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EMU AND ASYMMETRIES AND ADJUSTMENT PROBLEMS IN THE EMS: SOME EMPIRICAL EVIDENCE

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ABSTRACT

EMU and Asymmetries and Adjustment Problems in the EMS: Some Empirical Evidence*

The paper empirically analyses asymmetries in the EMS with special reference to their implications for the creation of a monetary union (EMU). Two types of asymmetries are analysed: those in the form of 'German dominance' are detected in the conduct of monetary policies in the EMS, in particular when the concept of 'Granger causality' is applied in vector autoregressions using money-market interest rates through which most of the short-term policy impulses are transmitted; and second, asymmetries in the shocks to macroeconomic variables are discussed. Asymmetric real-wage behaviour, important in the context of the optimal currency area literature, and asymmetric current-account behaviour, possibly reflecting the incompatibility of greater exchange rate stability with the underlying relative economic developments, are found to represent potential obstacles to further monetary integration.

JEL classification: 423, 431
Keywords: asymmetric shocks, asymmetric policies, monetary union

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NON-TECHNICAL SUMMARY

This empirical paper aims at analysing adjustment problems and asymmetries in the present European Monetary System (EMS) with special reference to their implications for the creation of the Economic and Monetary Union (EMU). Of course, any empirical work can only be related to the past performance of the EMS and may be of little relevance for the future EMU system if the 'Lucas critique' holds, since according to this the structure of econometric models changes whenever policy in changed. This is likely to be especially true in the case of a fundamental policy change such as the introduction of a monetary union.

A crucial question related to the transition from the present EMS to the EMU concerns the length of the transition period. In this context, the merits of moving immediately to a monetary union with internal exchange rate fixity have to be contrasted with those from the scenario of the Delors Report. It is frequently argued that the preferable scenario depends on the nature of the shocks to the system: a monetary union can optimally deal with external shocks that affect member countries symmetrically, since they require a symmetric policy response; while for predominantly asymmetric shocks, asymmetric policies, such as a realignment, are necessary. In a monetary union, however, the exchange rate is lost as an adjustment instrument, which may be of major importance only if shocks are predominantly asymmetric.

The relevance of this proposition for the present EMS system is examined empirically by applying the Aoki factorization of domestic and foreign variables into independent systems of sums and differences of their national counterparts for a variety of macroeconomic time series. It is found that the behaviour of nominal and real exchange rates, nominal interest rates, relative inflation rates and current accounts has been dominated by symmetric shocks. While the variances of shocks to nominal exchange rate, relative inflation rates and international competitiveness have declined under the EMS, the variance of shocks to external balances has increased. Since current external balances are an important indicator of the compatibility of macroeconomic performances with greater exchange rate stability, this current account externality of the EMS may be a serious obstacle to further monetary integration. It suggests that relative inflation rates and competitiveness have not moved sufficiently in the right direction to avoid imbalances, and may require supplementary asymmetric fiscal or supply-side politics to achieve the necessary reversal of external-balance developments before moving to economic and monetary union.

Second, while during the EMS period relative inflation rates are clearly dominated by symmetric shocks, real wages exhibit a relatively large proportion of asymmetric shocks. This suggests that substantial differences in the degree of wage moderation in response to deflation have remained during the EMS period. In addition, relative unemployment shocks, which prior to the EMS were predominantly symmetrical, are found to be predominantly asymmetrical during the EMS period. This result, however, does not apply to relative unemployment shocks between the former snake participants – Germany, the Netherlands, Belgium and Denmark – which after 1982 experienced predominantly symmetric unemployment shocks and relatively moderate and quite symmetric price and wage inflations. When judged on the basis of these relative labour-market developments, a monetary union between the former snake participants is therefore likely to be achievable at the cost of smaller labour-market distortions. Furthermore, it is shown that asymmetric fiscal policies significantly contributed to asymmetric real-wage behaviour between the three major ERM participants (France and Italy on the one side and Germany on the other). More symmetric real-wage behaviour between these countries is therefore likely to require further harmonization and coordination of fiscal policies.

Third, the predominantly symmetric behaviour of inflation rates is found to coincide with predominantly symmetric domestic demand and supply shocks. The decline in the variability of asymmetric demand and supply shocks during the EMS period is thereby consistent with the general decline of output growth rates and the increased synchronization of business cycles across most industrialized countries. It is important to note that the only asymmetric behaviour of domestic demand shocks is found for Germany and may largely be attributed to the strong performance of the German economy. In addition, this asymmetry in domestic-product demand is not inconsistent with the asymmetry in external demand for German products, which largely explains the massive current-account surplus for Germany. In order to eliminate such asymmetries before moving to economic and monetary union, ERM countries may have to pursue asymmetric domestic policies that improve their price and cost competitiveness.

Finally, relative money-supply shocks are found to be predominantly asymmetric, and money-demand shocks also exhibit a relatively large proportion of asymmetry. It is important to note that these asymmetric shocks would be eliminated under a monetary union with perfect capital mobility and currency substitution. The existence of asymmetric monetary shocks may therefore provide a rationale for further monetary integration since they prevent an efficient international coordination of monetary policies.

Asymmetric monetary shocks may simply be a reflection of asymmetries in the conduct of monetary policy within the EMS, however, where according to the 'asymmetry hypothesis' Germany provides the monetary anchor and all non-German ERM participants decide on the appropriate degree of exchange rate accommodation. The second issue analysed in the paper concerns the symmetric or asymmetric conduct of monetary policies in the EMS, in particular whether or not the EMS has worked like a *de facto* 'DM-zone'. Note that this asymmetry issue has important implications for monetary policy in a future European System of Central Banks (ESCB), with respect to both the status and design of this institution and the formulation of its objectives. In this context it is argued that a stable low-inflation ESCB would, like the Bundesbank, be required to be independent with a binding commitment to avoiding inflation and an explicit ban on monetizing deficits. These prerequisites for the ESCB may be less strict if the present EMS has not worked asymmetrically.

The paper first reviews the existing empirical literature, which recently has criticized the view that the EMS worked asymmetrically. This literature and its empirical evidence from vector autoregressions is then reconsidered with special emphasis on the relevance of the 'Lucas critique'.

Two major findings emerge: first, 'German dominance' in the EMS is not rejected by the data, but the EMS is far from being a 'DM-zone'. In particular, German short-term monetary policy actions, as reflected by interest rate innovations, seem to dominate interest rate policy in the non-German EMS member countries. This is especially true if the short end of the maturity range of interest rates is considered. Second, the paper suggests that the evidence from monetary aggregates, which points towards a symmetric working of the EMS, requires a reinterpretation. It is argued that the asymmetry in the use of sterilized interventions may generate the reversed causality patterns that are frequently found in 'Granger causality' tests of base-money equations. Causality here may merely be an indication of the dominant role of the Bundesbank in the EMS intervention system, given the Bundesbank's preferences for sterilized interventions.

Introduction

This empirical paper aims at analysing adjustment problems and asymmetries in the present European Monetary System (EMS) with special reference to their implications for the creation of the Economic and Monetary Union (EMU). Of course, any empirical work can only be related to the past performance of the EMS and may be of little relevance for the future EMU system if the 'Lucas critique' holds, since according to the 'Lucas critique' the structure of econometric models changes whenever policy is changed. This is likely to be especially true in the case of a fundamental policy change such as the introduction of a monetary union. However, it is beyond the scope of this paper to make quantitative predictions about the effects of policies under the EMU as opposed to the present EMS system. Instead the paper attempts to evaluate some of the standard assumptions underlying those theoretical macro models of the EMS, which in this volume are used to assess the possible costs of moving to a monetary union.

The central assumption of most theoretical macro models of the EMS is the 'asymmetry' assumption with respect to the conduct of monetary policy. In a series of papers Giavazzi and Giavannini (1987, 1988) were the first to articulate the view that the EMS worked asymmetrically.[1] Their proposition was based on the assumption that the EMS was used by high–inflation countries as a credible disinflation device: the commitment to the rules of the EMS and the loss of monetary sovereignty allowed high–inflation countries to borrow counterinflation reputation from the Bundesbank by locking into the German low–inflation monetary policy stance. As a result, so the argument, the EMS worked like a de facto 'DM–zone'. As Wyplosz (1989b) points out, this 'asymmetry' hypothesis enjoys much support among policymakers and analysts because it matches perceptions of how monetary policy has operated in Europe. Furthermore, the 'asymmetry' hypothesis has important implications for monetary policy in a future European System of Central Banks (ESCB), both with respect to the status and design of this institution and with regard to the formulation of its objectives. In this context it may be argued that a stable low–inflation ESCB would, like the Bundesbank, be required to be independent with a binding

[1]See Giavazzi and Giovannini (1987, 1988) and for further references also Giavazzi (1988, 1989), Giavazzi and Pagano (1985, 1988) and Giovannini (1986, 1988a,b).

commitment to avoiding inflation and an explicit ban on monetizing deficits. These prerequisites for the ESCB may be less strict if the present EMS does not work asymmetrically. In this context it is interesting to note that the 'asymmetry' hypothesis has recently been criticized in a number of papers[2], mainly on empirical grounds. This literature is reviewed below and the empirical evidence is reconsidered with special emphasis on the relevance of the 'Lucas critique'.

A second point to be taken up below concerns adjustment and convergence problems, which in recent times have frequently been addressed in the context of whether or not shocks are asymmetrical (country-specific). The argument here is that predominantly symmetric shocks facilitate a faster convergence of the economic performances of EMS member states' economies and that therefore the additional costs of moving to a monetary union can be expected to be smaller the more EMS economies have already converged. This is true for both internal and external shocks. Secondly, external symmetric shocks are likely to have a similar influence on the economic performances of EMS countries participating in the exchange rate mechanism (ERM)[3] and those outside the ERM, which would facilitate a convergence of economic performances between ERM and non-ERM countries. It may therefore be stated that under predominantly symmetrical external shocks the transition phase from the present EMS to EMU is likely to be shorter. This is of relevance because during the transition process, which according to the 'Delors report' should precede the irrevocable fixing of nominal bilateral exchange rates, the participation in the ERM is to be extended to all EMS currencies and the fluctuation bands of exchange rates are to be reduced to a narrow range, whilst at the same time realignments are to be made less frequent. However, under asymmetrical external shocks and divergent economic

[2]See De Grauwe (1989), Fratianni and von Hagen (1989a,b,c) and Cohen and Wyplosz (1989).

[3]At the onset of the EMS in March 1979 the ECU currency basket included, with the December 1989 relative weights indicated in brackets, the currencies from the EMS countries Belgium (7.6%), Denmark (2.45%), France (19.0%), the Federal Republic of Germany (30.1%), Ireland (1.1%), Italy (10.15%), Luxembourg (0.3%) and the Netherlands (9.4%) as well as that of the United Kingdom (13.0%), which was a member of the European Community, but did not participate in the exchange rate mechanism (ERM) of the EMS. In September 1984 the ECU basket was expanded to include the Greek drachma (0.8%) and in September 1989 the Spanish peseta (5.3%) and Portugese escudo (0.8%). Of these three countries only Spain currently participates in the ERM.

performances the economic costs of this transition period and hence the incentives to participate in a monetary union may differ drastically between both groups of EMS countries. Finally, note that asymmetrical shocks, regardless of whether internal or external, are not optimally dealt with by a monetary union since they require an asymmetrical policy response. Under predominantly asymmetrical shocks the loss of realignments as the prime asymmetrical monetary policy instrument may therefore imply high economic costs, despite the fact that in a monetary union asymmetrical fiscal policies can potentially substitute for realignments. To evaluate the relevance of these arguments the performance of key economic variables in EMS countries is studied empirically. However, it should be kept in mind that, the nature of shocks to the system may also be heavily regime–dependent and may therefore change fundamentally with the move to economic and monetary union.

The paper is organized as follows: asymmetries in the shocks to economic variables are discussed and quantified empirically in the first section of the paper for those countries participating in the ERM of the EMS from the beginning. In the second section 'asymmetries' in the conduct of monetary policy, frequently addressed under the heading of 'German dominance in the EMS', are analysed by applying vector autoregressions to a number of alternative definitions of national interest rates and monetary aggregates. Finally, some suggestions for further research conclude the paper.

1. Are Shocks Asymmetrical and External?

A crucial question related to the transition from the present EMS to the EMU concerns the length of the transition period. In this context the merits of moving immediately to a monetary union with internal exchange rate fixity have to be contrasted with those from the scenario of the 'Delors report'. In the paper by David Begg, which analyses the dynamics of output, prices, wages and interest rates under both the present EMS with partial exchange rate accommodation and the EMU with exchange rate fixity, it is argued that the answer as to which scenario is preferable depends on the nature of the shocks to the system: firstly, note that monetary union optimally deals with symmetric shocks, since such shocks – to the extent that they have some degree of persistence – require a symmetric policy response which may take the form of a co-ordinated aggregate policy for the fixed exchange rate zone as the whole. Conversely, to smooth out the effects of predominantly asymmetrical persistent shocks an asymmetrical policy response is preferable. In fixed but adjustable exchange rate systems like the EMS a prominent form of such an asymmetrical monetary policy response is a realignment, which in the EMS have primarily been used to incompletely compensate for cumulated inflation differentials. Note that under a monetary union with irrevocable exchange rate fixity the nominal exchange rate is lost as an adjustment instrument and differential (asymmetrical) monetary policy is not defined. It this case differential fiscal policy will have to supplement relative price variability to ensure that more than one type of asymmetric shocks can optimally be dealt with.

In attempting to provide empirical evidence on the relative importance of asymmetrical versus symmetrical shocks in the EMS, Cohen and Wyplosz (1989) apply the Aoki factorization of domestic variables (y_t) and foreign variables (y_t^*) into independent (+) and (–) systems and estimate the variabilities of the transitory and permanent components of the asymmetric ($y_t - y_t^*$) and the symmetric ($y_t + y_t^*$) system in order to determine which type of shocks has dominated in the past. Looking at real GDP, real wages and price levels in France and Germany Cohen and Wyplosz (1989) derive that shocks are predominantly symmetric, and that symmetric shocks tend to be more permanent than transitory. This suggests that the nature of shocks found in these time series from France and Germany are not inconsistent with the rationale of a monetary union between these two countries.

Before presenting any estimates on the relative importance of asymmetric versus symmetric shocks some remarks on the problems related to such evidence are in order. Firstly, since shocks are typically defined as the unpredictable component of a time–series, results may differ substantially depending on which model is used for quantifying the predictions. However, much of these differences between the residuals of alternative prediction models may cancel out when these residuals are aggregated over time by calculating their standard deviations, which in the present paper are used to compare the relative size of shocks. Furthermore, there are in general no substantial qualitative differences between the results derived from using standard deviations of residuals and standard deviations of the actual variables, given that the underlying series are stationary or transformed to achieve stationarity. This simply reflects the fact that less erratic time series (low variance) are more easily predicted (low error variance). I therefore follow Cohen and Wyplosz (1989) in using the standard deviations of the sums and differences of selected economic variables as proxies for the variability of symmetric and asymmetric shocks. Secondly, it is important to note that an asymmetric policy response to perfectly symmetrical external shocks, such as the oil price shocks which hit all countries alike, may also account for the asymmetrical behaviour of macroeconomic time series.[4] In this context a monetary union which eliminates differential monetary policies in responses to common symmetric shocks is likely to eliminate the asymmetric behaviour of these time series. Finally, Cohen and Wyplosz (1989) argue that the only variable which is delivered optimally in a monetary union is the price level (or the inflation rate). The immediate benefits from monetary union are therefore likely to be small if price levels (or inflation) shocks are predominantly symmetrical and prices (or inflation rates) have already converged to a large extent during the EMS period. In addition, the immediate economic costs of irrevocably locking parities may also be minor under predominantly symmetrical exchange rate shocks. These two propositions will be discussed first before turning to asymmetries in shocks to other economic variables which may be potentially relevant for the transition to monetary union.

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[4]It is argued in Fisher (1988) that the post 1979 recessions in the United States and Europe as opposed to Japan may be attributed to a differing degree of monetary accommodation of the common oil price shock.

1.1. Asymmetries in Exchange Rate Shocks

In order to judge the importance of asymmetric nominal exchange rate shocks two concepts of exchange rate variability are distinguished. *Internal variability* is related to the variability of exchange rates between ERM currencies (group 1). Note that the exchange rate mechanism with its bilateral parity grid, intervention limits and divergence indicator precisely aims at eliminating this source of exchange rate variability. An important second definition of exchange rate variability is related to *external variability*, and here I make a distinction between the variability of exchange rates between ERM countries and other European Community (EC) but non–ERM countries (group 2) on the one hand, and non–EC countries on the other (group 3). In comparing the variability of exchange rates between countries in these groups it should be possible to identify whether exchange rate shocks are symmetrical or asymmetrical and whether they are likely to be internal or external.

In drawing inference on the internal/external issue I concentrate on the short–term variability of exchange rates, as reflected in the month to month variations in exchange rates. Since exchange rates typically follow non–stationary time–paths, I use the standard deviation of the change (Δ_1) in the logarithm of the exchange rate relative to the month before as a measure of such short–term fluctuations. Note that if bilateral nominal exchange rates follow random walk time series processes, as frequently postulated in the empirical literature, this measure of exchange rate variability serves as a proxy for short–term unexpected exchange rate movements, as stressed by Ungerer et al. (1986). Such short–term unexpected fluctuations of exchange rates are of importance since they may – as discussed in the paper by Richard Baldwin in this volume – involve serious real costs, despite the fact that some of the risk involved can be hedged.

