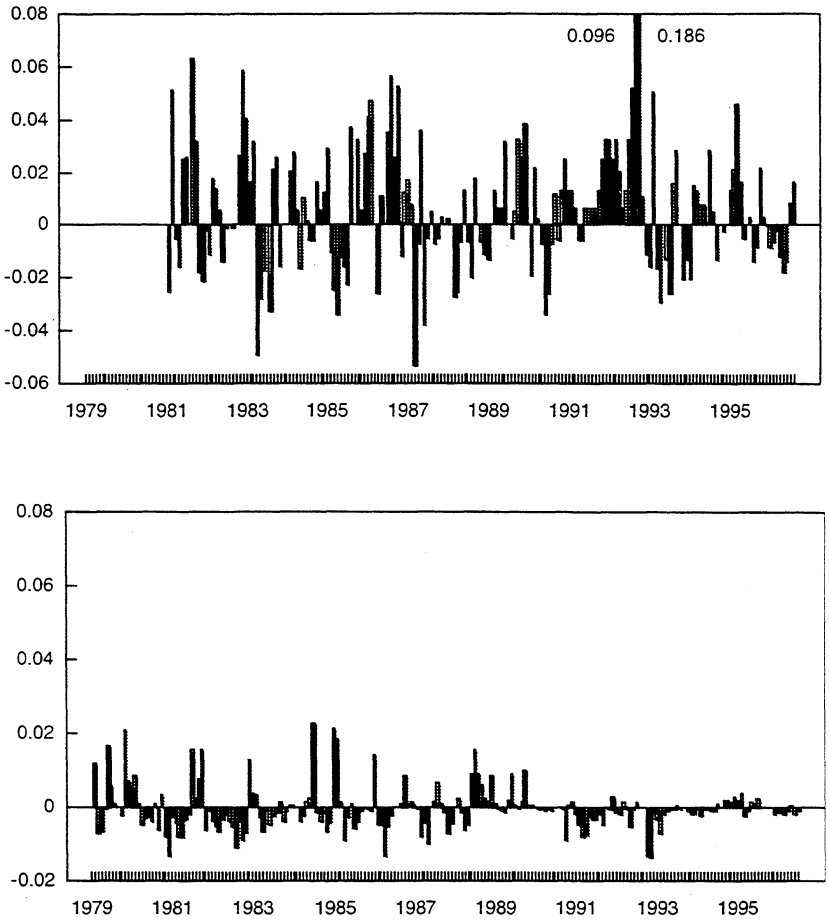


Figure 5.2 continued **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in Italy**

