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IS THE EUROPEAN MONETARY SYSTEM A DM-ZONE?

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ABSTRACT

Is the European Monetary System a DM-Zone?*

In this paper we analyse issues of symmetry and asymmetry in the workings of the EMS. We first measure how interest rates react to speculative disturbances. We find that despite the fact that speculative shocks have usually forced the *offshore* interest rates of the weak currencies to increase by the full amount of the expected realignments, these countries managed (almost) completely to insulate their *domestic* interest rates from speculative crises. They achieved this by capital controls and other instruments of market segmentation. Second, using Granger-causality tests, we find that the interdependence of interest rates is more symmetric than is usually assumed, involving, for example, an important two-way interdependence between Germany and France. In addition, we find that the domestic Italian money market is relatively isolated from the rest of the system.

JEL classification: 431, 432
Keywords: European Monetary System, symmetric and asymmetric exchange rate systems

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NON-TECHNICAL SUMMARY

The view that the EMS is a de facto Deutschmark zone is widespread. It stems from an interpretation which sees Germany as the centre country, determining its monetary policy more or less independently from the rest of the EMS. The other members peg their currencies to the DM and, in so doing, subordinate their monetary policies to German policy.

Whether the EMS works in an asymmetric way is important for discussions of the system's future institutional shape. Evidence that the system's success derives from the dominant role of Germany would indicate that Germany should be given a prominent role in future institutions; but if the system has worked in a symmetric way, such prominence would not be warranted.

In this paper I analyse issues of symmetry and asymmetry in the workings of the EMS, first by measuring how interest rates react to speculative disturbances. I find that in the offshore markets, speculative shocks have usually forced the interest rates of the weak currencies to increase by the full amount of the expected realignments, leaving the DM-interest rate unaffected. A second way to study the asymmetric operation of the EMS is to analyse the nature of the interdependence of interest rates. Using Granger-causality tests, I find that this interdependence is much more symmetric than is usually believed.

In efficient markets and in the absence of risk premiums, the forward premium (discount) on a currency reflects prevailing expectations about the rate at which it will appreciate (depreciate). If the open interest parity condition holds, interest rates in one country, e.g. France, are equal to interest rates in another country, e.g. Germany, plus the rate at which the DM is expected to appreciate. When, for some exogenous reason, agents expect a revaluation of the DM against the French franc, the forward premium of the DM will rise. This must lead either to an increase in French interest rates or to a decline in German rates or to some combination of both. Precisely how this speculative shock is absorbed by interest rate changes depends on how the two countries conduct their monetary policies.

An expected revaluation of the DM leads to purchases of DM and sales of FF. To defend the exchange rate the French authorities sell DM and buy FF. The sales of DM tend to increase the money stock in Germany. In an asymmetric situation the German authorities set German money stock independently of what happens in the exchange market. They sterilize the sales of DM, and the German money market is unaffected by the speculative disturbance. The whole adjustment comes from France in the form of an increase in French interest rates. By contrast, a symmetric adjustment implies that Germany allows the speculative disturbance to affect its domestic money market, so there is both a decline in German interest rates and an increase in French rates.

If one or more countries use capital controls, the open interest parity condition does not hold and adjustment to an expected realignment is different. If France, for example, has capital controls the authorities can keep the domestic money stock and interest rates unchanged. Even though Germany sets its money stock independently, the adjustment to the speculative disturbance becomes symmetric.

Data on French and German offshore interest rates and on the forward premium of the DM against the FF show that during periods of speculative pressure, when the forward premium increased, most of the interest rate adjustment took the form of increases in the French rate. Data on German and Italian offshore rates display a similar pattern. This would seem to confirm that the EMS has worked asymmetrically.

In countries with capital controls, however, domestic and offshore interest rates may diverge significantly during speculative crises. Comparisons of French and Italian domestic rates with their German counterpart and with the forward premium for the DM indicate very little asymmetry. The variability of the domestic interest rates of weak-currency countries has been much less than that of their offshore rates. France, Italy and Belgium seem to have been able almost completely to insulate their domestic rates from speculative shocks.