1.1.1. Asymmetries in Nominal Exchange Rate Shocks

The nominal exchange rate stabilization effects of the EMS have been frequently studied in the literature. Early studies, for example van Ypersele (1984) or Ungerer et al. (1983, 1986), have found that the unconditional variances of various definitions of nominal exchange rates, both bilateral and effective, were much lower within the group of ERM countries than for countries outside of the ERM. In addition, Ungerer et al. (1983) report that exchange rate variability declined among ERM currencies, but increased among non–ERM currencies as well as between ERM and non–ERM currencies. A similar conclusion was reached by Rogoff (1985) using conditional variances of nominal exchange rates and by Artis and Taylor (1988), using a variety of statistical procedures and exchange rate definitions. Lately these findings were supplemented by Wyplosz (1989b) using effective (MERM) and nominal exchange rates. He concludes that effective exchange rate variability did not, on average, decline more for ERM currencies than for the non–ERM ones.

In the empirical analysis I focus on sixteen OECD countries, which, as indicated above, constitute three groups: the first group (G1) consists of the countries which had been participating in the ERM from the onset of the EMS (Germany, France, Italy, the Netherlands, Belgium/Luxembourg, Denmark and Ireland), while the second group (G2) includes the remaining EC member countries (United Kingdom, Greece, Spain, Portugal), some of which joined the ERM at a later point in time (Spain). Finally I consider a number of non–EC countries, both smaller European countries (Switzerland, Austria) and three major non–European countries (United States, Canada, Japan), which are summarized as a third group (G3).

The results for short–term exchange rate variability are shown in Table 1, which reports the standard deviation of the change in the logarithm of the nominal bilateral spot exchange rates relative to the month before. The estimates for the bilateral rates in the upper part of the table are supplemented by unweighted averages of these variability measures for each currency with respect to the currencies of the three groups (G1,G2,G3) in the lower part of the table. The numbers below the diagonal in the upper part of Table 1 suggest a clear rating of the degree of short–term exchange rate variability during the EMS period[5]:

[5]In order to test the significance of the change in the variance of exchange rates between the pre–EMS and the EMS policy regime with the Goldfeld–Quandt (1965) homoscedastisity F–test, the sample has to be subdivided into two equally long sub–samples. The pre–EMS phase (August 1971–February 1979) starts with the closing of the gold window at the U.S. Treasury in August 1971, which formally ended the Bretton–Woods system. The corresponding sample period chosen for the EMS (February 1982–August 1989) explicitly allows for a transition period by ommitting some of the early EMS observations, which at the same time serves to accentuate any differences in the variances of both regimes.

(a) changes in the bilateral nominal exchange rate exhibit the lowest variance within the ERM group. The variability measure declines for all but two bilateral exchange rates, which are the Dutch guilder's (hfl) rate relative to both the Belgian–Luxembourg franc (bfr) and the Danish krona (dkr). Note that since these three currencies participated together with the German mark in the pre–EMS snake arrangement, the onset of the EMS in March 1979 did not represent a fundamental policy regime switch. This view is supported by two facts: firstly, the pre–EMS variability of exchange rates amongst these countries was already very low, and secondly, the identical fluctuation margins of 2.25 percent in both systems implied no additional stabilization effects. Another strong result in Table 1 is that the decline in variability of intra–ERM exchange rates is statistically significant at the one percent level for all currencies with the exception of the Irish pound/Italian lira (Ir£/Lit) rate.[6] The only statistically significant increase in the variance of medium–term exchange rate changes is found for the Dutch guilder/Belgian–Luxembourg franc (hfl/bfr) rate. Again this result is not surprising given that the Benelux countries during the early snake arrangement adopted a narrower bilateral fluctuation margin of 1.5 percent, which in March 1976 was expanded to 2.25 percent. Finally, exchange rate variability relative to the average of ERM currencies falls for all ERM countries, with the smallest decline being found for the Belgian/Luxembourg franc. Summarizing these findings, it can be stated that asymmetric exchange rate shocks appear to be of minor importance for the intra–ERM exchange rates and are almost eliminated in the EMS period for the German–Dutch (hfl/DM) bilateral exchange rate.

(b) The variability of exchange rates between the ERM countries and the remaining EC countries in Table 1 is systematically higher than the variability within the ERM. A decline in the variance of medium–term exchange rate changes is only found for the Spanish peseta (Ptas) and the Portugese escudo (Esc) which were subject to extreme fluctuations prior to the EMS. In the latter case all variance reductions are significant at the one percent level. For the British pound sterling (UK£) and the Greek drachma (drc) the variance of bilateral ERM exchange rates increases during the EMS period, for the latter significantly in most cases. This divergence of exchange rate performances of

[6]This result is dominated by the two large unilateral realignments of the Italian lira in July 1985 (–7.7% of ECU parity) and the Irish pound in August 1986 (–6.8 % of ECU parity).

ERM and non–ERM currencies points towards potentially high costs in the transition period to monetary union. Furthermore, given that non–ERM exchange rate variability during the EMS is – on average – higher than the pre–EMS exchange rate variability of the ERM currencies, the transition period may endure for some time.

(c) The variance of ERM currencies with respect to the U.S. Dollar (US$) increases significantly during the EMS period in all cases. This is largely due to the Federal Reserve's policy of 'benign neglect' for the exchange rate, but also reflects the fact that for the ERM currencies emphasis was placed primarily on *internal* as opposed to *external* exchange rate stabilization. Due to its close link with the U.S. dollar the above result also applies for the majority of exchange rates relative to the Canadian dollar (Can$). With respect to the Japanese Yen (Y), Swiss franc (sfr) and Austrian shilling (S) the variance of ERM exchange rates declines in many cases, frequently significantly. For the latter two countries these results may be explained by the close links which these countries traditionally have to Germany and, for Austria, by the existence of implicit exchange rate targets relative to the German mark. For the Japanese yen the decline in exchange rate variability relative to ERM currencies may partly be attributed to the increased coordination of foreign exchange market interventions among G7–countries after the Plaza agreement.

Table 1 therefore strongly supports the view that the EMS over the past decade was successful in reducing *internal* medium–term exchange rate variability, whilst at the same time not systematically affecting the *external* variability of ERM currencies. With respect to the issue of asymmetric shocks it can be argued that for nominal intra–ERM exchange rates asymmetric shocks are less important during the EMS period as opposed to the pre–EMS period. This is not true for the four non–ERM currencies of the EMS, where for the United Kingdom and Greece the size of asymmetric exchange rate shocks is found to have increased significantly.

A second important issue with respect to exchange rates is whether or not the EMS has recently tightened, in which case nominal exchange rates should have been stabilized significantly in the more recent EMS period. The results for nominal exchange rate variability are presented in Table 2, where the estimates of the short–term variability of bilateral rates above the diagonal are supplemented by the results for the medium–term variability, defined as the change of the logarithm of the spot exchange rate relative to the same month of the year before, and reported below the diagonal. The upper (lower) numbers indicate the unconditional standard deviation of exchange rate changes in the early (late) EMS for a sub–division of the sample into two equally long sub–samples (79M3–84M5, 84M6–89M7). It is found that short–term exchange rate variability is significantly reduced for all combinations of bilateral rates between Germany, France, the Netherlands and Belgium. Furthermore, an increased short–term variability is reported for most bilateral exchange rates involving Italy, Denmark and Ireland, whereby only for Ireland is this increase statistically significant. Note that this result depends largely on the massive devaluation of the Irish pound in the January 1987 realignment. Medium–term exchange rate variability is significantly reduced for all bilateral exchange rates between Germany, France, the Netherlands, Belgium and Denmark, but increases insignificantly for most Italian rates and significantly for all Irish bilateral exchange rates. Thus, with the exception of the Irish case, the hypothesis that the EMS has recently tightened is not rejected by the data.

1.1.2. Asymmetries in Real Exchange Rate or Competitiveness Shocks

Eliminating nominal exchange rate shocks, as achieved under a monetary union, will also tend to eliminate the variability of real exchange rates if asymmetrical price variability is of minor importance. The evidence on the stabilization effects of the EMS on real exchange rates, calculated by using monthly consumer price indices, is reported in Table 3 for a medium–term variability measure, defined as the standard deviation of bilateral real exchange rates relative to the same month of the year before.[7] Compared to the results for nominal bilateral exchange rates in Table 1, these findings are more homogeneous within the ERM group, although the reduction of real exchange rate variability is again not significant for some of the pre–EMS snake participants and increases significantly for the intra–Benelux rate. With respect to the non–ERM ECU currencies in group 2 and the non–EC currencies in group 3 the reduction of real as opposed to nominal exchange rate variability is less frequently statistically significant. This suggests that under the EMS asymmetrical internal competitiveness shocks were

[7]This stationarity transformation was chosen to ensures the independence of the results from cross–country differences in the seasonality patterns of the monthly price data.

considerably smaller than prior to the EMS, whilst for the bilateral rates with respect to the United Kingdom, the United States, Canada and Japan such a reduction in the variability of asymmetrical competitiveness shocks is not found.

1.2. Asymmetries in Inflation Shocks

The empirical evidence on asymmetrical inflation shocks, as measured by the standard deviation of relative consumer price inflation rates $(\pi_t-\pi_t^*)$ is summarized in Table 4. The decline in the variability of relative inflation shocks between ERM countries during the EMS period is significant at the one percent level in all cases. However, as reported earlier by Rogoff (1985), Ungerer et al. (1986) or Collins (1987), there is little difference between ERM and non–ERM countries, and most inflation differentials have declined significantly. Secondly, it is obvious from Table 4 that unlike in the case of nominal and real exchange rates the standard deviations of these asymmetrical inflation shocks vary considerably among ERM currencies, suggesting that at least part of the inflation shocks are country specific.

This hypothesis is investigated more formally by applying the Aoki factorization of national inflation rates into sums $(\pi_t+\pi_t^*)$ and differences $(\pi_t-\pi_t^*)$ and testing for the significance of the reduction of the variances of both components. These results are reported in Table 5 using quarterly instead of monthly consumer price inflation data. Inflation shocks are found to be predominantly symmetric with the exception of the German–Italian case in the pre–EMS period (71Q3–78Q4), where asymmetrical shocks slightly dominate the symmetrical ones. Furthermore, with the exception of the Danish–French and Danish–Italian cases, the variance of asymmetrical inflation shocks has been significantly reduced under the EMS regime. At the same time, however, the variance of symmetrical inflation shocks declined significantly only for inflation differentials relative to Ireland and increased significantly in the French–German case. The success of the EMS countries in reducing inflation differentials, as reported in Table 3, can therefore largely be attributed to their success in reducing the variability of asymmetrical inflation shocks. Finally, Tables 4 and 5 reveal that during the EMS period asymmetrical inflation shocks have been smaller in size between Germany, the Netherlands, Denmark and Belgium than between these countries and France, Italy or Ireland, implying that further monetary integration between the former snake participants is likely to involve smaller economic costs.

1.3. Asymmetries in Money Demand and Money Supply Shocks

An issue closely related to the above relative inflation shocks is that of relative monetary shocks. Tables 6 and 7 report the results for relative money supply shocks, approximated by the monetary base growth differentials, and relative money demand shocks, approximated by real money growth (M1/P) differentials.

A first result from Table 6 is that with the exception of Denmark[8] the variance of asymmetric money supply shocks has been significantly reduced between all ERM countries during the EMS period. This also applies to the majority of symmetrical money supply shocks, which have been reduced drastically. As a result, money supply shocks, which prior to the EMS were relatively large and predominantly symmetrical have become relatively small and predominantly asymmetrical during the EMS. Note that a monetary union, which would eliminate these asymmetrical money supply shocks, may therefore be desirable on these grounds.

According to Table 7 the variance of both symmetrical and asymmetrical real money demand shocks has been significantly reduced in the German–Italian case and in all cases involving France and Ireland, which exhibited relatively large variances prior to the EMS. Furthermore, there is no significant change in the variability of relative money demand shocks between the former snake participants Germany, the Netherlands, Belgium and Denmark. Finally, during the EMS the variabilities of asymmetric and symmetric money demand shocks are almost equally high in most cases, suggesting that the asymmetric effects of money supply shocks have been largely offset by the symmetric effects of relative price shocks. Again, a monetary union, which would render national currencies perfect substitutes and eliminate the asymmetric component of money demand shocks, may thus be desirable.

[8]This result for Denmark is due to the fact that the data used in this paper are not adjusted for the institutional changes in Danish monetary policy in the recent years. See also Fratianni and von Hagen (1989c) on this point.

1.4. Asymmetries in Nominal and Real Interest Rate Shocks

The above evidence on asymmetric monetary shocks, which have important implications for medium-term conduct of monetary policy, has to be supplemented by evidence from interest rates, through which short-term monetary policy is operated. Both relative shocks to short-term money market rates and long-term government bond yields are considered.

For short-term call money interest rates Table 8 reports a significant reduction in the variability of both symmetrical and asymmetrical interest rate shocks for all countries except France and Ireland, where the decline in variability is not significant in some cases. Table 8 also indicates that nominal interest rate shocks between ERM countries have been predominantly symmetric prior to the EMS, with the only exception being the German-Italian and German-Danish interest rate differentials. During the EMS period all interest rate shocks are predominantly symmetrical, and asymmetrical shocks are found to be relatively small in size in most cases. The elimination of the asymmetric component of interest rate shocks under a monetary union may therefore be expected to affect the overall behaviour of short-term interest rates to only a limited extent.

For long-term nominal interest rates in Table 9 the variance of asymmetrical shocks in relation to Germany has been reduced for all ERM countries, and with the exception of France this reduction is statistically significant. A significant increase in the variability of asymmetrical shocks to long-term interest rates is found for the Dutch-French and Dutch-Belgian interest rate differentials, whilst at the same time asymmetric shocks relative to Germany almost disappear. A second important result from Table 9 is that the variability of symmetrical shocks to long-term interest rates declines in none of the cases significantly, but increases significantly in eight cases, mostly in relation to Italy, Belgium and Denmark. Both results together imply that during the EMS period shocks to long-term interest rate differential are predominantly symmetric for all countries. Again, the elimination of the asymmetric component of these shocks may have only minor effects on the overall behaviour of long-term interest rates, in particular since shocks to long-term rates are more symmetrical than shocks to short-term interest rates.

With both nominal interest rates and inflation rates being dominated by symmetrical shocks during the EMS period, real interest rates, approximated here by the difference between a three-month interest rate and the inflation rate over this time span, may also be expected to be dominated by symmetrical shocks. However, Table 10 reveals that during the EMS period this has not been the case in Ireland with respect to shocks to real interest rates, which are found to be predominantly asymmetrical.[9] This asymmetry is likely to be caused by the sharp Irish post-1982 deflation in excess of the nominal interest rate decline. This may also be seen from the highly significant decline in the variances of both symmetrical and asymmetrical real interest rate shocks, which again is more marked for Ireland than for the remaining ERM countries.

1.5. Asymmetries in Domestic Demand and Supply Shocks

Tables 11 and 12 report the results for relative supply shocks, approximated by the differentials in the growth of industrial production indices, and relative demand shocks, approximated by the differentials in the growth of retail sales volume indices.

A first result from Table 11 is that there is a significant decline in the variability of symmetrical relative supply shocks in the majority of cases (18 out of 21), which reflects the general decline in output growth rates in the 1980's relative to the 1970's also reported in Baxter and Stockman (1989). Furthermore, the variability of asymmetrical relative supply shocks increases in two cases (France-Netherlands and Germany-Ireland) and declines significantly in eight cases (mostly relative to Italy and Belgium). Finally Table 11 indicates that relative supply shocks between ERM countries have been predominantly symmetric both prior to the EMS and during the EMS.[10] Note that this dominance of symmetrical relative supply shocks does not indicate any immediate need for asymmetrical fiscal stabilization policies under a monetary union.

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[9]This strong asymmetry in real interest rates between Ireland and the remaining EMS member countries is also reported in Dornbusch (1989), Figure 6, page 187.

[10]This result holds for all countries except Denmark, where due to data problems the production index used is defined for animal products only (source: OECD Main Economic Indicators), whilst for all other countries the index of total industrial production is used.

In Table 12 the variability of the proxy for symmetrical domestic aggregate demand shocks declines significantly in eight cases and increases significantly only in one case (Germany–Netherlands). Furthermore, the variability of asymmetrical demand shocks declines in twelve cases and increases in three cases (France, Belgium and Denmark relative to Germany). Finally, during the EMS period aggregate demand shocks are – with the exception of the Netherlands – predominantly asymmetrical in relation to Germany and predominantly symmetrical between the remaining ERM countries. The existence of such asymmetrical domestic demand shocks may therefore require asymmetrical fiscal stabilization policies under a monetary union.

1.6. Asymmetries in Real Fiscal Expenditure Shocks

Since in a monetary union the only potentially asymmetrical policy is fiscal policy, it is of interest to analyse to what extent fiscal policy over the past has been dominated by symmetrical or asymmetrical shocks, here approximated by changes in real government expenditure. Table 13, which contains the evidence on this point, reveals that the decline in variability of both symmetrical and asymmetrical fiscal shocks during the EMS period is only significant in some of the cases involving Italy or Ireland. Furthermore, predominantly asymmetrical fiscal shocks are found only between Germany on the one side and France and Italy on the other, but the degree of asymmetry between the latter countries and the remaining ERM countries is also relatively high. In absolute numbers fiscal shocks in relation to France are thereby relatively small, but relatively large in relation to Italy, Belgium and Ireland. For these countries further fiscal stabilization, that is a reduction of government spending which largely reduces the need for future tax revenues and inflationary finance, may therefore be called for in the transition to monetary union.

1.7. Asymmetries in Real Wage and Unemployment Shocks

The relative developments of national labour markets during the EMS period are examined in Tables 14 for real wage growth differentials and in Table 16 for unemployment differentials.