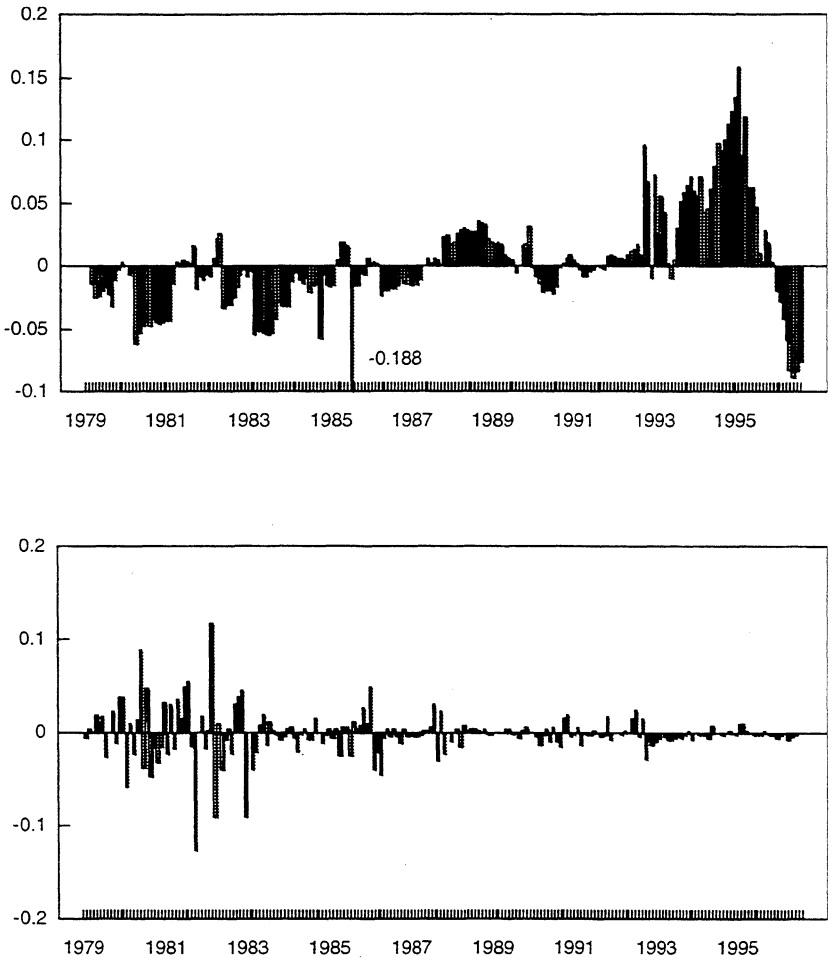


Figure 5.2 continued **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in The Netherlands**