I test more formally for the degree of asymmetry in the EMS by specifying a model which explains the monthly change in the interest rate in an EMS country (other than Germany) by its own past, by the monthly (past and present) change in the US interest rate, and by the change in the forward premium of the DM against its currency. For the German interest rate a similar equation is specified which includes the forward premiums for all EMS currencies against the DM, because each can potentially influence the German rate. If the coefficient that measures the increase in the other country's interest rate in response to a rise in the DM forward premium is close to 1, the system is asymmetric, since that country is forced to adjust its interest rate by the full amount of the expected future devaluation; but if it and the coefficient on the German rate are both close to 0.5, the two countries share the interest-rate adjustment.

I first estimate the model, with a SURE estimation procedure, using monthly observations of EMS offshore interest rates during 1979-88. The results produce coefficients for the increase in the interest rates of non-DM currencies very close to 1, indicating that changes in the forward premium of the DM against the other EMS currencies have been completely absorbed by changes in the offshore rates of the others, while the DM interest rate has been completely unaffected. This implies that the hypothesis that the EMS has worked in an asymmetric way cannot be rejected.

Estimation of the same equations using domestic interest rates produces quite different results, particularly for weak-currency countries that have capital controls. For France and Belgium (which has a dual exchange market system) the coefficient measuring the increase in the domestic interest rate is only 0.11, and for Italy it is close to zero. Since domestic interest rates have been largely unaffected by speculative crises, the EMS de facto has worked in a relatively symmetric way, allowing both Germany and the weak-currency countries to insulate their markets from speculative disturbances – Germany by sterilization policies, and the others by capital controls.

The results for the Netherlands, which has not used capital controls, suggest that in an environment of free capital mobility neither it nor Germany was completely able to insulate the domestic interest rate from speculative shocks involving the DM/guilder rate. That Germany could not completely insulate its money market from these disturbances is surprising.

The recent decisions to eliminate capital controls completely by 1990 will certainly affect the nature of these interest rate relations. When speculative crises occur more upward pressure will be exerted on the domestic interest rates of the weak currencies. It is, however, also likely that these disturbances will put more downward pressure on the German domestic interest rate than has been the case up to now. It is too early to tell whether the liberalization of the capital flows within the EMS will make it more or less symmetric.

Evidence that national authorities in EMS countries have been able to insulate their domestic interest rates from speculative disturbances does not mean that members' interest-rate policies have been determined independently of one another. I use Granger-causality tests to determine the nature of this interdependence. The first step in the test involves regressing the change in the interest rate of an EMS country on its own past changes and on past (changes) in the US interest rate. The second stage involves adding to this regression the past changes in the interest rate of another EMS country and testing whether the addition of the other country's interest rate adds significant explanatory power to the equation. These tests measure how far one EMS interest rate affects another EMS rate, given the US influence on both of them.

I apply the tests to short-term and then to long-term domestic interest rates, setting lags at six months. In the case of German short-term rates, the German rate appears to be significant in explaining rates in France, the Netherlands and Belgium, but also the French and Belgian rates are significant in explaining the German rate. French rates are also important for rates in the Netherlands, and there is two-way causality between France and Belgium. Italy's rate is 'Granger-caused' by France but not by Germany and seems not to affect the French or German rate. This suggests that the Italian money market has been relatively insulated from EMS influences.

The tests using long-term interest rates suggest that, given the US influence, there are few cases in which one EMS rate contributes additional power in explaining other long-term EMS rates. Surprisingly, one of the exceptions is that the French rate helps explain the German rate. In general the Granger-causality tests suggest little asymmetry: they indicate two-way interdependence for a number of short-term domestic interest rates and an absence of interdependence for most long-term rates.

I also present some information on contemporaneous dependencies, which Granger-causality tests disregard. The contemporaneous correlation of the changes in short-term domestic interest rates generally appear to be relatively small, but the correlations for long-term rates are substantially higher. The evidence does not, however, reveal asymmetries in the interdependence of interest rates within the EMS. This requires further research using more frequent (e.g. weekly) observations.