In Table 14 the variability of asymmetrical real wage shocks between ERM countries has declined significantly in 15 (out of 21) cases and increased significantly in four cases. On the other hand, the variability of symmetrical real wage shocks has declined significantly in ten cases and increased significantly in three cases. At the same time, a significant increase in the variance of both symmetrical and asymmetrical real wage shocks is found in the German–French, German–Belgian and French–Belgian cases. A combination of national differences in the degree of automatic wage–indexation scheme (Belgium), price controls (France) and trade union bargaining behaviour (Germany) is likely to account for this divergence of real wages. This view is supported by the fact that real wage shocks during the EMS period are predominantly asymmetrical between France, Italy and Belgium on the one side and Germany as well as Ireland on the other side. Also note that the only cases where asymmetrical real wage shocks are small both in absolute size and in relation to symmetrical real wage shocks are given by the German–Dutch–Danish combinations of real wage growth differentials. This suggests that the wage–price mechanism between these three countries are similar in structure, and that for the remaining ERM countries asymmetries in wage–price adjustments may increase as the EMS moves toward monetary union.

Since real wages – together with real interest rates – are important from the point of view of optimal currency area theory, it may be informative to check whether the symmetrical or asymmetrical real wage behaviour is 'Granger caused' by symmetrical or asymmetrical monetary or fiscal policies.[11] The evidence from vector autoregressions of changes in real wages on four own lags and four lags of a monetary policy variable (change in real base money growth) or a fiscal policy variable (change in real government expenditure) is reported in Table 15 and may be summarized as follows: asymmetrical real wage behaviour between France on the one side and Germany and the Netherlands on the other is 'Granger caused' by both asymmetrical fiscal and monetary policy, whilst between Italy and the latter countries only asymmetrical fiscal policy matters. Asymmetrical fiscal policy also significantly contributes to explaining asymmetrical real wage behaviour in the German–Belgian case, and for most cases in relation to Denmark asymmetrical monetary policy matters. The latter result may be explained by the fact that the Danish monetary policy reforms in 1985 coincided with a strong government interference in the two–year wage negotioations by enforcing strict upper–limit for wage increases. With respect to European monetary integration

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[11]A more detailed description of the concept of 'Granger causality' and its econometric application in vector autoregressions are given in section 2 below.

Table 15 suggests that the elimination of asymmetrical monetary policies under a monetary union may contribute to reducing some of the real wage asymmetries between ERM countries. However, in the French, Italian and Belgian cases relative to Germany a further harmonisation of fiscal policies appears to be at least equally as important in order to reduce real wage asymmetries.

The above evidence on labour market asymmetries as reflected in real wage asymmetries is supported by the evidence from Table 16 regarding relative unemployment shocks between ERM countries. Note that unemployment shocks, which between all countries were predominantly symmetrical prior to the EMS, have remained symmetrical between the former snake participants Germany, the Netherlands, Belgium and Denmark, but have become primarily asymmetrical between these countries and France, Italy and Ireland. This is due to the fact that in the former snake group the variability of both asymmetrical and symmetrical unemployment shocks has been reduced significantly. However, for the remaining countries only the variance of symmetrical unemployment shocks has been reduced significantly, whilst the variances of asymmetrical unemployment shocks have remained unchanged or have increased significantly. Therefore, to the extent that political action in response to unemployment shocks is concerned to be desirable, the above results may point towards a need for asymmetrical fiscal stabilization policies in a monetary union.

1.8. Asymmetries in External Balance or Current Account Shocks

The final point to be considered here concerns relative external balance or current account shocks between ERM countries. The evidence for differentials of current account indices (71Q2=100) in Table 16 suggests that during the EMS period the variability of both symmetrical and asymmetrical shocks to external balances has significantly increased. Furthermore, whilst current account shocks in the majority of cases are predominantly asymmetrical in the pre–EMS period, they tend to be more symmetrical during the EMS period. This is due to the fact that, on average, the variance of symmetrical current account shocks increased by a larger proportion than the variance of asymmetrical shocks. This increased variability and divergence between the external accounts of ERM countries represents a potential source of instability within the exchange rate mechanism and realignments in the period up to monetary and economic union may be crucial for the reversal of the process. This is supported by the fact that both real exchange rate (competitiveness) shocks and relative domestic supply shocks are found to be predominantly symmetrical and therefore are unlikely to contribute to a reversal of current account developments.

1.7. Summary and Conclusions

In this chapter it has been argued that in the transition period to economic and monetary union the loss of the nominal exchange rate as a policy instrument is of major importance only to the extent that relative shocks are predominantly asymmetrical. The relevance of this proposition for the present EMS system has been examined empirically by applying the Aoki factorization of domestic and foreign variables into independent systems of sums and differences of their national counterparts for a variety of macroeconomic time series. The findings from this analysis are summarized below.

Firstly, the behaviour of nominal and real exchange rates, nominal interest rates, relative inflation rates and current accounts has been dominated by symmetrical shocks. However, whilst the variances of shocks to nominal exchange rate, relative inflation rates and international competitiveness have declined under the EMS, the variance of shocks to external balances has increased. Since current external balances are an important indicator of the compatibility of macroeconomic performances with greater exchange rate stability, this current account externality of the EMS is a serious obstacle to further monetary integration. Furthermore, it suggests that relative inflation rates and competitiveness have not moved sufficiently in the right direction to avoid current account imbalances, and supplementary asymmetrical fiscal or supply side politics may be needed to achieve the necessary reversal of current external balance developments before moving to economic and monetary union.

Secondly, whilst during the EMS period relative inflation rates are clearly dominated by symmetrical shocks, real wages exhibit a relatively large proportion of asymmetrical shocks. This suggests that substantial differences in the degree of wage moderation in response to deflation have remained during the EMS period. In addition, relative unemployment shocks, which prior to the EMS were predominantly symmetrical, are found to be primarily asymmetrical during the EMS period. This result, however, does not apply to relative unemployment shocks between the former snake participants Germany, the Netherlands, Belgium and Denmark, which after 1982 experienced predominantly symmetrical unemployment shocks and relatively moderate and quite symmetrical price and wage inflations. When judged on the basis of these relative labour market developments a monetary union between the former snake participants is therefore likely to be achievable at the cost of smaller labour market distortions. Furthermore, it has been shown that asymmetrical fiscal policies significantly contributed to asymmetrical real wage behaviour between the three major ERM participants (France and Italy on the one side and Germany on the other). More symmetrical real wage behaviour between these countries is therefore likely to require further harmonization and coordination of fiscal policies.

Thirdly, the predominantly symmetric behaviour of inflation rates is found to coincide with predominantly symmetric domestic demand and supply shocks. The decline in the variability of asymmetrical demand and supply shocks during the EMS period is thereby consistent with the general decline of output growth rates and the increased synchronization of business cycles across most industrialized countries. It is important to note that the only asymmetrical behaviour of domestic demand shocks is found for Germany and may largely be attributed to the strong performance of the German economy. In addition, this asymmetry in domestic product demand is not inconsistent with the asymmetry in external demand for German products, which largely explains the massive current account surplus of Germany. To eliminate such asymmetries before moving to economic and monetary union ERM countries may have to pursue asymmetric domestic policies which improve their price and cost competitiveness.

Finally, relative money supply shocks are found to be predominantly asymmetrical, and money demand shocks also exhibit a relatively large proportion of asymmetry. It is important to note that these asymmetrical shocks would be eliminated under a monetary union with perfect capital mobility and currency substitution. The existence of asymmetrical monetary shocks may therefore provide a rationale for further monetary integration since they prevent an efficient international coordination of monetary policies. However, asymmetrical monetary shocks may simply be a reflection of asymmetries in the conduct of monetary policy within the EMS, where according to the 'asymmetry' hypothesis Germany provides the monetary anchor and all non–German ERM participants decide on the appropriate degree of exchange rate accommodation. The empirical relevance of these arguments is discussed in the following section.

2. Structural Asymmetries and the 'Lucas Critique'

According to the famous 'Lucas critique' the structure of econometric models is in general not invariant to changes in policy objectives, operating procedures, or policy constraints over time, especially if these models incorporate the optimal decision rules of economic agents, which are conditional on policy actions. Changes in policies will therefore typically alter the structure of such econometric models. In other words, the structural parameters of these models are policy variant, meaning that they will change whenever policy is changed. As a result, reduced form econometric models, which are frequently used for quantitative policy evaluation, tend to exhibit structural breaks if policy changes are of the once-and-for-all type, or, more generally, will have parameters which vary over time and follow deterministic or stochastic processes that may be either stationary (random) or non-stationary (random-walk) processes. In the latter case, as emphasized by Lucas (1976), even small standard errors of short-term policy projections do not rule out the possibility of an infinitely large variance of forecast errors in the long-run and hence render such models useless for a quantitative assessment of long-run policy effects.

The above type of policy induced structural change of reduced form econometric models has so far received little attention in studies of the European Monetary System (EMS). Two major reasons account for this: firstly, quantitative research on the EMS has only just begun since it is only recently that a sufficient number of observations has become available. Secondly, the majority of empirical work on the EMS is conducted by estimating single reduced form equations which frequently are postulated ad hoc rather than being explicitly derived from a structural economic model; hence the influence of policies on the structural parameters of these reduced form models is unclear and not directly testable. However, this does not imply that the 'Lucas critique' is irrelevant for these models.

The above point may be illustrated by referring to the paper of David Begg in this volume, which analyses the dynamics of output, prices, wages and interest rates under two versions of the present EMS, characterized by partial exchange rate accommodation in connection with 'German leadership', and a monetary union, defined as irrevocable nominal exchange rate fixity under a common monetary policy. For the simplified case of a two-country EMS the endogenous variables in the reduced forms of the non-centre country depend - in addition to their own past history - on the corresponding variables of the centre country. However, the reverse does not hold since the endogenous variables in the centre country depend only on their own past history. Furthermore, the coefficients of the centre country's lagged variables in the non-centre country's reduced form depend negatively on the degree of exchange rate accommodation, and hence decline as the EMS progressively tightens on the road to monetary union. This type of policy induced structural change highlights the relevance of the 'Lucas critique' for the EMS, in particular if vector autoregressive representations of economic models are estimated without identifying parameter restrictions. The empirical estimates below are, however, derived from such atheoretical vector autoregressions, primarily because all empirical evidence available to date on 'symmetry' versus 'asymmetry' in the EMS is based on these models. However, the focus of the analysis is on the structural stability of the estimates with special reference to potentially policy induced structural change, which may serve to illustrate the limitations of the econometric evidence on 'asymmetries' in the EMS provided to date.

2.1. Asymmetries and Monetary Policy Interactions

The empirical implications of the **'asymmetry' hypothesis** may be described as follows: given that the transmission of monetary policy impulses both within and between economies is sluggish and frequently involves long lags, the policy variables in the non-centre EMS countries should, in addition to their own history, also depend on the history of the corresponding policy variables of the centre country. However, the reverse does not hold and the policy variables in the centre country should only depend on their own history if monetary policy is set independently. Conversely, under the competing **'symmetry' hypothesis** of the EMS policy variables in both countries should only depend on their own history, and causality relations should not exist. Therefore, the 'asymmetry' hypothesis of the EMS may be tested econometrically by employing the concept of uni-directional 'Granger causality' between domestic and foreign variables.

Empirically such 'Granger causality' test are carried out by running two sets of independent vector autoregressions for domestic variables (y_t) and foreign variables (y_t^*) of the form:

$$y_t = a_0 + \sum_{i=1}^{n} a_i y_{t-i} + \sum_{i=1}^{m} b_i y_{t-i}^* , \qquad (1a)$$

$$y_t^* = a_0^* + \sum_{i=1}^{n} a_i^* y_{t-i}^* + \sum_{i=1}^{m} b_i^* y_{t-i} , \qquad (1b)$$

and computing F–tests or likelihood–ratio tests for the joint significance of the foreign variables in each country's regression equation. Since the distributions of these test statistics are well–known, their corresponding marginal significance levels can be calculated from the F–distribution or the χ^2–distribution respectively. In the analysis below I focus primarily on these statistics instead of reporting the F–tests and likelihood–ratio tests with their corresponding degrees of freedom.

Before proceeding, some remarks on the power of these tests are in order. Note that such simple causality tests of the 'asymmetry' hypothesis can be criticized on various grounds: firstly, they rely heavily on the assumption that the centre country sets its monetary policy instrument irrespective of the policy actions of the non–centre countries, as reflected by the degree of exchange rate accommodation. As Wyplosz (1989b) rightly argues, game theory shows that, whatever the policymakers' preferences, such a policy is clearly inferior to one where the centre country reacts to policy settings elsewhere. As a result, 'Granger causality' tests are likely to reveal cross–influences between countries even if the conduct of policy is strictly asymmetrical in the sense above. Secondly, due to policy changes in response to exchange market pressure, or as a result of the transition to the EMU, the problem of the structural stability of reduced form equations arises, as would be expected according to the 'Lucas critique'. The empirical relevance of this argument therefore has to be checked before any policy recommendations based on estimates of equations are to be considered for the design of future policies or policy institutions in the process towards monetary union.

2.3. The Empirical Evidence on Asymmetries, German Dominance and the Relevance of the 'Lucas Critique'.

The relevance of the 'Lucas critique' for the cross–country policy links in the EMS depends primarily on the frequency of monetary policy shifts in member countries as the EMS progressively tightened during the first decade of its existence. References to such policy shifts are frequently made in the literature: in Wyplosz (1987, 1988) the commitment towards the EMS is said to have tipped the scale toward monetary restraint in France with the adoption of the austerity programme after March 1983. Artis (1987) reports that Denmark seems to have used the EMS initially more as a 'crawling peg' and only later moved to a more counter–inflationary policy stance by adopting 'level–pegging' policies. In Andersen and Risager (1983) and Christensen (1987a,b, 1988) this Danish policy switch is related to the adoption of stabilization policies after the election of the Liberal–Conservative government in October 1982. Finally, in discussing Irish stabilization policies Dornbusch (1989) notes that not taking advantage of the EMS realignment in February and June 1982 for devaluations signifies a shift from accommodating exchange rate policy to a determined effort to squeeze inflation. Summarizing these arguments it can therefore be stated that policy shifts in connection with EMS membership appear to be have occured in a number of EMS countries. These policy shifts can be expected to have a non–neclectable influence on the 'asymmetry' properties and policy links of the system. In particular, it can be argued that the post–March–1983 EMS may have worked quite differently than the pre–1983 system.

In the empirical literature on the EMS a variety of specific versions of the above 'asymmetry hypothesis' can be found. Giavazzi and Pagano (1985), Giavazzi and Giovannini (1988) and De Grauwe (1988) discuss asymmetries under the heading '*DM–zone*' and study the behaviour and interrelation of on–shore interest rates, off–shore interest rates and forward premia. Cohen and Wyplosz (1989) provide similar evidence using domestic short–term interest rates and monetary base growth. Giovannini (1988b) reports empirical evidence derived from domestic interest rates and foreign reserve flows. Finally, Fratianni and von Hagen (1989a,b,c) analyse asymmetries in terms of '*German dominance*' by looking at monetary base growth, on–shore and off–shore interest rates and forward premia around major realignment dates. The evidence provided by these studies, which is primarily based on 'Granger causality' tests, is reviewed in Wyplosz (1989b) in a condensed form and may be summarized as follows: in all studies there is a rich pattern of interactions among the above monetary policy instruments. While German monetary policy impulses influence monetary policy instruments in other EMS countries, Germany is not immune from influences in the opposite direction, suggesting that the EMS worked quite symmetrically. However, given the above limitations of these causality tests, Wyplosz nevertheless states that "*the asymmetry hypothesis is probably correct*". It is argued in this paper that the time–variability of the estimates, resulting from structural breaks in the estimated relationships as the EMS progressively tightens, may explain this discrepancy between empirical findings and common intuition.

2.3.1. Asymmetries, Short–term Monetary Policy and Interest Rates

The strongest non–formal evidence on asymmetries in the EMS is based on the relative behaviour of on–shore and off–shore interest rates. Amongst others, the studies of Giavazzi and Pagano (1985), Giavazzi and Giovannini (1987, 1988), Artis (1987), Wyplosz (1987) and De Grauwe (1989) suggest that the EMS works in an asymmetrical fashion. Giovannini (1988b) explicitly states that the *asymmetries in the use of capital controls* are just a reflection of the central role played by the Bundesbank; countries other than Germany use capital controls as instruments to maintain their exchange rate targets without having to surrender their monetary sovereignty. This proposition is based on the observations that in France and Italy, which throughout most of the EMS period relied heavily on capital controls, both on–shore and off–shore interest rates showed large deviations in periods prior to realignments, whilst for Germany and the Netherlands both rates moved closely together. Graphs 1 and 2 illustrate this point for France and Germany.

A testable form of the hypothesis of asymmetry in the use of capital controls can be derived from the argument of Giavazzi and Pagano (1985) that capital controls in France and Italy effectively placed domestic interest rates under the control of the domestic monetary authority. Note that under perfect capital mobility domestic interest rates would be determined according to the covered interest rate parity condition by the centre country's interest rate plus the forward premium[12] or discount relative to the centre country:

$$i_t = i_t^* + \{(f_t - s_t)/s_t\} \tag{2}$$

where the second term on the right hand side represents the bilateral forward premium or discount, with f_t as the n–period forward exchange rate, s_t as the spot exchange rate and i_t and i_t^* as the domestic and foreign nominal returns on financial assets with n–period maturity respectively. Under free capital movements and fixed but adjustable exchange rates both interest rates in the above equation will tend to move closely together as long as the probability of a realignment is small. However, under speculative attacks (=high probability of a realignment) these close co–movements between both interest rates may break down. Taking off–shore rates as a proxy for the relevant interest rates under perfect capital mobility, the above capital control argument implies that *under effective capital controls there should be no causal relation from French off–shore to French on–shore interest rates.* The results from empirically testing this hypothesis are presented in Table 18, which reports the marginal significance level (λ_1) of the likelihood–ratio test on the joint significance of six lags (n=m=6)[13] of the off–shore interest rates in the on–shore interest rate equations, while the reverse test is labelled λ_3.[14] Furthermore, if the likelihood–ratio test λ_2 (λ_4) on the additional significance of the current off–shore (on–shore) interest rate in the on–shore (off–shore) interest rate equation is significant at the 1 percent level, λ_2=.99 (λ_4=.99), the corresponding causality tests λ_1 (λ_3) are marked as bold numbers. Note that λ_2 (λ_4) measures the marginal significance of instantaneous 'Granger feedback' or co–movements between the two interest rates. Table 18 allows the following conclusions to be drawn: in all cases highly significant instantaneous feedback (co–movement) exists between the on–shore

[12]Under fixed exchange rates this is to be interpreted as the expected capital gain arising from the probability that a realignment will occur during the lifetime of the asset held.