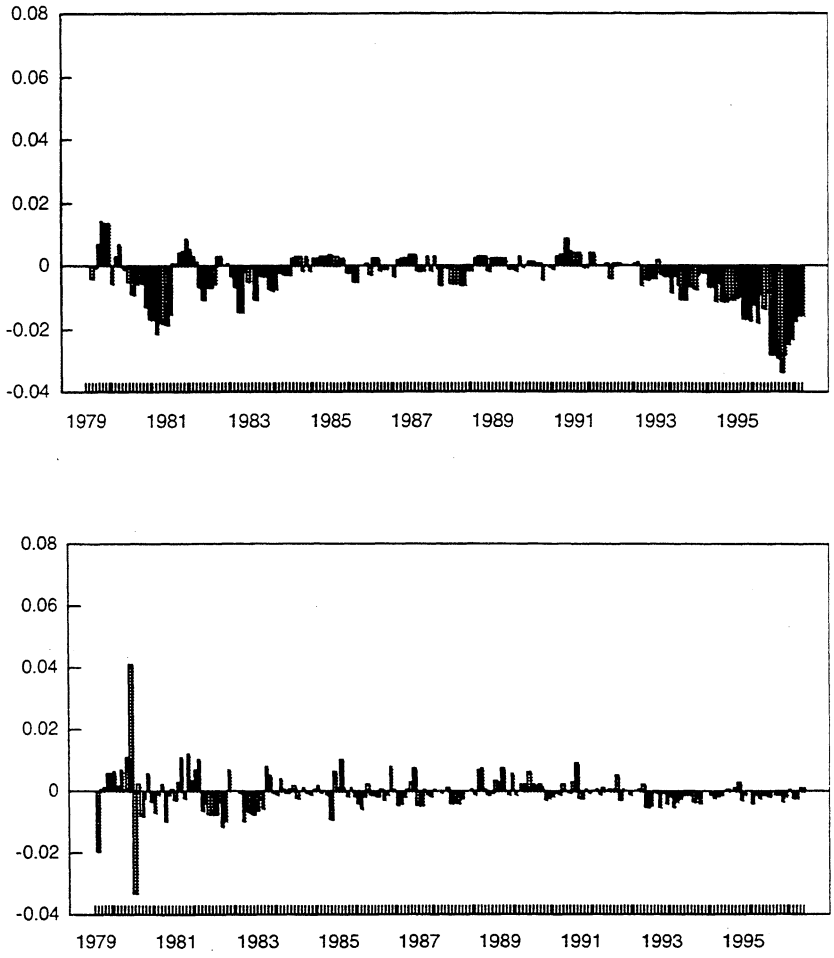
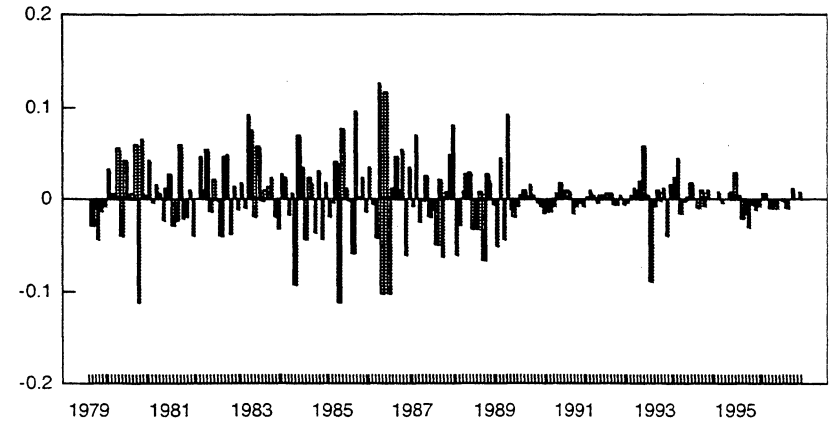
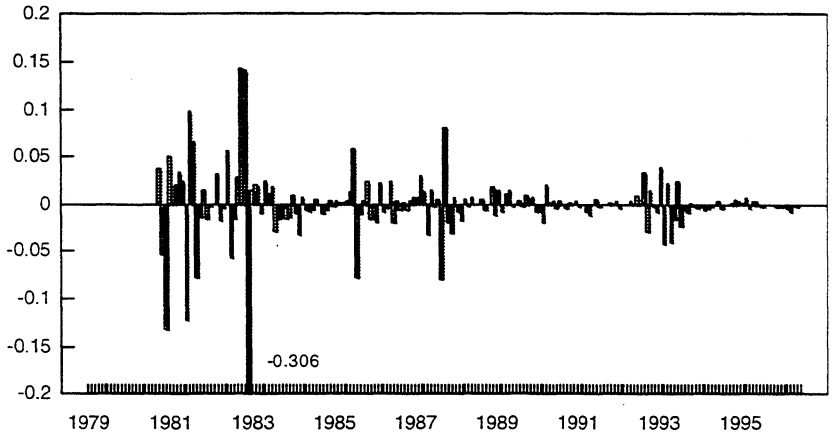
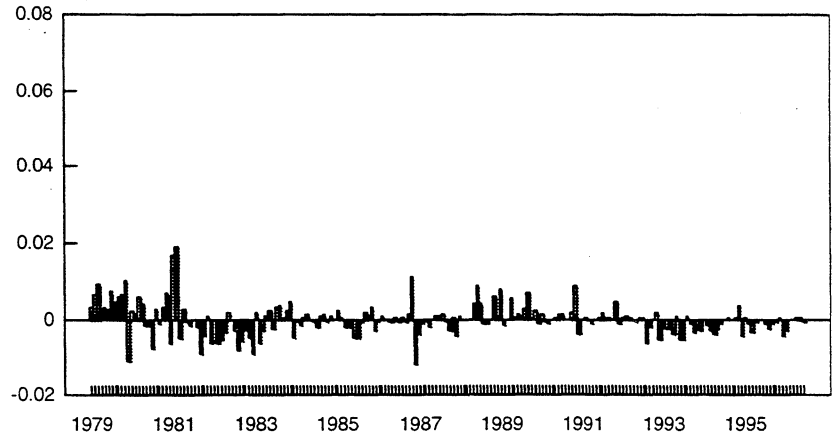


Figure 5.2 continued **Deviation of spot rate from central rate (upper panel) and interest rate variability (lower panel) in Spain**