The evidence provided in this paper is not consistent with the popular view that the EMS has operated as a DM-zone, in which the German monetary authorities set their monetary policies so that the other countries are forced to follow suit. The empirical evidence presented here suggests that the EMS works in a more symmetric way than is commonly assumed. These findings may have some implications for the future shape of the EMS institutions. A recent proposal by Thygesen argues that the asymmetric working of the EMS necessitates an asymmetric institutional set-up of the system, in which Germany would play a special role. Although it may be desirable that one country takes a leadership position in future EMS institutions, the argument for such an asymmetry should not be based on the present workings of the System. German leadership in monetary policy-making within the EMS has been weaker than many observers have concluded. This also suggests that the success of the EMS may have relatively little to do with German leadership. As a result, it is doubtful that future EMS institutions need to give a special role to Germany in order for these institutions to be robust.

Introduction

It has been claimed by many observers that the EMS works in an asymmetric way. In this asymmetric interpretation of the workings of the EMS, Germany is seen as the center country which determines its monetary policy more or less independently from what happens in the rest of the EMS. The other countries peg their currencies to the DM and, in so doing, subordinate their monetary policies to German policies. This interpretation of the EMS has led to the widespread view that the system is de facto a Deutsche-mark zone. It is no exageration to state that this interpretation of the workings of the EMS has become the conventional wisdom[1].

Recently, this view has been challenged by Fratianni and von Hagen[2]. These authors analyzed the behavior of the monetary aggregates in the EMS, and concluded that there is little evidence for the asymmetric hypothesis.

The issue of symmetry and asymmetry in the workings of the system is an important one for the discussion about the future institutional shape of the EMS. For example, if there is evidence that the system's success is due to the dominant role of Germany, one may have to give this country a prominent role in the future EMS institutions[3]. If on the other hand, it appears that the system has worked in a symmetric way, the institutional reforms of the system would not need to give the same prominence to one country.

In this paper some additional evidence on the symmetry issue is presented. We will concentrate on the behavior of the interest rates in the EMS, and analyze in what sense, if any, it can be said that Germany has dominated the behavior of interest rates in the EMS.

The issue of asymmetry in the EMS is analyzed in two steps. First, we concentrate on the question of how expectations of realignments have affected interest rates. Second, we study the nature of the interdependence of the interest rates in the EMS, using Granger-causality tests.

I. Expected Realignments and Adjustments in Interest Rates

It is useful to start from the (closed) interest parity condition, which can be written as follows :

$$r_F = r_G + fp \qquad (1)$$

where r_F and r_G are the interest rates in country F (France) and G (Germany); fp is the forward premium of the German mark relative to the French franc.

In efficient markets and in the absence of risk premia, the forward premium (fp) reflects prevailing expectations about the rate at which the DM will be revalued against the French franc in the future. We then obtain the open interest parity condition :

$$r_F = r_G + \mu \qquad (2)$$

where μ is the rate at which the mark is expected to be revalued in the future. In a later section of this paper, risk premia produced by capital controls are introduced.

We now consider what happens when, for some exogenous reason, agents expect a future revaluation of the DM relative to the FF. Such an expectation will increase the forward premium of the DM (μ). It is then immediately clear from equation (2) that this must lead to an increase in the French interest rate (r_F) and/or a decline in the German interest rate (r_G). There are infinitely many combinations of French interest rate increases and German interest rate declines which can sustain this change in expectations.

The precise manner in which this speculative shock is absorbed by interest rate changes then depends on the way the two countries conduct their monetary policies. Consider, first, an asymmetric situation in which Germany sets its money stock independently from what happens in the DM/FF exchange market. The adjustment mechanism can then be described as follows. The expected revaluation of the DM leads to purchases of DM (sales of FF). In order to keep the DM/FF rate within the margins, the Banque de France will sell DM (buy FF). The sale of DM tends to increase the money stock in Germany. This effect, however, is automatically sterilized by the German authorities (who are assumed not to change their money targets). As a result, the German money market will be unaffected by the speculative disturbance. It also follows that the whole

adjustment will have to come from France by an increase in the French interest rate.