[13]Alternatively experiments were conducted using both both n=m=3 and n=m=9, without affecting the basic results.

[14]Stars indicate significance at five (*) and one (**) percent levels respectively.

and off-shore interest rates of each country.[15] With respect to the hypothesis regarding the *asymmetries in the use of capital controls* the results show that in addition to significant co-movements in off-shore and on-shore rates of each country significant lagged causality patterns also exist. In none of the cases reported does causality run from on-shore to off-shore rates, but there is reversed causality for Germany in the first sub-period (79M3–83M3) and for France in the second sub-period (83M4–89M10). This suggests that France, at least in the early EMS, which as Graph 2 shows is when most of the variability of off-shore rates occurred, was successful in insulating domestic rates from speculative attacks.

The insulation of domestic interest rates from speculative attacks under capital controls does not, however, necessarily prevent the transmission of monetary policy impulses from abroad. Assuming that the conduct of short-term monetary policy is primarily carried out through interest rate policy, this implies that under an asymmetric EMS with German dominance in monetary policy any interest rate innovations in Germany should 'Granger cause' interest rates in the remaining EMS member countries, whilst 'reversed Granger causality' should not be found. In the following section this proposition is tested empirically using a variety of interest rate definitions in order to ensure the robustness of the findings.

Table 19 reports our results for 3-month interest rates. With respect to German dominance it can be stated that in the overall period and in the pre-1983 period German interest rates cause interest rates in France, the Netherlands and Belgium at a one percent significance level, while the reversed causality test is insignificant. The same result holds for Italy at the five percent level. This strong lagged interest rate relationships appear to dissolve in the post-1983 period, where with the exception of the Belgian-Irish case no significant lagged causality relationships are found. Note that this phenomenon may be explained by the progressive tightening of the EMS: a decline in the degree of exchange rate accommodation will speed up the transmission of policy impulses and as a result the more distant lags of the foreign country's policy variables in the vector

[15]Note that, due to their simultaneous equation estimation method, Fratianni and von Hagen (1989a,b,c) are unable to discriminate between lagged 'Granger causality' and instantaneous 'Granger feedback' between policy variables. As will be discussed below, this tends to bias the results towards the rejection of the 'German dominance' hypothesis.

autoregressions of the domestic equations will tend to have estimated coefficients which are no longer statistically different from zero. Hence these foreign variables will tend to have no additional explanatory power, which in Table 19 applies to the France and Italy where the German variables in the post–1983 EMS are only significant at the ten percent level. At the same time the progressive tightening of the EMS implies that the co–movements between domestic and foreign variables will increase. This is found to be true for Belgium and the Netherlands, where after 1983 the instantaneous co–movements with German interest rates are significant at the one percent level. The same applies to France at the five percent significance level. However, this does not imply that the EMS has recently worked more symmetrically; it only means that the effects of possibly asymmetric monetary policies are transmitted in a shorter time–span than the one used in the estimation.

With respect to asymmetries in the EMS, the main message from Table 19 is that German short–term monetary policy, as reflected in domestic interest rate innovations, is found to have a powerful influence on the remaining EMS countries,[16] while the reverse does not hold.[17] In particular, the significant bi–directional French–German or Belgian–German causality links reported in De Grauwe (1988) and Cohen and Wyplosz (1989) could not be reproduced in our estimates. I will return to this point below. Secondly, as in the Cohen and Wyplosz (1989) paper, the non–German EMS countries are also found to transmit their interest rate innovations.[18] For example, there is an important bi–directional causality link between France and Italy, which is also reported in De Grauwe (1988). The significance of these French–Italian and Dutch–French causality links can also be established if the causality of these variables is tested in addition to

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[16]In Fratianni and von Hagen (1989b) this test is labelled 'independence from German policy'. In the estimates adjusted for a structural break in 89M3 this test is rejected for France, the Netherlands and Ireland in the first sub–sample and for France, Belgium and the Netherlands in the second sub–sample.

[17]Fratianni and von Hagen (1989b) reject this test, which they label 'German policy independence' in all estimates for both sub–samples. However, note that their test is rejected if causality runs from any non–German EMS coutries to Germany, and that their notion of causality is based on both lagged and instantaneous 'Granger causality'. Such a strong hypothesis is unlikely, however, not to be rejected.

[18]This corresponds to the 'EMS insularity' test of Fratianni and von Hagen (1989b), which in the estimates adjusted for a structural break at 83M3 is rejected in both sub–samples for Italy, Denmark and Ireland, but can not be rejected for France, Belgium and the Netherlands.

the inclusion of German interest rate innovations (6 lags) in the corresponding equations. This result does not hold for the Belgian–Dutch link, which is insignificant given the German influence.[19] However, whilst this evidence might suggest that the EMS did not work as a full 'DM–zone', it does not rule out 'German dominance' in the EMS, which is viewed as the less strong hypothesis.

In order to check the robustness of the above results alternative definitions of interest rates were employed. For the short maturity end the call money interest rate, which plays an important role in the conduct of domestic monetary policies, was used, whilst the long end of the maturity range is represented by the long–term government bond rate. Tables 20 and 21 summarize the results from these vector autoregressions. The call money rate largely reproduces the results for the three month interest rate: German interest rate innovations are found to have a significant impact on interest rates in all remaining EMS countries, while the only bi–directional causality relationship is the German–Italian interest rate link in the first sub–sample. Contrary to the evidence for three–month interest rates, the causality patterns for call money rates do not dissolve after 1983. The influence of Germany's interest rate policy is highly significant at the one percent level for the Netherlands, Belgium and Ireland, and at the five percent level for France and Denmark. Significant reversed causality is not found in any of the cases. Again, this result points toward an asymmetrical conduct of monetary policies within the EMS. With respect to the interaction of non–German EMS member countries Table 20 also reveals a strongly interactive pattern: whilst the highly significant uni–directional Belgian–Italian, French–Dutch and Irish–Dutch causality links break down after 1983, this result does not apply to the highly significant bi–directional Danish–Belgian and the uni–directional Irish–Danish and Italian–Irish interest rate links, which also are all significant in addition to a given German influence. Finally, significant external causality links, as measured

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[19] A similar point is made by De Grauwe concerning the German influence on EMS interest rates <u>given</u> the influence of U.S. interest rates on these countries. Surprisingly De Grauwe (1988) does not also test the reversed proposition on the inclusion of the U.S. interest rates <u>given</u> the German influence. In Fratianni and von Hagen (1988b) this reversed test is carried out under the label 'world insularity' test, which in the structurally stable estimates was only rejected for Italy in the second sub–period. We also find that for the 3–month interest rates the inclusion of the U.S. interest rate (6 lags) in addition to the German rate (6 lags) was only significant in the case of Italy. Finally note that De Grauwe (1988) includes both the <u>current and lagged</u> U.S. rates and then tests for the significance of additional lagged German rates, which in our view introduces a bias of the results towards the rejection of the 'DM–zone' hypothesis.

by the influence of the U.S. interest rate given the German influence, only exist for Italy in the first sub–period, as was the case for the three–month rates above.

The evidence from long–term government bonds is somewhat different to the results reported above. The influence of German interest rate innovations is highly significant for Italy and Belgium, and significant reversed causality links do not exist for any country. However, the hypothesis of independence from German policy cannot be rejected for France, the Netherlands and Denmark in both sub–samples. Furthermore, Table 21 also reveals a less elaborate interactive pattern. Major interactions are only found for the Dutch–Italian and French–Italian as well as the Irish–Belgian and Dutch–Belgian interest rate linkages. Moreover, the latter two are not significant if tested in addition to a given German influence. Finally, long–term interest rates also exhibit stronger external interest rate linkages, as indicated by the significance of the U.S. government bond rate (6 lags) in addition to a given German influence in the regressions for France, the Netherlands and Belgium in the first sub–period and for Italy and Denmark in the second sub–period.

The results discussed so far may best be summarized by saying that Germany appears to be an important and non–dominated player in the EMS monetary policy game, while this is not true for the remaining EMS member countries. In this sense there is 'asymmetry' in the system. However, this is far from saying that Germany is the only relevant policymaker in the EMS, as is frequently required under stronger formulations of the 'German dominance' hypothesis. Such strong formulations of the dominance hypothesis are clearly rejected by the data.

A second important result from above is that causal relationships between interest rates in the EMS frequently appear to break down between the two sub–samples. This corresponds to the results of Fratianni and von Hagen (1989b), who also find that their 'Granger causality' tests are sensitive to the break in the sample. To test this hypothesis more formally I employ a variety of parametric stability tests. Note that if there were a single structural break at an known point in time, for example around the March 1983 realignment, the significance of this break can be tested for by using the parametric F–test of Chow (1960), the likelihood–ratio test of Quandt (1958, 1960) or the CUSUM–OF–SQUARES tests of Brown, Durbin and Evans (1975). An example of the evidence from these stability tests is reported in Table 22. In general, the stability test results can be summarized as follows: firstly, based on the CUSUM–OF–SQUARES forward and backward tests there is significant instability at the one percent level in all estimated equations for 3–month rates, while for call money rates and long–term government bond rates only the Italian regressions show no significant instability. Secondly, based on the F–test of Chow (1960) the hypothesis of regression parameter stability could rarely be rejected for the German, Dutch, Belgian, Danish and Irish regressions whilst significant parameter stability is frequently found in the French and Italian regressions, regardless of the definition of the interest rate. Finally, based on the likelihood–ratio test of Goldfeld and Quandt (1973a,b, 1976) the stability of the Italian regressions could in general not be rejected if judged on the basis of a critical value from the χ^2–distribution with k+1 (number of regressors + 1) degrees of freedom.[20] Summarizing these findings it may stated that the problem of structural instability of the estimated interest rate equation appears to be relevant in the vast majority of cases.

The above results apply to the a–priori split of the sample in March 1983. More generally, the most likely point of structural break may be estimated by using switching regression methods and calculating the above test statistics and the likelihood–ratio test of Goldfeld and Quandt (1973a,b, 1976) at every possible point of structural break. To illustrate the results from this analysis I focus on the German–French interest rate linkage and display these time–varying stability test statistics for the three–month interest rate equations in Graphs 3 to 6. These Graphs clearly show the significant instability of the estimated vector autoregressions: the Chow test and the forward and backward CUSUM–OF–SQUARES tests all point towards a significant structural break after the presidential elections in May 1981 or the realignment in October 1981. The likelihood–ratio test of Goldfeld and Quandt (1973a,b, 1976), which is more

[20]The likelihood–ratio test of Goldfeld and Quandt (1973a,b, 1976) tests the full null–hypothesis of k constant coefficients and constant residual variance, hence k+1 corresponds to the number of restrictions across regimes. Quandt (1960) demonstrates that the likelihood test statistic $-2\ln\lambda$ does not follow an unmodified χ^2–distribution. However, Lehner and Möller (1981) demonstrate that the χ^2–distribution with k+1 degrees of freedom may be used to construct a conservative test for stability.

reliable[21] in detecting the timing of departures from structural stability, points towards the June 1982 or March 1983 realignments as the most likely points of structural break. Note that at all four points in time speculative attacks on the French franc occurred and interventions to stabilize nominal exchange rates in combination with a progressive tightening of foreign exchange controls were carried out.

The implications of this significant structural instability for the 'asymmetry' issue is examined in Graph 7, where the marginal significance level of the likelihood–ratio test statistics λ_1 and λ_3 of the 'Granger causality' test are calculated for every possible break–point of the EMS sample by fixing the end–point of the sample (89M10) and iterating the starting point of the vector autoregressions. The time–paths of the marginal significance of this time–varying 'Granger causality' tests are plotted in Graph 7 against the standard significance levels. From the backward regressions it is obvious that for the overall sample (= starting points of test trajectories) there is highly significant causality link from German to French three month interest rates (λ_1), whilst reversed causality (λ_3) is non–significant throughout the sample. As more initial observations are dropped from the sample, λ_1 remains constant until just after the presidential elections in France, and then falls below the .95 percent significance line. Between the March 1983 and the July 1985 realignment λ_1 fluctuates between the .9 and .95 percent significance lines, and declines toward zero after mid–1985. With respect to the 'asymmetry' issue Graph 7 therefore shows that over most of the EMS period German interest rate innovations are more likely to cause accommodating movements in French rates than vice versa.

Graph 8 for the German–French call money rate linkage demonstrates this point more clearly. The influence of German interest rate innovations on French rates is significant at least at the .95 percent significance level throughout almost all the sample, whilst the reversed test is insignificant. Again the evidence points towards 'German dominance'. However, this evidence from the short end of the

[21]Toyoda (1974) demonstrates that the Chow–test is biased in the presence of heteroscedasticity. See also Jaytissa (1977) and Schmidt and Sickles (1977) on this point. For problems of the Chow–test under misspecification see Thursby (1982). Finally Brown, Durbin and Evans (1975) state that the CUSUM–OF–SQUARES test is not a very high powered parametric test for detecting specific departures from regression model constancy.

maturity range does not hold for long–term maturities. Graph 9 for the long–term government bond rate shows that the significant reversed causality relationship between France and Germany breaks down if observations prior to the May 1981 presidential elections are excluded from the sample.

2.3.2. Asymmetries, Medium–Term Monetary Policy and Monetary Aggregates

Before drawing any conclusions on the validity of the 'asymmetry hypothesis' the empirical evidence based on vector autoregressions using interest rates has to be supplemented by evidence derived from monetary aggregates. I firstly consider broader definitions of monetary aggregates, which are frequently used as intermediate targets for medium–term monetary policy, and only later discuss the evidence from the directly controllable monetary aggregate, the monetary base.

Tables 23 and 24 display the evidence for changes in the growth rates of money (M1, cash plus demand deposits) and quasi money (M2 = M1 plus time deposits or M3 = M2 plus saving deposits). German innovations in M1 growth rates are found to exert a significant influence on money growth in Italy, the Netherlands, Belgium and Ireland. However, Germany itself is not free from reversed influences from Belgium and Denmark in the first sub–sample and from Ireland in the second sub–sample. For quasi money growth such reversed causality is also found for the Netherlands and Denmark. This clearly violates the 'German dominance' hypothesis, which is therefore rejected on the basis of Tables 23 and 24.

In checking the structural stability of the estimates it is found that almost all money and quasi–money equations are structurally stable regardless of which of the above stability tests is employed. The only significant departures from stability were detected in the Italian equations with respect to France, Germany and Belgium.

With respect to the sensitivity of the 'Granger causality' test regarding the choice of the sample period Graph 11 reveals that in the French–German money growth relationship both test statistics λ_1 and λ_3 are non–significant for the overall period (= starting point of trajectory) and for the post March 1983 sub–period. However, as in the case of the interest rate equations above German money growth rates are more likely to cause French money growth rates than vise versa. Furthermore, note that after the July 1985 realignment the test for 'German dominance‘ λ_1 becomes significant, whilst the reversed test λ_3 on German policy dependence remains insignificant. This again points towards ‘asymmetries‘ in the effects of medium-term monetary policy, as reflected by the international transmission of money growth rates.

A problem with using the wider monetary aggregates such as M1, M2 or M3 for the evaluating the effects of monetary policy is that they are jointly influenced by the behaviour of private sector agents and by the policy actions of the central bank. It is therefore preferable to use narrow aggregates which are directly controllable by the authorities. For this reason Fratianni and von Hagen (1989a,c), and Cohen and Wyplosz (1989) run vector autoregressions using monetary base growth (M0), which is the sum of changes in net foreign assets (FA) and net domestic credit (DC). In order to understand the findings from these estimates it is, however, necessary to discuss briefly the intervention rules of the EMS.

At the bilateral intervention margins intervention in the partner currency concerned is obligatory and potentially unlimited in amount for *both* participating countries. These compulsory interventions are automatically financed under mutual credit lines in the European Monetary Cooperation Fund (EMCF) by the respective partners' central bank. Thus, for unsterilized interventions this ‘very short-term financing facility‘ (VSTFF) immediately implies inverse *symmetrical short-term liquidity effects* on the monetary base of both countries concerned. However, the obligation to repay the funds at the latest 9 1/2 months after the month of the intervention[22] results in a medium-term depletion of the limited stock of foreign exchange reserves in the ‘weak‘ currency country and in an accumulation of foreign exchange reserves in the ‘strong‘ currency country, regardless of which country intervenes in the foreign exchange markets. This secondary effect will be labelled the *asymmetrical medium-term foreign exchange reserve effects.*

The above symmetric liquidity effect of unsterilized interventions is likely to result in significant co-movements between the monetary bases of the countries concerned. However, large scale unsterilized interventions are typically in conflict with the strong currency country's domestic monetary targets. Therefore these

[22]See Bofinger (1988) for the details on the derivation of this maximum time span.

liquidity effects may be sterilized by offsetting movements in the domestic credit component of the monetary base. If sterilization in the month of the intervention is incomplete and therefore has to be spread over time, this is likely to result in reversed causality links running from the liquidity effect in the monetary base of the 'weak' currency country to the sterilization effect in the monetary base of the 'strong' currency country. Finally, in the absence of intervention the standard causality link from the centre country's monetary base to the non-centre country's monetary base may be detected. Summarizing, vector autoregressions using monetary base growth are unlikely to reveal any insight with regards to 'asymmetries' in the EMS since a multitude of non-discriminable hypotheses is tested. Note that this reservation with respect to these tests carries over to the tests for monetary aggregates from above, given that a stable base multiplier exists.