Interest rate variability in Germany



It was empirically shown also in Hughes-Hallet et al. (1993) that the EMS induces system instability for participating countries when agents anticipate parity changes.[20] The authors argue that this potential instability has forced not only greater rigidity in parities but also greater cooperation and the abandonment of monetary independence. They also found empirical evidence that an EMS with no parity change and fixed money supplies exhibited reasonable stability. In an earlier paper (Ranki, 1996), we also found that "core" countries do not suffer from persisting realignment expectations. The results showed that during the period 1987-1992, which is identical to the second subperiod in this study, the BEF/DEM and NLG/DEM exchange rates had the smallest devaluation expectations, ie they were practically negligible. The DKK/DEM and FRF/DEM exchange rates gained credibility throughout the period. The remaining currencies GBP/DEM, ITL/DEM and ESP/DEM, in contrast, suffered from relatively poor credibility. Thus, utilizing these results we can conclude that, as the theory says, if the central rate is credible, then the domestic monetary authority can delegate the adjustment burden to the exchange rate. This is what has happened to an extent in the third period of our analysis in the case of the "core" countries who have enjoyed exchange rate credibility. This has also been suggested in the EMI 1994 Annual Report. According to the report some EU central banks have gained credibility in financial markets from their determination to maintain an anti-inflationary policy stance.[21]

6.3 Consensus on monetary policy targets

The third part of the interpretation concerns the phenomenon that the interest rate depends, to an increasing extent, on its own past. However, any such discussion should be prefaced by stating that there has been a change in the way monetary policy is conducted in Europe. As Driffill (1988) notes, the only reason for countries not to want to maintain fixed exchange rates is a difference in preferred inflation rates. Looking at the history of the EMS, we get the impression that preferences concerning the inflation rate have converged over time. In the early years, some ERM countries were inflation prone, while others conducted anti-inflationary monetary policy. In particular, Germany became the leading country because of its superior price stability record. However, as the prominent position of the DEM as the nominal anchor was eroded after the German unification and inflation in Germany picked up, the relations between the EMS currencies became more symmetric. Moreover, there is today an agreement among the EU central banks that the final target of monetary policy is the achievement and maintenance

[20] One early empirical contribution in the discussion of the trade-off between interest and exchange rate variability in the context of the EMS is the study of Artis & Taylor (1988). They found evidence for a reduction in the volatility of interest rates for ERM members. The authors attributed this reduction to the enhanced credibility of the exchange-rate policies of the respective countries.

[21] They point out the synchronized nature of the economic upswing also has played a favorable role in this regard.

of monetary stability. The strategies to achieve these targets can vary[22], but there is a strong consensus on the final target. The EMI 1995 Annual Report notes (p. 3), "Overall, monetary policies geared towards the primary objective of price stability have contributed to a general decline in inflation."

Evidence for this change in the preferences is the convergence of the inflation rates. This, of course, improves the sustainability of fixed exchange rates between the ERM countries. Moreover, since the inflation rates in most ERM countries have stabilized at low levels, emphasis can now be put on stabilizing interest rates. Indeed, since the turbulence on the foreign exchange markets in autumn 1993 and early 1995, official and key interest rates have been lowered on several occasions. As stated in the EMI 1994 and 1995 Annual Reports, ERM countries have continued their policies of gradually lowering official or key interest rates, thus allowing short-term market interest rates to decline. The conduct of monetary policy seems to have changed so that today, a reputation for consistency in monetary policy has become a key element in achieving monetary stability.