A second adjustment mechanism is symmetric. This one implies that Germany allows the domestic money market to be affected by the speculative disturbance. This adjustment mechanism then also implies that the German interest rate declines, and that the French interest rate increases. It follows that the degree of deflation imposed on France is reduced compared to the asymmetric system.

In the previous discussion, it was assumed that open interest parity holds perfectly. If one or more countries use capital controls, however, there will be deviations from interest parity. This also allows for the adjustment following the expected realignment to be different than the one discussed in the previous paragraphs.

One can formalize the capital controls as follows[4]. Capital controls have the effect of introducing a wedge in the interest parity condition, i.e.

$$r_F - (r_G + \mu) = \pi \qquad (3)$$

where π reflects the wedge in the interest parity condition introduced by capital controls in France.

The implications for the adjustment mechanism following a speculative disturbance can be described as follows. The expected devaluation of the franc leads to a positive μ in equation (3). The French capital controls, if fully

effective, lead to an offsetting movement in π. As a result, the French interest rate does not change. In this case, both the domestic French money market and the German money market are insulated from the speculative disturbance. Thus, even in an asymmetric system (in which Germany pursues its independent domestic policy), the existence of capital controls allows the French authorities to keep the domestic money stock and interest rate unchanged, at least if capital controls can be made to work perfectly. In that case, the adjustment to the speculative disturbance becomes symmetric, even though Germany sets its money stock independently.

In practice, it will often be difficult to implement tight capital controls. The adjustment in π will then be less than the change in μ, so that France must allow a partial adjustment in its money market. Asymmetry will reappear, because capital controls cannot completely segment the two markets.

The previous theoretical discussion has set the stage for measuring the degree of asymmetry in the workings of the EMS. During periods of speculative crises, the forward premia (discounts) increase. This necessitates a combination of an interest rate increase in the weak-currency country and an interest rate decline in the strong-currency country. If the system works symmetrically, the upward and downward movements in the interest rate

should be (approximately) equal in absolute value. In an asymmetric adjustment system, this will not be the case.

Before describing the econometric procedure used to measure the degree of asymmetry, it is useful to look at the time series of the interest rates in the EMS. Some preliminary information is presented in Figures 1 and 2. Figure 1 presents the French and German offshore interest rates together with the forward premium of the German mark relative to the French franc. It can be seen that during periods of speculative pressure, when the forward premium increased, most of the interest rate adjustments took the form of increases in the French interest rate. The same conclusion can be drawn from Figure 2 which compares the Italian interest rate to the German one.

From this visual evidence, one may be tempted to conclude that the EMS has worked in an asymmetric way, forcing the weak currency countries to do all the monetary adjustment, and allowing the German authorities to insulate their domestic money markets from these speculative disturbances[5].

This conclusion, however, is not warranted. In Figures 1 and 2, we have compared the offshore interest rates. In countries where capital controls exist, the domestic interest rates may deviate significantly from the offshore interest rates during periods of speculative crises. This can also be seen from equations (2) and (3). The former

equation determines the French offshore interest rate, whereas equation (3) determines the French domestic interest rate. The difference between the two interest rates then will be equal to π. During periods of speculative crises, π will tend to increase so as to shield the domestic interest rate from speculative movements.

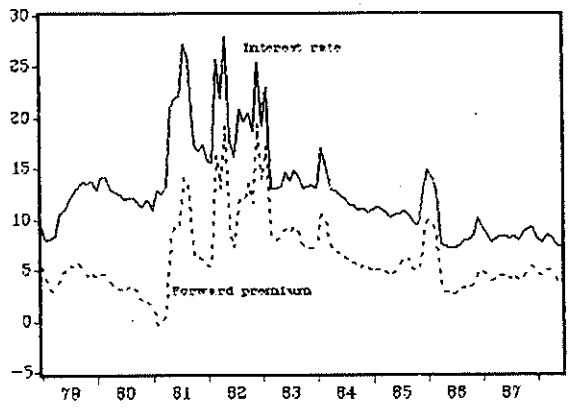
This is confirmed by Figures 3 and 4. It can be seen that especially during periods of speculative disturbance, the differential between the domestic and the offshore interest rates of the same currencies increases in countries like France and Italy.