Table 25 reports our evidence for base money growth. In the early EMS period the German money base innovations significantly effect the monetary base in France and Belgium, whilst highly significant reversed causality links exist with the Netherlands and Denmark. In the second sub-period Table 25 reveals uni-directional causality from Germany to the Netherlands and Denmark, bi-directional causality between Germany and Belgium, and reversed causality between Germany and France, Italy and Ireland. Note that the latter three currencies have been devaluated in the post-1983 EMS relative to the EMS average whilst the opposite holds for the former EMS currencies. More precisely, EMS intervention to support the Italian lira in March to July 1985, the Belgian franc in December 1985 to January 1986, and the French franc and Irish pound in April 1986 may account for this reversed causality findings given the German Bundesbank's preferences for sterilized interventions. In other words, reversed causality findings in monetary base data may simply be a reflection of the dominant role of the Bundesbank in the EMS interventions given its preferences for sterilization rather than evidence of foreign policy dominance.

This view is supported by the evidence from Table 26, which reports our results for the causality tests based on changes in foreign exchange reserves. Note that under the above asymmetric reserve effect the repayment of funds provided for interventions in the EMS will create causality links running from the 'weak' currency country to the 'strong' currency country. Table 26 indicates such causality links in the French-German and Italian-German equations for the second sub–period, as would be expected from the findings regarding money base growth. The causality links between German–French and German–Dutch foreign exchange reserves in the first sub–period, which are also highly significant, are likely to reflect the intervention in support of the 'weak' German mark surrounding October 1980 and February 1981.

A second important finding with regard to asymmetries in the behaviour of base money in EMS member countries is that the hypothesis of structural stability of the vector autoregressions could only be rejected for Denmark, irrespective of which stability test is considered. This instability for Denmark, which is due to institutional changes in Danish monetary policy in recent years, is also reported in Fratianni and von Hagen (1989c).

Finally, as a result of the stability of the estimates the evidence on 'Granger causality' also tends to be less sensitive with respect to the chosen sample period. This point is illustrated in Graphs 10 and 11 for the French–German base money and foreign exchange reserve link. Note that when observations covering the initial German mark weakness are excluded from the sample the reversed causality from France to Germany is highly significant, which supports the above argument on the interpretation of the results.

Summarizing these findings, it can be stated that evidence on 'asymmetries' in the EMS, derived from regressions using base money data, is likely to reject the hypothesis of 'German dominance' due to the asymmetric use of sterilized interventions by the Bundesbank. Unfortunately, the non–availability of intervention data makes it impossible to test this hypothesis directly. Further research on the exact interactions of sterilized interventions, short–term liquidity effects and medium–term reserve effects is necessary before drawing any conclusions on the validity of the 'German dominance' hypothesis from data of monetary aggregates.

2.4. Summary and Conclusions

With respect to 'asymmetries' in the conduct of monetary policy within the EMS the above findings question the relevance of some of the empirical evidence provided to date. Firstly, with respect to the evidence derived from interest rates it is argued that the 'Lucas critique' appears to be relevant since the findings are very sensitive to both changes in the political environment and to realignments within the EMS. This result is documented in some depth for the French–German interest rate linkage. The message from the above evidence is clear: ‘German dominance‘ in the EMS is not rejected from the data, but the EMS is far from being a ‘DM–zone. In particular, German short–term monetary policy actions, as reflected by interest rate innovations seem to dominate interest rate policy in the non–German EMS member countries. This is especially true if the short end of the maturity range of interest rates is considered.

Secondly, the evidence from monetary aggregates, which points towards a ‘symmetric‘ working of the EMS, also has to be questioned, albeit on different grounds. Here the ‘Lucas critique‘ appears to be less relevant. This is not too surprising since medium–term policy considerations, which govern money supply decisions are typically less erratic and more orientated toward stable and predictable money growth. However, it is argued that the ‘asymmetry‘ in the use of sterilized interventions requires a re–interpretation of the results. In particular, it is pointed out that reversed causality, which is frequently found in ‘Granger causality‘ tests of base money equations, may merely be an indication of the dominant role of the Bundesbank in the EMS intervention system given the Bundesbank's preferences for sterilized interventions. In summing up I therefore tend to agree with the statement of Wyplosz (1989b) that the ‘asymmetry hypothesis‘ on the working of the EMS is probably correct.

The above conclusion has important implications for the process of monetary integration: if the success of the present EMS can be attributed to ‘German dominance‘, this should be reflected in the design of the future European system of central banks. In this context it may be argued that a stable, low–inflation ESCB would, like the Bundesbank, be required to be independent with a binding commitment to avoiding inflation and an explicit ban on monetizing deficits.

3. Summary and Suggestions for Further Research

The paper aims at empirically analysing 'asymmetries' in terms of 'shocks' and 'policies' in the present EMS. Of course, both issues cannot really be separated, either analytically or empirically, without an elaborate theoretical model, which, however, frequently is impossible to test econometrically. The above exercise may therefore be viewed as an attempt to 'make the data talk' on a number of policy relevant issues in connection with the creation of the EMU.

The first part of the paper on 'asymmetries in shocks' to major macroeconomic variables is thereby based on admittedly crude approximations of the 'shocks', which are nevertheless defendable given the fact that less erratic time series (low variance) are more easily predicted (low error or 'shock' variance), regardless of the prediction methods employed. However, using conditional rather than unconditional variances by estimating ARIMA time series models or structural regression models for each of the relevant national variables and their 'symmetrical' (sums) and 'asymmetrical' (differences) components may be viewed as a next step. This would also allow to separate identification of transitory and permanent shocks, whereas this paper focused primarily on the latter by taking the appropriate differences (first or fourth differences in the case of seasonality) of the levels of the original series.

In the second part of the paper atheoretical vector autoregressions were employed to draw inference on the 'symmetrical' or 'asymmetrical' conduct of monetary policy within the EMS. The present paper finds more 'asymmetry' than the contributions quoted from the literature. This result applies in particular to the short-term conduct of monetary policy as implemented through the interest rate innovations, especially as far as the short end of the maturity range is concerned. However, the limitations and problems of this evidence based on vector autoregressions are highlighted by implementing time-varying 'Granger causality' test procedures, which clearly demonstrate the instability of the estimates. On the basis of this evidence it is believed that the concept of 'Granger causality' is too crued a way of thinking about an 'asymmetrical' conduct of policies. To understand asymmetrical policies they should be addressed empirically in terms of 'credibility' and 'discipline' in connection with deflation efforts, as analysed in Weber (1988) for the EMS. Similar work on existing monetary unions may provide insights that help to resolve the 'credibility problem' of the future EMU.

Data Descriptions

Monthly Data

exchange rates	IMF-International Financial Statistics, line rf.
foreign exchange reserves	IMF-International Financial Statistics, line 1d.d.
consumer price indices	IMF-International Financial Statistics, line 64, exceptions: for Ireland and Spain data on wholesale price indices from IMF-International Financial Statistics, line 63, were used.

Monthly and Quarterly Data

interest rates:	
call money rates	IMF-International Financial Statistics, line 60b, exceptions: for Ireland and Greece data from OECD-Main Economic Indicators were used.
3-month rates	OECD-Main Economic Indicators, exception: for Italy a six month rate was used.
3-month euro market rates	IMF-International Financial Statistics, line 60ea.
government bond rates	IMF-International Financial Statistics, line 61.
monetary aggregates:	
base money	IMF-International Financial Statistics, line 14.
narrow money (M1)	OECD-Main Economic Indicators, index (1985=100) of seasonally adjusted money.
quasi money (M2,M3)	OECD-Main Economic Indicators, index (1985=100) of seasonally adjusted quasi money.

Quarterly Data

wages	OECD-Main Economic Indicators, index (1985=100) of hourly rates in industry or manifacturing.
industrial production	OECD-Main Economic Indicators, index (1985=100) of seasonally adjusted total industrial production, exception: for Denmark an index of industrial animal products was used.
retail sales	OECD-Main Economic Indicators, value index (1985=100) of seasonally adjusted total retail sales.
unemployment rates	OECD-Main Economic Indicators, seasonally adjusted standardized unemployment rate.
government expenditure	IMF-International Financial Statistics, line 82, exception: for France data from OECD-Main Economic Indicators on seasonally adjusted real (1980=100) government expenditure were used
current account balance	OECD-Main Economic Indicators, billions of national currency units. To facilitate a comparison this series was transformed into an index series (71Q2=100).

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Table 1: Standard Deviation of Changes in the Logarithm of the Bilateral Nominal Exchange Rate Relative to the Month Before, Average Monthly Exchange Rates, Sample Periods: 72M8 to 79M2 and 82M2 to 89M8

	G	F	I	N	B/L	D	E	GB	GR	S	P	US	C	J	CH	A
G		3.4*	3.8*	1.1*	1.5*	1.7*	3.5*	3.5	2.8*	4.5	4.9*	3.8*	4.8*	3.8	3.2*	0.8*
F	2.0		2.7*	3.2*	3.0*	2.6*	3.7*	3.7	3.9	4.0*	4.5*	4.3*	5.4*	4.4*	3.6	3.3*
I	1.5	1.7		3.3*	3.2*	3.4*	2.6	3.7*	3.9	4.0	4.5*	4.4*	5.5	4.1*	3.6*	3.7*
N	0.3	2.0	1.6		0.9*	1.4	3.1*	3.1	2.2*	4.1	5.1*	3.4*	4.5*	3.9	3.2*	0.8*
B/L	2.1	1.2	1.6	2.2		1.4*	3.0*	3.0*	2.4*	4.3*	5.0*	3.4*	4.6*	3.5	3.1	1.2*
D	1.3	1.1	1.4	1.4	1.1		3.7*	3.7	2.7*	3.4	4.2*	3.3*	4.2*	4.1*	3.0*	1.4
E	1.9	1.6	2.1	1.9	2.3	1.7		0.0*	2.9*	5.0*	5.8*	4.3*	5.5	3.8	3.7*	3.4*
GB	3.9	3.5	3.9	3.9	4.0	3.6	2.9		2.9*	5.0*	5.8*	4.3*	5.5	3.8	3.7	3.4
GR	4.2	4.4	3.8	4.2	4.6	4.2	4.0	3.9		4.3	5.0*	2.6*	3.7	4.2	4.1	2.5*
S	3.9	2.8	3.1	3.8	3.3	3.4	2.9	3.6	3.5		4.0*	4.7*	4.9*	5.7	5.2	4.4
P	3.7	2.7	3.1	3.6	3.2	3.3	2.9	4.0	3.8	2.0		5.2*	4.8*	7.1*	5.9*	4.8*
US	6.7	7.1	6.6	6.9	7.4	6.8	6.2	6.0	5.2	6.8	7.4		2.0	4.6*	4.5*	3.5*
C	6.6	6.9	6.3	6.7	7.1	6.6	6.1	5.5	4.3	6.4	6.8	2.1		5.8	5.6	4.6*
J	3.1	3.2	2.8	3.3	3.0	2.8	3.3	4.3	5.0	4.6	4.8	6.6	6.4		3.9	4.1*
CH	1.7	3.0	2.9	1.8	3.1	2.4	2.9	4.5	4.6	4.7	4.4	7.1	7.0	3.4		3.1*
A	0.1	2.0	1.6	0.4	2.1	1.3	1.9	3.9	4.1	3.9	3.7	6.7	6.6	3.1	1.7	
G1	2.5	3.1	3.2	2.2	2.2	2.4	3.3	3.3	3.4	4.9	5.7	4.5	5.8	4.6	4.1	2.4
	1.5	1.6	1.7	1.6	1.8	1.3	1.9	4.3	4.9	3.9	3.8	8.0	7.7	3.6	3.0	1.6
G2	3.9	4.0	3.8	3.6	3.7	3.5	3.4	3.4	3.1	3.3	3.7	4.2	4.7	5.2	4.7	3.8
	3.9	3.4	3.5	3.9	3.8	3.6	3.2	2.9	2.8	2.3	2.5	6.4	5.8	4.7	4.6	3.9
G3	4.1	4.7	4.7	3.9	3.8	3.9	4.5	4.5	3.5	5.1	5.7	2.2	2.6	3.5	4.7	4.1
	5.5	5.7	5.2	5.6	5.8	5.4	5.2	5.3	4.8	5.9	6.3	2.9	2.8	4.3	5.8	5.5

Key: All numbers are standard deviations (* 100). Columns contain the nominator currencies and rows the denominator currencies of the respective bilateral exchange rates, calculated as cross rates from the bilateral U.S. dollar exchange rates. Standard deviations for the pre-EMS period (August 1971–February 1979) and an equally long EMS interval (February 1982–August 1989) are are reportet above and below the diagonal in the upper part of the table. Numbers in bold face characterize a higher variance of the series prior to the EMS and stars indicate the significance of the F-test on a change in the variance between regimes at a 1 percent level. The lower part of the table presents unweighted averages of the standard deviations (first pre-EMS, then EMS) of each country's exchange rates relative to the remaining countries in the ERM group (G1), the EC but non-ERM group (G2) and the group of three non-European countries (G3=US,C,J).

Tab. 2: Standard Deviations of Changes in Logarithms of Bilateral Nominal Exchange Rates, First and Twelfth Differences, Average Monthly Exchange Rates, Sample Periods: 79M3 to 84M5 and 84M6 to 89M8

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		4.2 2.4**	4.1 3.1*	1.9 0.6**	4.4 1.3**	3.7 4.1	3.4** 6.4
France	2.2 1.1**		3.8 3.3	4.3 2.5**	4.7 2.5**	4.5 4.2	3.4** 6.0
Italy	1.2 1.3	1.5 1.7		4.0 3.3	4.8 3.1**	4.2 4.9	3.5** 6.5
Holland	0.6 0.2**	2.2 1.2**	1.4 1.4		4.4 1.3**	4.0 4.2	2.8** 6.4
Belgium	2.2 0.5**	1.3 0.9**	1.7 1.3**	2.4 0.5**		4.1 4.1	4.5** 6.3
Denmark	1.5 0.8**	2.2 0.9**	1.6 1.5	1.6 0.9**	2.0 0.5**		4.1** 7.2
Ireland	1.4** 2.1	1.3 1.2	1.3** 2.3	1.3** 2.1	1.9 1.8	2.0 1.8	

Key: The numerical values are standard deviations of changes in bilateral nominal exchange rates relative to the month before (above the diagonal) and relative to the same month of the year before (below the diagonal). The first (second) standard deviations in each row applies to the early (late) EMS, with the sample being split in May 1984. The stars indicate the significance of the heteroscedasticity test at 5 (*) or 1 (**) percent levels respectively.

Table 3: Standard Deviation of Changes in the Logarithm of the Bilateral Real Exchange Rate Relative to the Same Month of the Year Before, Average Monthly Exchange Rates and Consumer Price Indices, Sample Periods: 72M8 to 79M2 and 82M2 to 89M8.

	G	F	I	N	B/L	D	E	GB	GR	S	P	US	C	J	CH	A
G		3.4*	3.6*	1.4*	2.2*	1.8*	4.6*	4.0	4.0*	3.6	3.9	4.0*	4.8	2.9	3.2*	1.2*
F	1.6		2.6*	3.0*	2.8*	3.0*	6.0*	3.2	5.1*	4.0*	3.9*	4.0*	5.1	3.9	3.1*	3.2*
I	1.2	1.9		2.8*	2.4*	3.1*	5.0*	2.2*	4.4*	3.6	4.2*	3.6*	4.9	3.5	3.9*	3.2*
N	0.5	1.7	1.4		1.2*	1.3	4.3*	3.4	3.7	3.2	3.2	3.2*	4.1	3.0	3.3*	0.9*
B/L	1.9	1.3	1.9	2.1		1.4	4.3*	3.0*	4.0	3.5	3.4*	3.1*	4.1	3.1	3.2	1.4
D	1.2	1.2	1.5	1.3	1.1		4.1*	3.8	3.7	3.1	3.4	3.3*	4.2	3.1	2.8*	1.1
E	2.5	2.1	2.6	2.4	2.9	2.5		4.5*	2.7	4.3*	4.7*	4.3	5.0	4.5	5.0*	4.1*
GB	4.0	3.6	4.2	4.1	4.1	3.9	3.0		4.3	4.4*	4.3	3.4*	4.9	3.7	4.0	3.7
GR	3.0	3.2	2.9	3.1	3.6	3.0	3.3	3.7		3.8*	4.3*	3.4*	4.3	4.1	4.8*	3.6
S	3.6	2.9	3.4	3.6	3.4	3.3	2.7	3.1	2.9		3.8*	3.9*	4.5	3.6	4.1	3.4
P	3.1	2.3	3.0	3.1	2.9	2.7	2.6	3.6	2.8	1.7		4.0*	4.1*	5.2*	4.2	3.3
US	6.5	6.4	5.9	6.6	6.8	6.6	5.1	5.8	5.3	5.2	5.5		1.9*	3.5*	4.5*	3.4*
C	6.3	6.5	5.8	6.5	6.8	6.4	5.3	5.5	4.8	5.3	5.6	2.0		4.5*	5.3*	4.2*
J	3.2	3.0	2.8	3.4	2.7	2.8	3.7	4.6	4.3	4.0	3.8	6.6	6.6		3.5	3.1
CH	1.6	2.3	2.3	1.5	2.7	2.1	3.0	4.5	3.4	4.2	3.7	7.0	6.8	3.6		3.1
A	0.5	1.5	1.2	0.5	1.7	1.1	2.5	4.1	3.1	3.5	3.0	6.6	6.5	3.1	1.5	
G1	2.8	3.5	3.3	2.3	2.4	2.5	4.7	4.0	4.6	4.2	4.5	4.3	5.4	4.0	4.1	2.5
	1.5	1.6	1.8	1.6	1.9	1.5	2.5	4.5	3.7	3.8	3.3	7.3	7.3	3.6	2.6	1.5
G2	3.9	4.1	3.6	3.4	3.5	3.5	4.1	3.3	3.1	3.0	3.1	3.7	4.5	4.2	4.3	3.5
	3.4	3.0	3.4	3.5	3.5	3.2	2.9	2.6	2.4	1.9	2.0	5.5	5.3	4.2	4.0	3.4
G3	3.9	4.3	4.0	3.4	3.4	3.5	4.6	4.0	3.9	4.0	4.4	1.8	2.1	2.7	4.4	3.6
	5.3	5.3	4.8	5.5	5.4	5.3	4.7	5.3	4.8	4.8	5.0	2.9	2.9	4.4	5.8	5.4

Key: All numbers are standard deviations (* 1000). Columns contain the nominator currencies and rows the denominator currencies of the respective bilateral exchange rates, calculated as cross rates from the bilateral U.S. dollar exchange rates. Standard deviations for the pre-EMS period (August 1971–February 1979) and an equally long EMS interval (February 1982–August 1989) are are reportet above and below the diagonal in the upper part of the table. Numbers in bold face characterize a higher variance of the series prior to the EMS and stars indicate the significance of the F-test on a change in the variance between regimes at a 1 percent level. The lower part of the table presents unweighted averages of the standard deviations (first pre-EMS, then EMS) of each country's exchange rates relative to the remaining countries in the ERM group (G1), the EC but non-ERM group (G2) and the group of three non-European countries (G3=US,C,J).