Alternatively, one could interpret the development of the role of the EMS so that it gradually came to be regarded as an implicit coordination mechanism through which countries could improve their performance by coordinating their economic policies. Hence, the EMS seems to have become more symmetric in the 1990s, and to function more as it was originally intended. Since the widening of the fluctuation bands, or should we say, since the liberalization of the capital markets, there has been a strengthening consensus that monetary policy should provide a credible anchor for nominal stability. In terms of this study, as the target values of $\bar{y}$ and $\bar{\pi}$ as well as the weight σ given for the inflation target (see equation 4) have converged in the individual countries, the role of the ERM-related variables as a restrictive guiding line for domestic monetary policy has diminished. The restoration of domestic monetary stability, then, also implies stability within the ERM. In terms of equation 4, since δ and the interest rate differential $r-r^*$ have decreased, their effect on domestic monetary policy has, automatically, decreased even if the value of λ would not have become smaller. In the words of the EMI 1994 Annual Report (p. 45), "As the convergence of inflation towards low levels makes further progress, ensuring that competitive positions do not get sharply out of line, this will be the best guarantee of limiting exchange rate tensions in the future." The interest rate policies can thus become more smooth than was the case in the unstability-prone past of the EMS.

7 Conclusion

In this study, we have derived a monetary policy rule, the interest rate rule, from a minimization problem faced by the central bank. The loss function trades off costs of interest rate instability against benefits from succesful demand management and a stable exchange rate in the ERM. ERM-related considerations, particularly, exogenous effects from German interest rates as well as deviations from the ERM-central rates, were introduced into the analysis through the latter channel. In the

[22] See the Annual Report 1994 of the *European Monetary Institute* for s survey of the monetary policy strategies of the EU central banks.

empirical section of the paper, we quantified the significance of the effects of the various factors on the domestic interest rate of an ERM-country by performing regression analysis with the domestic interest rate as the dependent variable. The evidence suggests that the countries can be divided into two groups. In the first group (Belgium, Denmark, France and the Netherlands) the trade-off of monetary policy was a choice between domestic and external targets in the early years of the EMS. The second subperiod was a period of convergence and tight exchange rate stabilization. As a result of the convergence, in the third subperiod, the exchange rate has deviated *more* from the central rate since the widening of the fluctuation bands than it has done before. At the same time, the effects of the German interest rate have diminished, while the significance of the lags of the domestic interest rate has remained high or even increased. In the traditionally more inflation prone countries (Great Britain, Italy and Spain) the trade-off of monetary policy has been rather a question between the two domestic factors than between the domestic and foreign components of the loss function.

These results seem to be consistent with the interpretation that the EMS has become more symmetric, especially as regards the "core" countries. Or, one could interpret the development of the role of the EMS so that it gradually came to be regarded as an implicit coordination mechanism through which countries could improve their interest rate convergence by coordinating their economic policies. It has evolved into a group of countries with mutually consistent targets, being still of an external constraint for countries with diverging economies, but a transparent indicator of the success of economic policies in the countries with a high degree of convergence.

References

Alesina, A. - Grilli, V. (1991) **The European Central Bank: Reshaping Monetary Politics in Europe.** Discussion Paper No. 563, CEPR.

Artis, M. - Taylor, M. (1988) **Exchange Rates, Interest Rates, Capital Controls and the European Monetary System: Assessing the Track Record.** In Giavazzi, F. - Micossi, S. - Miller, M. (eds.): The European Monetary System, Cambridge University Press, Cambridge, 185-210.

Artus, P. - Avouyi-Dovi, S. - Bleuze, E. - Lecointe, F. (1991) **Transmission of U.S. Monetary Policy to Europe and Asymmetry in the European Monetary System.** European Economic Review, Vol. 35, 1369-1384.

Barro, R. - Gordon, D. (1983) **Rules, Discretion, and Reputation in a Model of Monetary Policy.** Journal of Monetary Economics, Vol. 12, pp. 101-121.

Basevi, G. - Calzolari, M. (1984) **Multilateral Exchange Rate Determination: A Model for the Analysis of the European Monetary System.** In Bilson, J.F. - Marston, R. (eds.): Exchange Rate Theory and Practice, The University of Chicago Press, Chicago.

Begg, D. - Wyplosz, C. (1993) **The European Monetary System: Recent Intellectual History.** In The Monetary Future of Europe, CEPR, London.

Bell, M. (1995) **The ERM and the Route to EMU.** In Currie, D. - Whitley, J. (eds.): EMU after Maastricht: Transition or revaluation? Lothian Foundation Press.