In Figures 5 and 6, we, therefore, compare the French and Italian domestic interest rates with their German counterpart and with the forward premium of the mark. It is now less obvious that the system has worked in an asymmetric way. We observe that during the periods of speculative crises (high forward premia), the French and Italian domestic interest rates do not seem to be affected very much. There is one interesting exception during the period 1981-82 in France. The French domestic interest rate increases significantly during periods of strong increases in the forward premium of the DM. From 1983 on, however, little movement in the French domestic interest rate is observed during similar periods of speculative crises.

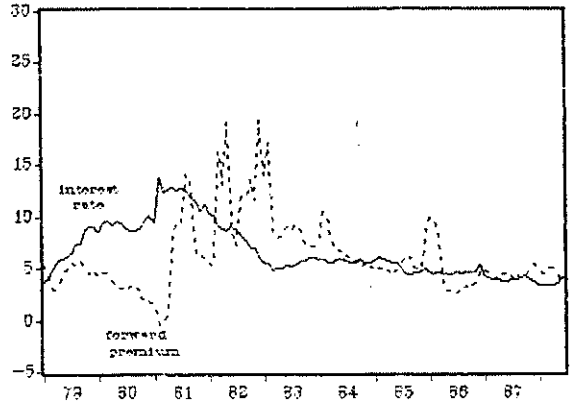
The visual evidence of Figures 1 and 2 and of Figures 5 and 6 also makes clear that the variability of the offshore

interest rates has been much higher than the variability of the domestic interest rates in the weak currency countries. This is confirmed by Table 1 which presents the conditional and the unconditional standard deviations of the monthly changes in the EMS interest rates. It can be seen that in the offshore markets, the variability of the French, Italian and Belgian interest rates has been substantially higher than the German (and Dutch) interest rates. This difference in the variability of the interest rates, however, disappears completely in the domestic money markets. Thus, despite large variabilities of the offshore interest rates, which are associated with speculative disturbances, France, Italy and Belgium seem to have been able to almost completely insulate their domestic interest rates from these speculative shocks.