Table 4: Standard Deviation of Changes in the Logarithm of the Consumer Price Index Relative to the Same Month of the Year Before, Average Monthly Consumer Prices, Twelfth Differences of Logarithms of Levels, Sample Periods: 72M8 to 79M2 and 82M2 to 89M8

	G	F	I	N	B/L	D	E	GB	GR	S	P	US	C	J	CH	A
G		11.5*	22.8*	5.8*	11.8*	13.5*	43.6*	22.1*	27.6*	24.0*	32.2*	11.4*	10.9*	19.7*	8.8*	4.8
F	9.2		14.0*	10.6*	8.2*	8.5	39.1*	17.5*	23.3*	17.7*	22.5	4.4*	4.9*	17.6*	16.6*	9.1
I	14.8	7.8		20.6*	15.7*	14.5*	33.9*	18.7	26.3*	18.3*	19.8	16.2	16.7*	21.0*	27.3*	19.6*
N	4.0	7.3	13.0		8.5*	14.1*	42.8*	18.3*	28.7*	24.8*	31.1*	11.9*	11.2*	19.2*	11.7*	3.8
B/L	6.5	9.1	14.2	6.3		12.8*	39.6*	14.6	26.1*	23.3*	26.9*	10.6	10.1	15.9*	15.1*	8.1
D	6.4	7.3	11.6	6.0	9.6		36.3*	22.7*	22.8*	14.6	23.5	9.5*	10.2*	17.0*	17.1*	11.9*
E	18.9	12.4	10.2	17.4	19.4	15.6		45.4*	29.9*	37.3*	40.8*	40.0*	41.8*	29.0*	43.7*	41.0*
GB	13.0	13.0	14.9	12.8	17.4	10.4	15.7		30.8*	29.2*	27.7	19.3*	18.1*	24.3*	26.3*	19.2*
GR	12.8	13.8	16.4	11.7	13.1	12.9	23.1	17.3		24.8	29.7	22.4*	23.4*	18.4*	28.0*	26.4*
S	17.1	10.4	9.3	15.5	15.8	15.2	9.6	17.6	20.7		20.4*	18.5	18.4	26.4*	29.0*	23.2*
P	22.9	20.3	24.0	21.9	19.3	23.7	24.5	28.8	26.0	18.4		23.0	24.1	29.7	35.8*	30.3*
US	9.9	11.1	14.4	9.7	14.7	8.0	16.0	5.9	15.3	17.2	27.4		4.1*	17.8*	15.7*	10.4*
C	6.4	8.4	13.2	6.1	10.0	6.1	18.2	12.7	12.5	17.9	25.6	9.3		19.4*	16.3*	9.9*
J	5.9	11.1	15.3	5.9	9.7	7.8	19.7	11.3	11.8	18.0	25.2	8.2	8.8		17.9*	17.6*
CH	3.8	11.7	17.2	6.0	7.1	8.6	21.3	15.5	13.1	19.7	23.6	12.1	7.8	7.5		10.6*
A	4.9	10.6	16.2	4.4	6.7	8.4	20.4	15.0	11.9	18.1	22.3	11.5	8.6	5.9	5.3	
G1	18.2	15.3	20.3	17.1	16.1	16.6	39.2	26.6	30.8	26.7	32.8	17.3	17.6	23.2	23.4	16.4
	10.0	8.9	11.9	9.0	10.9	9.4	15.7	16.2	17.3	15.5	26.1	14.0	11.4	12.6	12.6	11.9
G2	26.5	20.3	20.8	25.7	22.7	20.9	38.3	21.9	21.3	18.6	19.5	20.8	21.0	24.7	29.8	24.8
	16.5	14.4	16.2	15.5	16.4	15.6	18.2	15.9	16.0	14.2	18.3	16.5	17.2	16.6	18.0	16.8
G3	14.0	9.0	18.0	14.1	12.2	12.2	36.9	20.6	21.4	21.1	25.6	7.3	7.8	12.4	16.6	12.6
	7.4	10.2	14.3	7.2	11.5	7.3	18.0	10.0	13.2	17.7	26.1	5.8	6.0	5.7	9.1	8.7

Key: All numbers are standard deviations (* 1000) of changes in inflation rates between the countries in the corresponding rows and columns. The standard deviations for the pre-EMS period (August 1971–February 1979) and an equally long EMS interval (February 1982–August 1989) are reportet above and below the diagonal in the upper part of the table. Numbers in bold face characterize a higher variance of the series prior to the EMS and stars indicate the significance of the F-test on a change in the variance between regimes at a 1 percent level. The lower part of the table presents unweighted averages of the standard deviations (first pre-EMS, then EMS) of each country's inflation differential relative to the remaining countries in the ERM group (G1), the EC but non-ERM group (G2) and the three non-European countries (G3=US,C,J).

Tab. 5: Standard Deviations of Symmetric and Asymmetric Shocks to Consumer Price Inflation Rates, Quarterly Data, Sample Periods: 71Q3 to 78Q4 and 82Q1 to 89Q2.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		1.2* 1.3*	2.3** 2.2	0.6** 1.3	1.2** 1.7	1.4** 1.5	4.4** 4.8**
France	0.8 2.1		1.4** 3.1	1.0** 1.5	0.8** 2.3	0.8 2.2	3.9** 5.3**
Italy	1.1 2.4	0.6 3.1		2.1** 2.6	1.6** 3.3	1.5 3.3*	3.4** 6.3**
Holland	0.4 1.6	0.7 2.3	1.0 2.6		0.9* 2.0	1.4** 1.6	4.3** 4.9**
Belgium	0.7 1.9	0.5 2.6	0.6 3.0	0.6 2.1		1.3** 2.3	4.0** 5.4**
Denmark	0.5 1.6	0.8 2.3	1.1 2.6	0.5 1.7	0.7 2.0		3.7** 5.6**
Ireland	1.4 2.7	0.9 3.4	1.0 3.7	1.3 2.9	1.0 3.2	1.4 2.8	

Key: The lower (upper) numbers are standard deviations of sums (differences) of changes (Δ_4) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 6: Standard Deviations of Symmetric and Asymmetric Shocks to Monetary Base (M0) Growth Rates, Quarterly Data, Sample Periods: 71Q3 to 78Q4 and 82Q1 to 89Q2.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		5.6** 9.5**	6.4** 4.5**	4.3** 5.7**	3.6** 5.5**	8.7** 8.8**	5.1** 5.1**
France	3.5 3.1		8.9** 4.9	7.5** 6.0**	5.9** 7.1**	11.5* 7.9**	7.2** 6.4**
Italy	2.4 2.2	2.8 3.7		4.0** 4.0**	4.0** 2.9**	6.9** 9.4**	3.4** 4.7**
Holland	2.6 1.9	3.2 3.4	2.3 2.3		2.4** 3.0**	7.0** 8.8**	3.8** 3.1
Belgium	1.8 1.8	3.2 2.6	2.0 1.4	1.8 1.7		7.6** 7.7**	2.9* 2.7
Denmark	17.7 17.5	16.2 19.2	17.1 18.1	17.9 17.2	17.9 17.2		7.9** 8.0**
Ireland	2.4 2.5	2.9 3.8	2.0 2.8	2.4 2.5	1.9 2.0	17.3 18.0	

Key: The lower (upper) numbers are standard deviations of sums (differences) of changes (Δ_4) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre-EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub-period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 7: Standard Deviations of Symmetric and Asymmetric Shocks to Real Money (M1/P) Growth Rates, Quarterly Data Sample Periods: 71Q3 to 78Q4 and 81Q3 to 89Q1.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		*2.8*** *2.4***	1.5** 1.5**	1.1 1.8	1.0 1.3	1.2 1.9	2.1** 2.8**
France	1.0 1.0		*2.7*** *2.6***	2.7** 2.7**	2.4** 2.7**	*2.8*** *2.7***	3.1** 3.5**
Italy	0.8 1.0	0.9 0.9		*1.7* *1.6*	1.1 1.5**	1.6 1.9	2.2** 2.8**
Holland	1.2 1.6	*1.5* *1.4*	*1.5* *1.3*		1.3 1.5	1.3 2.1	2.0* 3.0**
Belgium	0.9 1.1	0.9 1.1	*1.0* *0.9*	1.4 1.5		1.2 1.7	2.0** 2.7**
Denmark	1.3 1.4	1.3 1.4	1.2 1.4	1.7 1.7	1.4 1.4		1.9 3.2**
Ireland	1.0 1.4	1.2 1.3	1.1 1.3	1.5 1.8	1.3 1.3	1.6 1.6	

Key: The lower (upper) numbers are standard deviations of sums (differences) of changes (Δ_1) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 8: Standard Deviations of Symmetric and Asymmetric Shocks to Nominal Short–term Interest Rates, Quarterly Data Sample Periods: 72Q1 to 78Q4 and 82Q4 to 89Q3.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		**2.5**** **4.7****	*5.4*** *4.8**	**3.4**** **5.5****	**3.2**** **4.2****	*5.2*** *5.0***	**3.0** **5.0***
France	1.6 2.8		**3.3**** **6.1**	**2.6** **5.6****	**1.5** **4.7**	**3.6**** **6.0****	**2.3** **5.1**
Italy	2.4 3.6	1.2 4.9		**4.3*** **6.6****	**2.8**** **6.3***	**3.9**** **7.5****	**4.2**** **6.1**
Holland	0.6 1.6	2.0 2.4	2.8 3.2		**2.2*** **5.7****	**4.3**** **6.6****	2.7 **6.1****
Belgium	1.3 2.5	1.1 3.7	1.6 4.5	1.5 2.2		**3.7**** **5.9****	**2.3** **5.0**
Denmark	2.2 3.1	1.8 4.2	2.2 5.0	2.5 2.7	1.7 4.0		**4.8**** **5.6**
Ireland	2.8 3.6	2.2 4.7	2.1 5.6	3.0 3.3	2.1 4.5	2.1 5.2	

Key: The lower (upper) numbers are standard deviations of sums (differences) of the levels of the variables for the two countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 9: Standard Deviations of Symmetric and Asymmetric Shocks to Long–term Interest Rates, Quarterly, Data, Sample Periods: 72Q1 to 78Q4 and 82Q3 to 89Q2.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		1.7 2.1	4.1** 2.2**	1.3** 2.3	1.8* 1.7**	2.5** 2.1	2.7** 3.3
France	1.4 2.9		2.5** 3.5*	0.6** 1.9*	0.6 1.7**	1.2 2.5*	1.9* 3.4
Italy	2.6 4.1	1.5 5.4		2.8 3.2	2.3* 3.5	2.2 4.1	2.6 4.8
Holland	0.2 1.9	1.3 3.1	2.5 4.3		0.7* 1.6*	1.4 2.4	1.9 3.4
Belgium	1.2 2.8	0.7 4.0	1.7 5.2	1.1 2.9		1.2 2.3*	2.0* 3.3
Denmark	1.7 2.9	1.2 4.2	2.0 5.3	1.5 3.0	1.3 4.0		2.1** 3.8
Ireland	1.7 2.9	1.3 4.1	2.4 5.2	1.6 3.0	1.3 4.0	1.5 4.1	

Key: The lower (upper) numbers are standard deviations of sums (differences) of the levels of the variables for the two countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 10: Standard Deviations of Symmetric and Asymmetric Shocks to 3–Month Real Interest Rates, Quarterly Data, Sample Periods: 71Q3–78Q4 and 81Q3–88Q4.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		3.5** 3.9**	*5.2*** *4.3***	4.0 6.6**	4.0** 5.0**	n.a. n.a.	*14.3*** *13.4***
France	2.2 2.2		4.3** 7.2**	4.3* 4.3**	3.6** 5.1*	n.a. n.a.	13.5** 13.7**
Italy	1.9 2.7	2.2 2.5		5.6** 6.0**	3.5** 5.9**	n.a. n.a.	12.1** 15.6**
Holland	*2.9* *2.7*	2.7 3.0	2.7 3.1		4.3* 6.6**	n.a. n.a.	*14.4*** *14.1***
Belgium	1.7 3.1	2.2 2.8	2.3 3.0	2.9 3.3		n.a. n.a.	13.5** 14.3**
Denmark	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.		n.a. n.a.
Ireland	*3.6* *3.1*	*4.4* *2.8*	*3.9* *3.0*	*3.9* *3.3*	3.7 4.0		

Key: The lower (upper) numbers are standard deviations of sums (differences) of the levels of the variables for the two countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 11: Standard Deviations of Symmetric and Asymmetric Shocks to Industrial Production Growth Rates, Quarterly Data, Sample Periods: 71Q3 to 78Q4 and 82Q2 to 89Q1.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		1.1 4.2**	2.3* 5.4**	1.3 3.7*	1.5 4.6**	2.3 2.6	1.2** 4.4**
France	1.3 1.9		1.9* 5.7**	0.9** 4.1**	1.2** 4.9**	2.6* 2.8**	1.7 4.4**
Italy	1.6 2.6	1.3 2.2		2.3* 5.2**	1.9 6.0**	3.7* 3.9**	2.7* 5.5**
Holland	1.1 2.7	1.6 1.7	1.7 2.6		1.3 4.5**	2.3 2.3	2.0 3.9
Belgium	1.1 2.1	0.8 1.5	1.4 2.2	1.3 2.0		*3.1*** *3.0***	2.0 4.8**
Denmark	*2.0* *1.9*	*1.8* *1.3*	*2.6* *1.5*	*2.2* *1.8*	*1.8* *1.4*		2.4 3.2**
Ireland	2.2 2.8	2.0 2.5	2.0 3.2	2.2 2.9	1.9 2.6	*3.0* *1.9*	

Key: The lower (upper) numbers are stabdard deviations of sums differences of changes (Δ_4) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the series between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 12: Standard Deviations of Symmetric and Asymmetric Shocks to Retail Sales Growth Rates, Quarterly Data, Sample Periods: 71Q3 to 79Q4 and 82Q2 to 89Q1.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		1.0** 1.1	1.7 1.8*	1.2 1.2*	0.9** 1.4	1.3* 1.7	1.4 1.4
France	*1.6* *1.3*		1.7** 2.0*	1.1 1.5*	1.2** 1.4	1.4** 1.7	1.3* 1.6**
Italy	*1.9* *1.3*	0.7 1.4		1.8** 2.0**	1.9** 1.9*	1.6** 2.5**	1.7** 2.3**
Holland	1.4 1.6	0.9 1.0	1.0 1.2		1.2 1.6	1.5 1.9*	*1.7*** *1.4*
Belgium	*1.8* *1.2*	0.7 1.2	0.8 1.4	0.9 1.1		1.5** 1.9	*1.8*** *1.4*
Denmark	*1.9* *1.3*	0.8 1.4	0.9 1.5	1.2 1.2	0.7 1.5		1.8** 1.9
Ireland	1.6 1.6	1.0 1.3	1.0 1.5	1.1 1.3	1.0 1.4	1.0 1.5	

Key: The lower (upper) numbers are standard deviations of sums differences of changes (Δ_1) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre-EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the series between the first and the second sub-period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 13: Standard Deviations of Symmetric and Asymmetric Shocks to Real Government Expenditure Growth, Quarterly Data, Sample Periods: 71Q3–78Q4 and 81Q3–88Q4.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		**2.0** **2.2**	5.7 **6.6****	2.0 3.2	4.1 4.4	n.a. n.a.	**4.5** **7.4****
France	*1.9* *1.8*		**5.7** **6.0****	1.8 2.0*	3.6 3.9	n.a. n.a.	**5.5**** **6.1****
Italy	*3.8* *3.5*	3.0 3.4		**5.5*** **6.6**	***7.2*** ***6.6***	n.a. n.a.	**6.2**** **9.8****
Holland	2.2 3.3	2.1 2.2	3.4 4.2		*4.3* *3.9*	n.a. n.a.	**5.2**** **6.8***
Belgium	4.2 4.8	4.1 4.3	5.1 5.4	4.3 5.0		n.a. n.a.	**6.4*** **7.3**
Denmark	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.		n.a. n.a.
Ireland	3.6 3.9	3.2 3.4	3.8 5.3	2.9 4.7	4.2 6.1	n.a. n.a.	