Beyer, A. - Schmidt, K.J.W. (1992) **Ist das Europäische Währungssystem symmetrisch? - Ein alternativer empirischer Ansatz.** Johann Wolfgang Goethe-Universität, Working Papers Nr. 29, Frankfurt am Main.

Bini Smaghi, L. - Micossi, S. (1990) **Monetary and Exchange Rate Policy in the EMS with Free Capital Mobility.** In deGrauwe, P. - Papdemos, L. (eds.): The European Monetary System in the 1990's, Longman, London.

Biltoft, K. - Boersch, C. (1992) **Interest Rate Causality and Asymmetry in the EMS.** Open Economies Review, Vol. 3, 297-306.

Bernanke, B. - Mishkin, F. (1992) **Central Bank Behaviour and the Strategy of Monetary Policy: Observations from Six Industrialized Countries.** NBER Macroeconomic Annual 1992, 183-228.

Bofinger, P. (1991) **Festkurssysteme und geldpolitische Koordination.** Schriften zur monetären Ökonomie, Nr. 29, Nomos Verlagsgesellschaft, Baden-Baden.

Bradley, M. - Potter, S. (1985) **The State of the Federal Budget and the State of the Economy: Further Evidence.** Economic Inquiry, Vol. 23, 143-153.

Bryant, R. - Hooper, P. - Mann, C. (1993a) **Evaluating Policy Regimes and Analytical Models: Background and Project Summary.** In Bryant, R. - Hooper, P. - Mann, C. (eds.): Evaluating Policy Regimes. New Research in Empirical Macroeconomics, The Brookings Institution, Washington, D.C., 3-44.

Bryant, R. - Hooper, P. - Mann, C. (1993b) **Stochastic Simulations with Simple Policy Regimes.** In Bryant, R. - Hooper, P. - Mann, C. (eds.): Evaluating Policy Regimes. New Research in Empirical Macroeconomics, The Brookings Institution, Washington, D.C., 373-415.

Canzoneri, M. - Nolan, C. - Yates, A. (1996) **Mechanisms for Achieving Monetary Stability: Inflation Targeting Versus the ERM.** CEPR, Discussion Paper, Nr. 1418.

Chouraqui, J-C. (1989) **The Conduct of Monetary Policy: What Have We Learned from Recent Experience?** European University Institute, Florence.

Cohen, D. - Wyplosz, C. (1991) **France and Germany in the EMS: The Exchange Rate Constraint.** In Alogoskoufis, C. - Papademos, L. - Portes, R. (eds.): External Constraints on Macroeconomic Policy: The European Experience, Cambridge University Press, Cambridge.

Collins, S. (1990) **PPP and the Peso Problem: Exchange Rates in the EMS.** In Claassen, E.-M. (ed.): International and European Monetary Systems, Praeger Publishers, New York.

Driffill, J. (1988) **The Stability and Sustainability of the European Monetary System with Perfect Capital Markets.** In Giavazzi, F. - Micossi, S. - Miller, M. (eds.): The European Monetary System, Cambridge University Press, Cambridge, 211-228.

European Monetary Institute: Annual Report 1994, Frankfurt am Main.

European Monetary Institute: Annual Report 1995, Frankfurt am Main

Fratianni, M. - Hagen, J. von (1990a) **German Dominance in the EMS: The Empirical Evidence.** Open Economies Review, Vol. 1, pp. 67-87.

Fratianni, M. - Hagen, J. von (1990b) **The European Monetary System Ten Years After.** In Meltzer, A. (ed.): Unit Roots, Investment Measures and Other Essays, Carnegie-Rochester Conference Series on Public Policy 32, North-Holland, Amsterdam, 173-241.

Gale, D. (1982) **Money: In Equilibrium.** Cambridge. 349.

Giannini, C. (1991) **Topics in Structural VAR Econometrics.** Università degli Studi di Ancona, Ancona.