Figure 1 : French Offshore 3 month interest rate and forward premium DM/FF

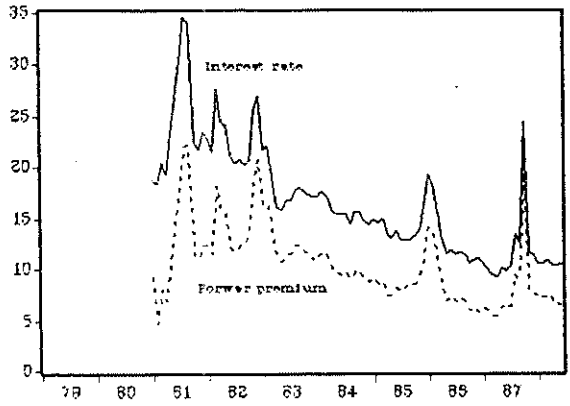


German Offshore 3 month interest rate and forward premium DM/FF

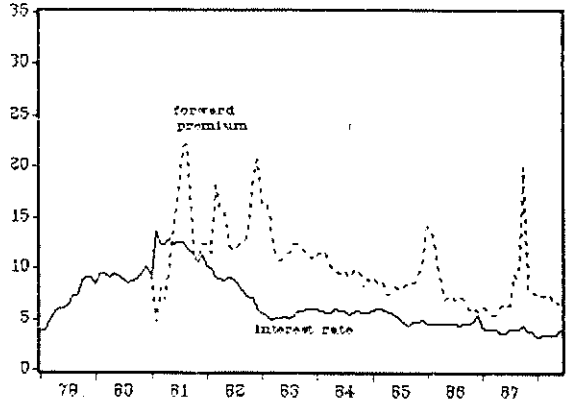


Source : Wharton Econometrics

Figure 2 : Italian Offshore 3 month interest rate, forward premium DM/Lira



German Offshore 3 month interest rate, forward premium DM/Lira



Source : Wharton Econometrics

Figure 3 : Differential Offshore and domestic interest rate (3 month) France

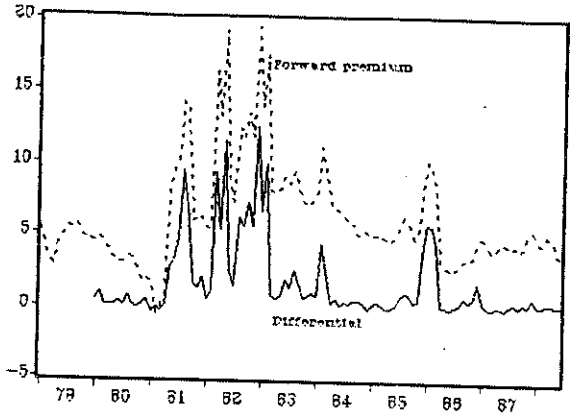
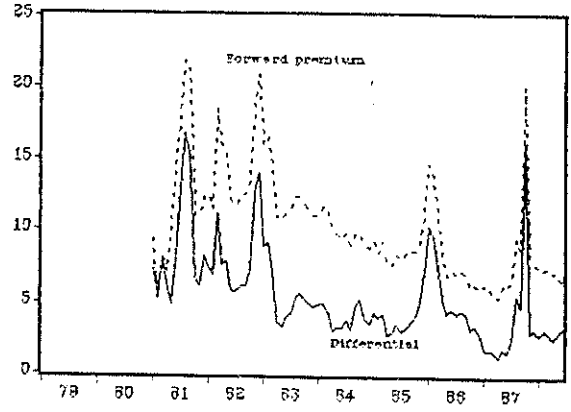


Figure 4 : Differential Offshore and domestic interest rate (3 month) Italy



Source : Wharton Econometrics

Figure 5 : French domestic interest rate (3 month) and forward premium DM/FF

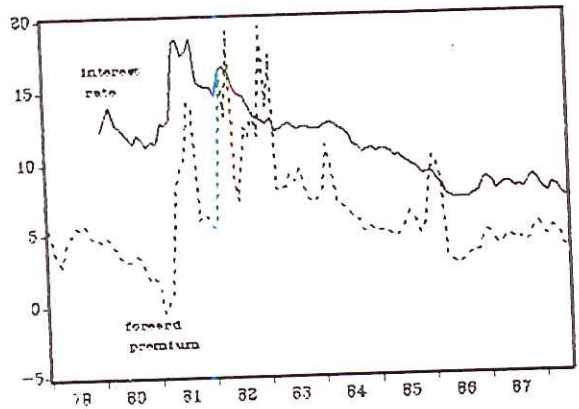
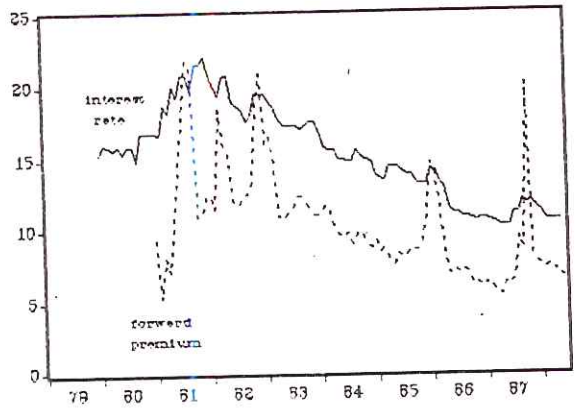


Figure 6 : Italian domestic interest rate (3 month) and forward premium DM/Lira



Source : Wharton Econometrics.