Key: The lower (upper) numbers are standard deviations of sums (differences) of changes (Δ_4) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 14: Standard Deviations of Symmetric and Asymmetric Shocks to Real Wage Growth Rates, Quarterly Data, Sample Periods: 71Q4 to 79Q4 and 82Q1 to 89Q1.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		0.9** 0.5**	1.7* 1.7**	1.2** 1.4	0.7* 0.6**	1.6** 1.5	5.1** 4.8**
France	1.6 1.1		1.6 1.8	1.2 1.4	0.7* 0.8**	1.2* 1.9	4.7** 5.2**
Italy	1.3 1.0	1.4 1.4		2.1** 1.9**	1.5** 1.8**	2.0** 2.4**	4.6** 5.7**
Holland	0.6 1.4	1.3 1.3	1.1 1.1		1.6** 0.9	1.3** 2.3**	5.1** 5.0**
Belgium	1.2 1.0	1.1 1.5	1.0 1.2	1.0 1.0		1.6* 1.5	4.8** 5.1**
Denmark	0.8 1.7	1.4 1.6	1.3 1.3	0.8 1.5	1.2 1.3		4.6** 5.6**
Ireland	1.2 2.1	2.0 1.8	2.0 1.5	1.5 1.8	1.8 1.6	1.6 2.0	

Key: The lower (upper) numbers are standard deviations of sums (differences) of changes (Δ_4) in the logs of variables for the countries in the rows and columns. Results are reported for both the pre-EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub-period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 15: Granger Causality Test Results for Real Wage Growth Dependence on Monetary Policy Shocks (Changes in Real Base Money) or Fiscal Policy Shocks (Changes in Real Government Expenditure), Quarterly Data, 79Q1 to 88Q2, m=n=4.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.988* .984*	.021 .981*	.664 .284	.887 .982*	.981* n.a.	.336 .620
France	.922 .985*		.985* .694	.996** .979*	.914 .869	1.00** n.a.	.262 .654
Italy	.912 .607	.214 .998**		.741 .988*	.793 .707	.794 n.a.	.360 .641
Holland	.532 .997**	.416 .171	.341 .026		.721 .574	.994** n.a.	.748 .641
Belgium	.927 .707	.390 .111	.458 .908	.554 .895		1.00** n.a.	.111 .289
Denmark	.988* n.a.	.947 n.a.	.995** n.a.	.998** n.a.	.998** n.a.		1.00** .874
Ireland	.722 .651	.345 .739	.936 .824	.243 .884	.436 .862	.874 n.a.	

Key: The numerical values are the marginal significance levels of the likelihood-ratio tests. λ_1 for the differences (above the diagonal) and λ_2 for the sums (below the diagonal) test the joint significance of 4 lagged changes (Δ_4) of the policy variables in the AR(4) autoregression of real wage growth (Δ_4). The upper (lower) likelihood-ratio tests are for the monetary (fiscal) policy shocks of the two countries in the rows and columns. Stars indicate the significance of these tests at 5(*) or 1(**) percent levels respectively. Bold numbers mark predominantly asymmetrical real wage behaviour from Table 14.

Tab. 16: Standard Deviations of Symmetric and Asymmetric Shocks to Standardized Unemployment Rates, Quarterly Data, Sample Periods: 71Q3 to 78Q4 and 81Q3 to 88Q4.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		0.6** 2.3**	1.2 1.8**	0.4** 2.9**	1.2 3.4**	1.4** 3.9**	3.2 5.7**
France	1.3 1.3		0.8 1.6	0.8** 2.6**	1.2* 3.2**	1.7 3.6**	3.5** 5.4**
Italy	*1.5* *1.3*	0.6 2.1		1.3* 2.1**	1.7 2.8**	2.3 3.1**	4.1** 4.9*
Holland	0.7 1.8	*1.8* *1.2*	*2.0* *1.0*		0.9* 3.7**	1.2** 4.2**	2.9 6.0**
Belgium	0.9 1.4	*1.7* *0.9*	*1.9* *0.7*	0.7 1.9		0.9 4.8**	2.6 6.5**
Denmark	0.9 1.6	*1.9* *0.8*	*2.0* *0.8*	0.6 2.0	0.8 1.7		2.1** 7.0**
Ireland	2.7 3.0	1.8 3.7	1.8 3.8	*3.3* *2.6*	*3.3* *2.4*	*3.4* *2.3*	

Key: The lower (upper) numbers are standard deviations of sums (differences) of the levels of the variables for the two countries in the rows and columns. Results are reported for both the pre–EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub–period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 17: Standard Deviations of Symmetric and Asymmetric Shocks to Current Account Indices, Quarterly Data, Sample Periods: 71Q3 to 78Q4 and 81Q3 to 88Q4.

	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		8.2** 9.1**	_14.1_** _9.5_**	_6.4_** _5.2_**	5.0** 6.2**	5.1** 5.8**	n.a. n.a.
France	18.2 26.7		9.2** 15.6**	6.4** 8.2**	_7.6_** _6.8_**	_7.5_** _6.6_**	n.a. n.a.
Italy	_35.4_ _35.1_	28.3 39.5		9.2** 12.8**	_12.0_** _9.9_**	_11.1_** _10.7_**	n.a. n.a.
Holland	_18.0_ _17.5_	15.3 16.5	28.8 33.4		_4.1_** _2.2_*	_3.1_** _2.9_**	n.a. n.a.
Belgium	14.4 20.7	13.3 18.4	29.8 32.7	6.7 7.4		_2.7_** _2.3_**	n.a. n.a.
Denmark	15.8 18.6	14.4 16.4	_31.0_ _30.9_	_6.4_ _4.6_	5.1 6.5		n.a. n.a.
Ireland	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.	n.a. n.a.

Key: The lower (upper) numbers are standard deviations of sums (differences) of the level indices of the variables for the two countries in the rows and columns. Results are reported for both the pre-EMS (above the diagonal) and EMS (below the diagonal) period. Italic numbers indicate predominantly asymmetric shocks, bold numbers mark a reduction in the variability of the shocks between the first and the second sub-period and stars characterize the significance of the heteroscedasticity test at 5(*) or 1(**) percent levels.

Tab. 18: Granger Causality Test Results for 3–Month Euro Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10, m=n=6.

to \ from	On–shore Germany	On–shore France	On–shore Holland	Off–shore Germany	Off–shore France	Off–shore Holland
On–shore Germany		.481 .251 .573	.123 .258 .912	.999** .997** .047	.982* .437 .991**	1.00** .999** .367
On–shore France	1.00** 1.00** .989		.994** .954* .451	.962 .741 .792	.994** .749 .987*	.996 .990 .464
On–shore Holland	.985* .979* .920	.979 .687 .925		.928 .745 .256	.815 .733 .995**	.984 .778 .451
Off–shore Germany	.997 .914 .541	1.00** 1.00** .961*	1.00** .995** .721		.993** .604 .994**	1.00** .999** .439
Off–shore France	.190 .055 .580	.304 .425 .645	.568 .550 .193	.749 .292 .902		.584 .504 .237
Off–shore Holland	.931 .816 .165	1.00** .990** .962*	.911 .772 .306	.988* .975* .203	.717 .609 .992**	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub-samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 1 percent level.

Tab. 19: Granger Causality Test Results for 3–Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10, m=n=6.

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.481 .251 .573	.123 .258 .912	**.853** .730 **.315**	**.306** .180 **.342**	n.a. n.a. n.a.	.334 .624 .201
France	1.00** 1.00** .909		.994** .954* .451	**1.00**** .994* **.945**	.989 .929 **.327**	n.a. n.a. n.a.	.489 .455 .542
Italy	.985* .979* .920	.979 .687 .925		**.946** **.870** **.870**	.897 .717 .826	n.a. n.a. n.a.	.707 **.933** .161
Holland	**1.00**** .999** **.736**	**.998**** .992** **.813**	.997 .839 .830		.995** .992** .067	n.a. n.a. n.a.	.960 .881 .856
Belgium	1.00** .993** .796	.990 .890 .395	.635 .362 .576	.604 .362 .815		n.a. n.a. n.a.	.691 .850 .877
Denmark	n.a. n.a. n.a.	n.a. n.a. n.a.	n.a. n.a. n.a.	n.a. n.a. n.a.	n.a. n.a. n.a.		n.a. n.a. n.a.
Ireland	.875 .722 .278	.716 .759 .286	.722 **.883** .360	.392 .256 .320	.950* .805 .976*	n.a. n.a. n.a.	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub-samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 1 percent level.

Tab. 20: Granger Causality Test Results for Call Money Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10, m=n=6.

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		**.636** .234 .845	.982* .979* .444	**.950** **.862** .887	.690 .293 .031	.977* .791 .141	.926 .819 .408
France	**1.00**** 1.00** .963*		.912 .943 .772	.480 .398 .823	1.00** 1.00** .222	.939 .918 .048	.144 .435 .474
Italy	.931 .953* .468	.832 .265 .997**		**.514** **.965*** .682	.835 .712 .359	.689 .640 .047	.765 .703 **.106**
Holland	1.00** .976* .999**	1.00** .997** .291	**.988** **.869** .885		.975 .885 .400	.885 .727 .002	.995** .993** .844
Belgium	1.00** .815 .999**	.838 .692 .643	.775 **.358** .910*	.317 .094 .889		1.00** .996** .998**	**.641** .678 **.973***
Denmark	.909 .414 .987*	.998 .915 .854	.703 .929* .061	.972* .785 .992**	.996** .992** .991**		.986* .961* 1.00**
Ireland	.455 .117 .994**	.263 .066 .453	.998** .889 **.970****	.811 .463 .818	**.840** .558 **.817**	.984 .834 **.848**	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub–samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 1 percent level.

Tab. 21: Granger Causality Test Results for Long–Term Government Bond Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10, m=n=6.

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		**.942** **.810** **.273**	.472 .842 .114	**.313** **.073** **.081**	**.180** .250 **.248**	.646 .909 .893	**.918** .581 .742
France	**.761** **.792** **.340**		.836 .993 .307	**.665** .755 **.426**	**.864** .884 **.809**	.750 .829 .899	**.957** .926 **.780**
Italy	1.00** .983* .999**	.987* .473 .956*		.999** .998** .991**	.943 .828 .618	.155 .314 .065	.336 .815 .662
Holland	**.787** **.408** **.597**	**.713** **.672** .187	.275 .900 .233		**.754** .837 **.605**	.787 .855 .878	.998** .967* .926
Belgium	**.939** .991** **.990****	**.978** .845 **.914**	.374 .205 .421	**.841** .958* **.954***		.077 .725 .276	.995** .967* .958*
Denmark	.531 .882 .500	.939 .996** .789	.554 .915 .278	.731 .963* .929	.900 .853 .835		.890 .975* .765
Ireland	**.455** .712 .656	**.160** .143 **.319**	.842 .329 .942	.208 .058 .315	.399 .047 .524	.506 .279 .348	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub-samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 1 percent level.

Tab. 22: Stability Test Results for Call Money Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10, m=n=6.

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.94 .16 .99** .99**	.92 .80 .99** .99**	.95* .59 .99** .99**	.84 .03 .99** .99**	.81 .09 .99** .99**	.90 .38 .99** .99**
France	.99** 1.0** .99** .99**		1.0** .97** .99** .99**	1.0** .79 .99** .99**	.99** 1.0** .99** .99**	.99** .90 .99** .99**	1.0** .85 .99** .99**
Italy	.61 .96* – –	.39 .77 – –		.83 1.0** – .95*	.49 .89 – –	.43 .86 – –	.45 .88 – –
Holland	1.0** .34 .99** .99**	1.0** .66 .99** .99**	1.0** .14 .99** .99**		1.0** .22 .99** .99**	1.0** .08 .99** .99**	1.0** .91 .99** .99**
Belgium	.64 .12 .99** .99**	.54 .30 .99** .99**	.63 .23 .99** .99**	.66 .23 .99** .99**		.64 .73 .99** .99**	.81 .73 .99** .99**
Denmark	.95* .13 .99** .99**	.83 .12 .99** .99**	.91 .77 .99** .99**	.96* .42 .99** .99**	.94 .87 .99** .99**		1.0** .96* .99** .99**
Ireland	.99** .41 .99** .99**	.97* .15 .99** .99**	.97* .32 .99** .99**	.98* .32 .99** .99**	.98* .39 .99** .99**	.97* .43 .99** .99**	

Key: The first and second numbers are the marginal significance levels of the likelihood–ratio test of Goldfeld and Quandt and the F–test of Chow respectively. The third and fourth numbers are the significance levels of the forward and backward Cusum–of Squares Tests of Brown, Durbin and Evans. All test statistics are reported for the 83M3 breaking point of the sample. Stars indicate the significance at 5(*) or 1(**) percent levels respectively.

Tab. 23: Granger Causality Test Results for Money Growth Rates (M1), Monthly Data, First Differences, Sample Period: 79M3 to 89M7,[1] m=n=9.

to / from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.462 .946 .504	.158 .213 .937	**.654** .940 **.472**	.994** **.951*** .942	.892 .989* .746	.993** .796 .963*
France	.805 .161 .837		.308 .723 .957*	.755 .689 .611	.438 .967* .374	.896 .871 .676	.295 .237 .733
Italy	.983* .999** .921	.584 .267 .412		.753 .997** .459	.442 .975* .883	.880 .968* .962*	.737 .999* .175
Holland	**.972*** .987* **.963***	.831 .912 .489	.385 .580 .520		.491 .901 .745	.466 .996* .907	.973* .927 .997**
Belgium	.998** **.986*** .995**	.719 .993** .744	.455 .959* .979*	.789 .977* .508		.756 .371 .580	.971* .998** .933
Denmark	.805 .906 .336	.980* .997** .986*	.312 .195 .559	.837 .077 .995**	.849 .986* .665		.863 .977* .931
Ireland	.806 .959* .637	.229 .336 .099	.848 .972* .768	.650 .433 .803	.994** .938 .996**	.784 1.00* .084	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both subsamples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 5 percent level.

[1]For the regressions including Belgium the sample period is 79M3 to 89M3.

Tab. 24: Granger Causality Test Results for Money Growth Rates (M2,M3), Monthly Data, First Differences, Sample Period: 79M3 to 89M6, m=n=9.

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.768 .695 .922	**.243** .112 .903	.834 .999** .991**	n.a. n.a. n.a.	.392 .495 **.961****	.487 .866 .870
France	.595 .413 .802		.933 .999** .998**	.707 .952* .469	n.a. n.a. n.a.	.883 .409 .956*	1.00** 1.00** .998**
Italy	**.072** .292 .580	.351 .550 .010		.166 **.868** .829	n.a. n.a. n.a.	.344 **.985*** .669	.680 .648 .355
Holland	.883 .998** .455	.106 .928 .875	.979* **.879** .904		n.a. n.a. n.a.	.585 .855 .855	.427 .995** .822
Belgium	n.a. n.a. n.a.	n.a. n.a. n.a.	n.a. n.a. n.a.	n.a. n.a. n.a.		n.a. n.a. n.a.	n.a. n.a. n.a.
Denmark	.981* .881 **.996****	.032 .067 .957*	.859 **.810** .941	.999** .949 .973*	n.a. n.a. n.a.		.307 .967* .689
Ireland	.926 .999** .931	.831 .451 .988*	.999** .999** .959*	.619 .946 .847	n.a. n.a. n.a.	.914 .920 .919	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub–samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 5 percent level.

Tab. 25: Granger Causality Test Results for Reserve Money (M0), Monthly Data, Twelfth Differences, Sample Period: 79M3 to 89M10, m=n=9.

to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.666 .910 .960*	.981* .901 .966*	.867 .991** .759	.930 .083 .996**	.133 .994** .453	.924 .398 .969*
France	.897 .877 .944		.986* **.754** 1.00**	.677 **.710** .935	**.253** .999** **.792**	.967* .740 1.00**	.575 .999** .849
Italy	.858 .998* .452	.949 **.996**** .996**		.015 **.806** .322	.765 .738 .375	.384 .545 .898	.093 **.870** .483
Holland	.886 .900 .958*	.174 **.806** .161	.083 **.857** .565		.721 .707 .698	.973* .271 .974*	.224 .810 .637
Belgium	.992** .979* .966*	.773 .641 **.908**	.980* .991** .423	.820 .993** .982*		.777 **.926** .544	.948 .883 .985*
Denmark	.864 .321 .979*	.814 .985* .865	.725 .999* .875	.695 .268 .675	.388 **.962*** .792		.705 1.00** .673
Ireland	.741 .916 .287	.905 .989** .836	.910 **.933** .969*	.996** .880 .999**	.507 .853 .688	.021 .181 .173	

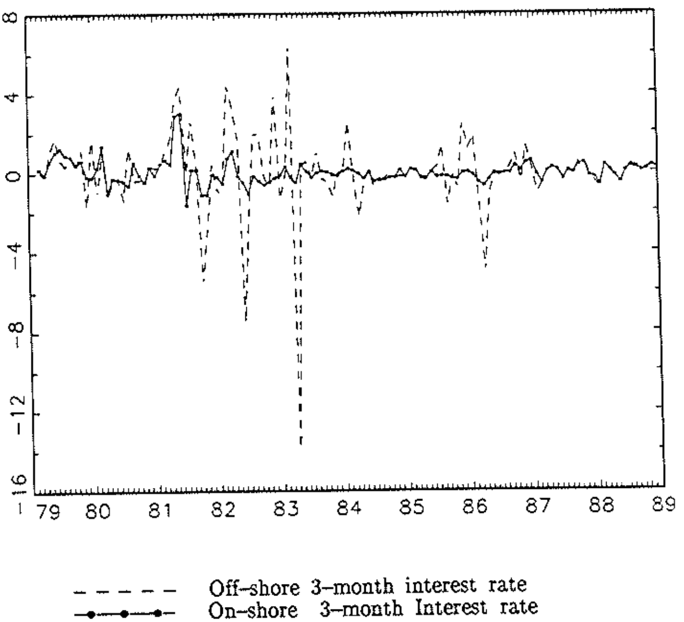
Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub–samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 5 percent level.