Giavazzi, F. (1989) **The Exchange-Rate Question in Europe.** Commission of the European Communities, Economic Paper, No. 74.

Giavazzi, F. - Giovannini, A. (1987) **Models of the EMS: Is Europe a Greater Deutsche-Mark Area?** European Economic Review.

Giavazzi, F. - Giovannini, A. (1988) **The Advantage of Tying One's Hands. EMS Discipline and Central Bank Credibility.** European Economic Review, Vol. 32, pp. 1055-1082.

Giavazzi, F. - Giovannini, A. (1989) **Limiting Exchange Rate Flexibility: The European Monetary System.** MIT Press, Cambridge (Mass.)

Giovannini, A. (1988) **How do Fixed-Exchange-Rates Regimes Work?: The Evidence from the Gold Standard.** Bretton Woods and the EMS, Discussion Paper no. 282, CEPR, London.

Grauwe, P. de (1988a) **Is the EMS a DEM-Area?** Working paper, Katholicke Universiteit Leuven.

Grauwe, P. de (1988b) **Is the European Monetary System a DM-zone?** Geld und Währung Working Papers, Nr. 11, Johann Wolfgang Goethe-Universität, Frankfurt am Main.

Green, J. (1996) **Inflation Targeting: Theory and Policy Implications.** IMF Staff Papers, Vol. 43, No. 4, 779-795.

Gros, D. - Thygesen, N. (1992) **European Monetary Integration. From the European Monetary System to European Monetary Union.** Longman, London.

Hagen, J. von (1992) **Policy-Delegation and Fixed Exchange Rates.** International Economic Review, Vol. 33, 849-870.

Hagen, J. von - Fratianni, M. (1989) **Credibility and Asymmetries in the EMS.** Discussion Paper Nr. 432, Indiana University, Indianapolis.

Hagen, J. von - Fratianni, M. (1990) **German Dominance in the EMS: Evidence from Interest Rates.** Journal of International Money and Finance, Vol. 9, pp. 358-375.

Hakkio, C. - Sellon, G Jr. (1994) **Monetary Policy without Intermediate Targets: Federal Reserve Policy since 1983.** Federal Reserve Bank of Kansas City, Nr. 14

Hamilton, J. (1994) **Time Series Analysis.** Princeton.

Herz, B. - Röger, W.W. (1992) **The EMS is a Greater Deutschmark Area.** European Economic Review, Vol. 36, 1413-1425.

Honohan, P. - McNelis, P. (1989) **Is the EMS a DM Zone? - Evidence from the Realignments.** The Economic and Social Review, pp. 97-110.

Hughes-Hallet, A. - Minford, P. - Rastogi, A. (1991) **ERM & EMU - Survival, Costs & Prospects.** Working Paper, no. 93, Fackföreningsrörelsens Institut för Ekonomisk Forskning, Stockholm.

Hughes-Hallett, A. - Minford, P. - Rastogi, A. (1993) **The European Monetary System: Achievements and Survival.** In Bryant, R. - Hooper, P. - Mann, C. (eds.): Evaluating Policy Regimes. New Research in Empirical Macroeconomics, The Brookings Institution, Washington, D.C., 617-670.

Karfakis, C. - Moschos, D. (1990) **Interest Rate Linkages within the European Monetary System: A Time Series Analysis.** Journal of Money, Credit and Banking, Vol. 22, No. 3, pp. 388-394.

Kirchgässner, G. - Wolters, J. (1991a) **Gibt es eine DM-Zone in Europa.** In Siebke, J. (ed.): Monetäre Konfliktfelder der Weltwirtschaft, Duncker & Humblot, Berlin.

Kirchgässner, G. - Wolters, J. (1991b) **Interest Rate Linkages in Europe before and after the Introduction of the European Monetary System.** Working Paper, nr. 9108, Universität Osnabrück.

Koedijk, K. - Kool, C. (1992) **Dominant Interest and Inflation Differentials within the EMS.** European Economic Review, Vol. 36, pp. 925-943.