Tab. 26: Granger Causality Test Results for Foreign Exchange Reserves, Monthly Data, First Differences, Sample Period: 79M3 to 89M10, m=n=9.

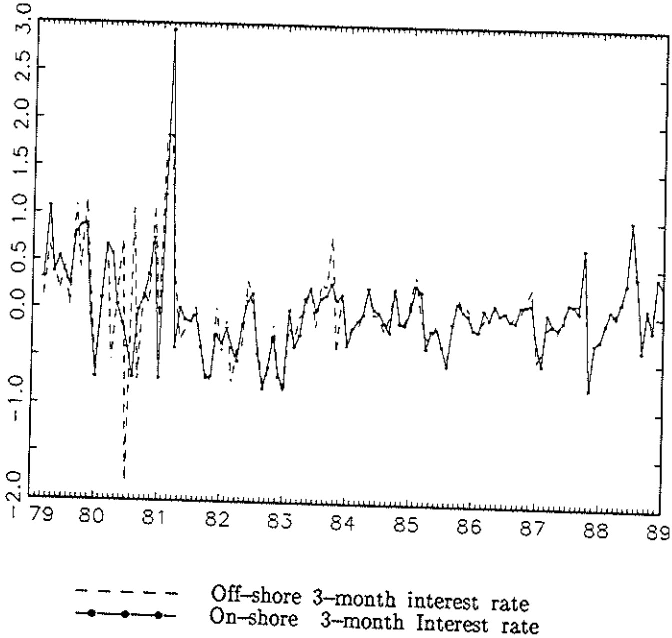
to \ from	Germany	France	Italy	Holland	Belgium	Denmark	Ireland
Germany		.682 .193 .987*	.006 .552 .185	.748 .839 .566	.233 .585 .796	.449 .591 .410	.956* .866 .997**
France	.584 .959** .355		.065 .533 .903	.991** .959* .818	.654 .645 .870	.128 .096 .904	.312 .715 .993**
Italy	.930 1.00** .620	.581 .477 .985*		.988 .861 .925	.975* .515 .989*	.043 .423 .232	.658 .361 .971*
Holland	.873 .875 .687	.109 .615 .981*	.442 .520 .254		.822 .884 .352	.103 .203 .134	.961* .777 .999**
Belgium	.658 .582 .828	.652 .867 .681	.640 .568 .297	.918 .972* .177		.011 .236 .036	.658 .826 .416
Denmark	.289 .173 .365	.612 .285 .791	.051 .125 .632	.205 .296 .462	.447 .558 .876		.603 .996** .962*
Ireland	.048 .969* .754	.442 .488 .962*	.062 .483 .240	.102 .081 .710	.871 .643 1.00**	.426 .956* .650	

Key: The numerical values are the marginal significance levels of the likelihood–ratio tests λ_1 and λ_3. λ_1 (above the diagonal) and λ_2 (below the diagonal) tests the joint significance of 6 lags of the variables of the country in each column in the regression of the country in each row. Tests are reported for the overall sample (top) and for both sub-samples, with 83M3 as breaking point. Stars indicate the significance at 5(*) or 1(**) percent levels respectively. Bold numbers point to the additional significance of the likelihood–ratio test for instantaneous 'Granger causality' or co–movements between the variables at a 5 percent level.

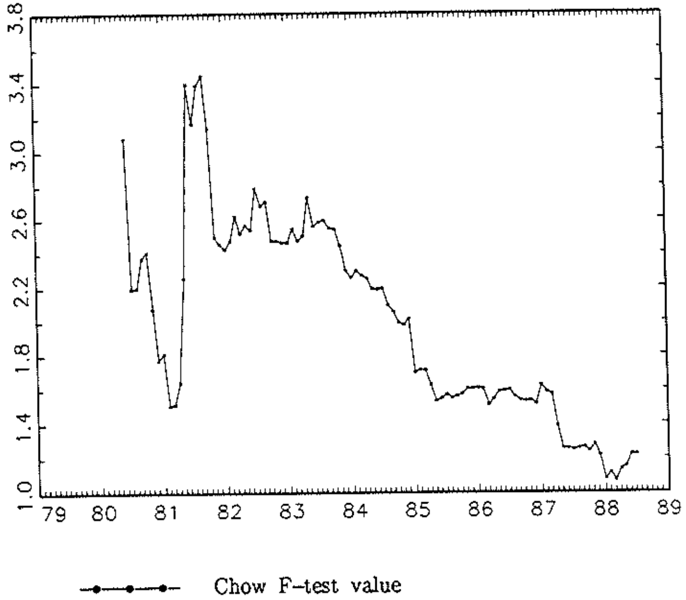
Graph 1: Time Path of French 3-Month Domestic Interest Rates and 3-Month Euro Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,



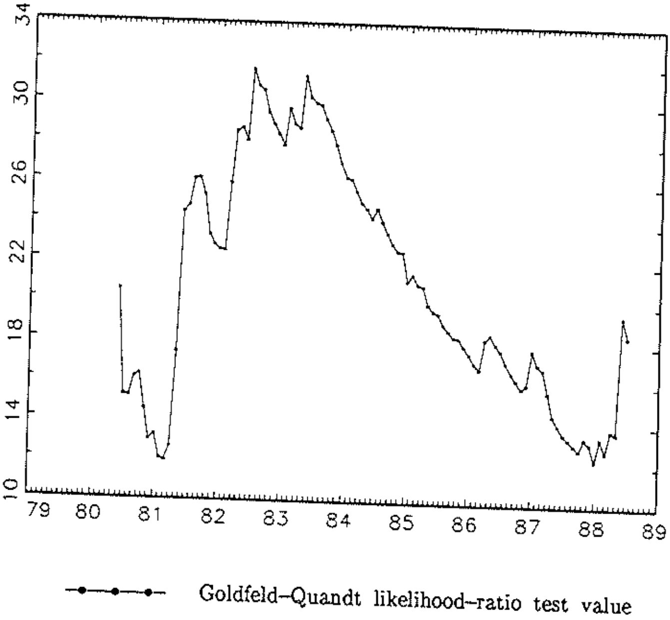
Graph 2: Time Path of German 3–Month Domestic Interest Rate and 3–Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,



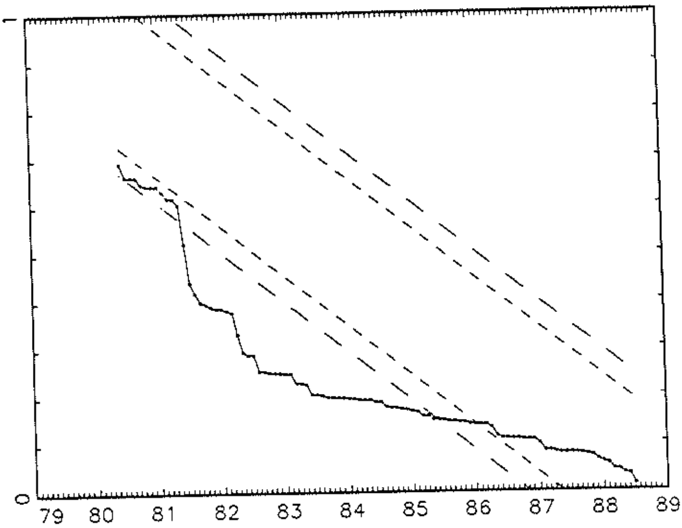
Graph 3: Time Path of Chow F–test Test for 3–Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,



Graph 4: Time Path of Goldfeld–Quandt Likelihood–Ratio Test for 3–Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,

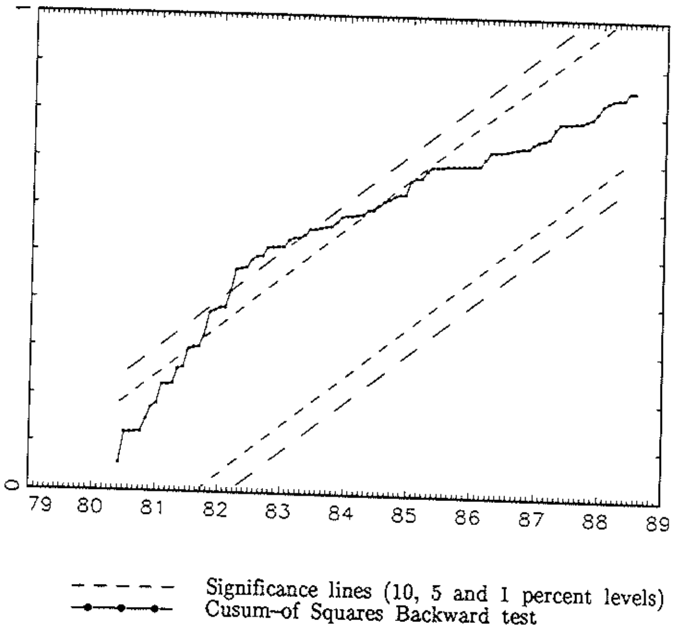


Graph 5: Time Path of Brown, Durbin and Evans Cusum–of–Squares Backward Test for 3–Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,



- - - - - Significance lines (10, 5 and 1 percent levels)
—•—•—•— Cusum–of Squares Backward test

Graph 6: Time Path of Brown, Durbin and Evans Cusum-of-Squares Forward Test for 3-Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,



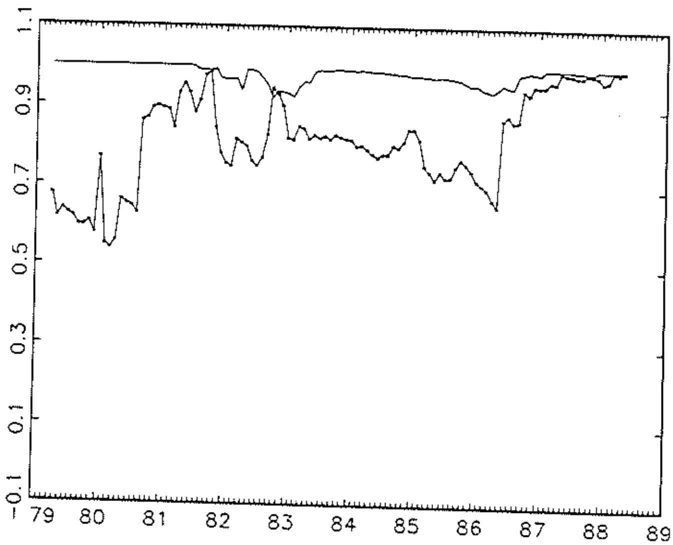
Graph 7: Time Path of Granger Causality Test for French–German 3–Month Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,

——— Causality runs from Germany to France (λ_1)

—•—•— Causality runs from France to Germany (λ_3)

.... Significance lines (10, 5 and 1 percent levels)

Graph 8: Time Path of Granger Causality Test for French–German Call Money Interest Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,

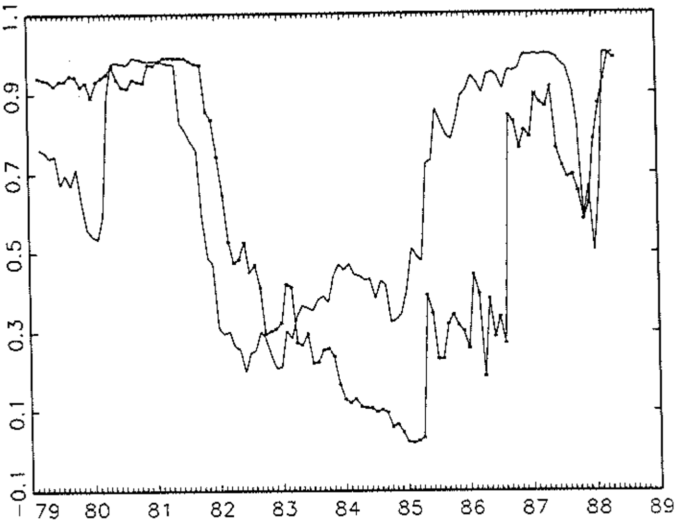


Causality runs from Germany to France (λ_1)

Causality runs from France to Germany (λ_3)

Significance lines (10, 5 and 1 percent levels)

Graph 9: Time Path of Granger Causality Test for French–German Government Bond Rates, Monthly Data, First Differences, Sample Period: 79M3 to 89M9,



——————— Causality runs from Germany to France (λ_1)

—•——•——•— Causality runs from France to Germany (λ_3)

.... Significance lines (10, 5 and 1 percent levels)

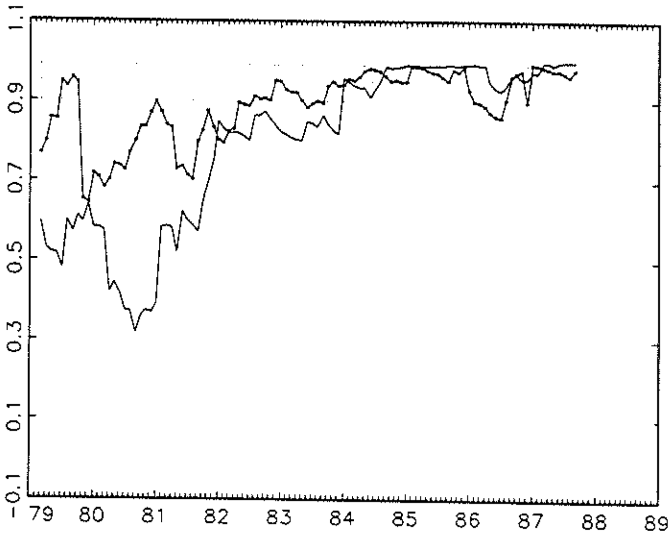
Graph 10: Time Path of Granger Causality Test for French–German Money Growth Rates (M1), Monthly Data, First Differences, Sample Period: 79M3 to 89M7,

——— Causality runs from Germany to France (λ_1)

—•—•—•— Causality runs from France to Germany (λ_3)

········· Significance lines (10, 5 and 1 percent levels)

Graph 11: Time Path of Granger Causality Test for French–German Money Growth Rates (M2,M3), Monthly Data, First Differences, Sample Period: 79M3 to 89M6,

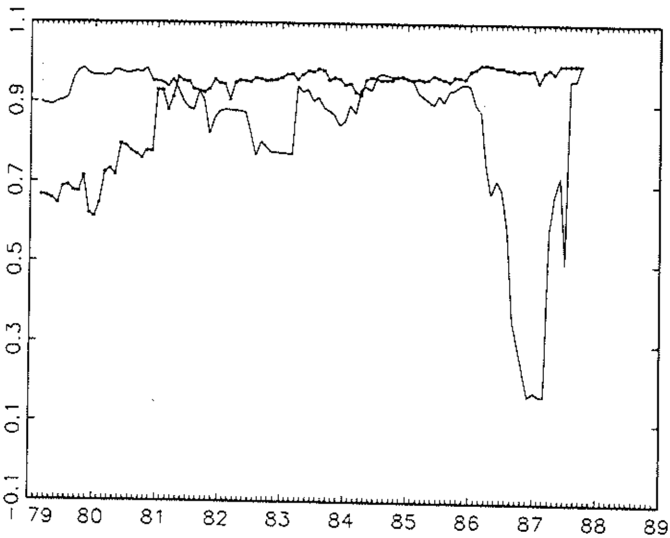


——— Causality runs from Germany to France (λ_1)

–•–•–•– Causality runs from France to Germany (λ_3)

········ Significance lines (10, 5 and 1 percent levels)

Graph 12: Time Path of Granger Causality Test for French–German Reserve Money (M0), Monthly Data, Twelfth Differences, Sample Perid: 79M3 to 89M7,

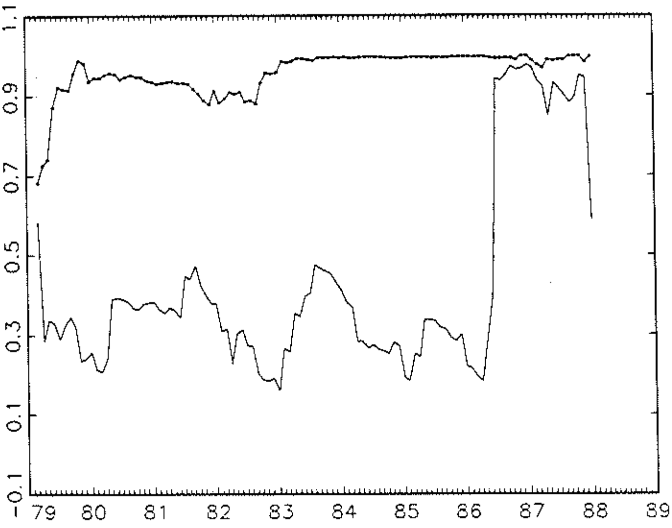


——— Causality runs from Germany to France (λ_1)

—•—•—•— Causality runs from France to Germany (λ_3)

.... Significance lines (10, 5 and 1 percent levels)

Graph 13: Time Path of Granger Causality Test for French–German Foreign Exchange Reserves, Monthly Data, First Differences, Sample Period: 79M3 to 89M10,



——— Causality runs from Germany to France (λ_1)
—•—•—•— Causality runs from France to Germany (λ_3)
.... Significance lines (10, 5 and 1 percent levels)