Kutan, A. (1991) **German Dominance in the European Monetary System: Evidence from Money Supply Growth Rates.** Open Economies Review, Vol. 2, No. 3, pp. 285-294.

Levy, M. (1981) **Factors Affecting Monetary Policy in an Era of Inflation.** Journal of Monetary Economics, Vol. 8, 351-373.

Loureiro, J. (1992) **Foreign Exchange Intervention, Sterilization and Credibility in the EMS.** An empirical Study, Ekonomiska studier, Handelshögskolan vid Göteborgs universitet, 33.

Lütkepohl, H. - Reimers, H-E. (1992) **Impulse Response Analysis of Cointegrated Systems.** Journal of Economic Dynamics and Control, Vol. 16, 53-78.

MacDonald, R. - Taylor, M. (1990) **European Policy Convergence and the EMS.** IMF Working Paper, Nr. 104.

Mastropasqua, C. - Micossi, S. - Rinaldi, R. (1988) **Interventions, Sterilisation and Monetary Policy in European Monetary System Countries, 1979-1987.** In Giavazzi, F. - Micossi, S. - Miller, M. (eds.): The European Monetary System, Cambridge University Press, Cambridge.

Neumann, M. (1996) **Monetary Targeting in Germany.** Bank of Japan, Discussion Paper, E-15.

Pindyck, R. - Rubinfeld, D. (1991) **Econometric Models & Economic Forecasts.** McGraw-Hill, Inc., New York.

Ranki, S. (1996) **Realignment Expectations in the ERM: Causes and Measurement.** Bank of Finland, E:4.

Schulstad, P. - Serrat, Á. (1995) **An Empirical Examination of a Multilateral Target Zone Model.** Banco de España, Discussion Paper nr. 9532.

Svensson, L.E. (1994) **Why Exchange Rate Bands? Monetary Independence in Spite of Fixed Exchange Rates.** Journal of Monetary Economics, Vol.33, 157-199.

Taylor, J. (1996) **Policy Rules as a Means to a More Effective Monetary Policy.** Bank of Japan, Discussion Paper, E-12.

Ueda, K. (1996) **Japanese Monetary Policy. Rules or Discretion?** Bank of Japan, Discussion Paper, E-16.

Weber, A. (1991) **EMU and Asymmetries and Adjustment Problems in the EMS - Some Empirical Evidence.** European Economy, Special Edition No. 1, pp. 187-207.

Welfens, P. (1990) **International Implications of German Monetary Unification.** Unpublished paper prepared for the conference of the American Institute for Contemporary German Studies.

Welfens, P. (1991a) **Creating a European Central Bank after 1992: Issues of EC Monetary Integration and Problems of Industrial Innovation.** In Welfens, P. (ed.): European Monetary Integration. From German Dominance to an EC Central Bank?, Springer Verlag, Berlin.

BANK OF FINLAND DISCUSSION PAPERS

ISSN 0785-3572

1/97 Peter Nyberg **Macroenomic Aspects of Systemic Bank Restructuring**. 1997. 30 p. ISBN 951-686-541-0. (KASI)

2/97 Anne Brunila **Fiscal Policy and Private Consumption – Saving Decisions: Evidence from Nine EU Countries**. 1997. 36 p. ISBN 951-686-542-9. (TU)

3/97 Antti Ripatti **Limited and Full Information Estimation of the Rational Expectations Demand for Money Model: Application to Finnish M1**. 1997. 30 p. ISBN 951-686-543-7. (TU)

4/97 Mika Pösö – Mikko Spolander **Estimating Exchange Market Pressure and the Degree of Exchange Market Intervention for Finland during the Floating Exchange Rate Regime**. 1997. 24 p. ISBN 951-686-544-5. (RP)

5/97 Sinimaaria Ranki **Monetary Policy in the ERM: Internal Targets or External Constraints?** 1997. 62 p. ISBN 951-686-545-3. (TU)