Table 1 : Unconditional and conditional standard deviations of the monthly changes of the offshore and the domestic interest rates in the EMS

	Unconditional	Conditional
Offshore interest rates		
France	2.91	2.37
Germany	0.61	0.53
Italy	2.84	2.51
Netherlands	0.55	0.43
Belgium	1.70	1.30
Domestic interest rates		
France	0.81	0.67
Germany	0.61	0.53
Italy	0.66	0.52
Netherlands	0.44	0.55
Belgium	0.64	0.59

Note : The conditional standard deviation was obtained by regressing the changes of the interest rates on their own past changes (with six lags) and on the changes of the US interest rate (present and past). The standard deviation of the residuals of these equations was used as the measure of the conditional standard deviation.

Source : Wharton Econometrics. The domestic interest rates are the treasury bill rates, except for France where we use the commercial paper rate.

The previous evidence was descriptive. One can test more formally for the degree of asymmetry in the EMS as follows. We first specify a simple model which explains the monthly

change of the interest rate in country K (an EMS country outside Germany) by its own past, by the monthly change in the US interest rate (past and present), and by the change in the forward premium of the German mark relative to currency K:

$$\Delta r_{K,t} = \sum_{i=1}^{n} \alpha_{iK} \Delta r_{K,t-i} + \sum_{i=0}^{n} \beta_{iK} \Delta r_{A,t-i} + b_K \Delta fp_{GK} + u_{Kt} \quad (4)$$

where r_K is the interest rate in country K, fp_{GK} is the forward premium of the mark relative to currency K, and r_A is the US interest rate (which can be assumed to be exogenous). The model implies that when the forward premium of the mark relative to currency K increases, this will increase the interest rate in country K, as measured by the coefficient b_K[6].

A similar equation is specified for the German interest rate. However, since the forward premium of the mark relative to the currency K can potentially influence the German interest rate, one has to include all these forward premia in the German equation. Thus we have

$$\Delta r_{G,t} = \sum_{i=1}^{n} \alpha_{iG} \Delta r_{G,t-i} + \sum_{i=0}^{n} \beta_{iG} \Delta r_{A,t-i} + \sum_{K=1}^{4} e_K \Delta fp_{GK} + u_{Gt} \quad (5)$$

The estimation of equations (4) and (5) allows us to measure the degree of asymmetry of the system from the estimated coefficient b_K. If b_K is close to 1 (and e_K close

to 0), the system is asymmetric, in that it forces country K to adjust its interest rate by the full amount of the expected future depreciation, leaving the German interest rate unaffected. If b_K and e_K are close to 0.5 both country K and Germany share in the adjustment of the interest rate to expectations of future exchange rate changes.

The model was estimated using, first, monthly observations of offshore interest rates of the EMS countries during the sample period 1979-88. Since the interest rates in equations (4) and (5) are influenced by common factors, one can expect that the disturbance terms are correlated across equations. Therefore, a SURE estimation procedure was used. The results are presented in Table 2. (The coefficients of the lagged own interest rates and of the US interest rates are omitted here. The complete estimation results are presented in the appendix).

Table 2 : Estimation of equations (4) and (5); Offshore interest rates

	b_K	e_B	e_F	e_I	e_N	R^2	DW
Belgium	1.00 (0.01)					0.96	1.78
France	0.99 (0.01)					0.99	1.81
Italy	1.00 (0.01)					0.99	1.78
Netherlands	0.99 (0.04)					0.53	1.80
Germany		0.00 (0.01)	0.00 (0.01)	0.00 (0.00)	-0.02 (0.04)	0.20	1.82

Note : The numbers in parenthesis are the standard errors of the coefficiient.

The results of Table 2 lead to the conclusion that changes in the forward premium of the mark against the other EMS currencies have been completely absorbed by changes in the offshore interest rates of the non-DM currencies, leaving the DM-interest rate completely unaffected. This can be seen from the estimated coefficients b_K, which are all very close to one, and from the coefficients e_K, which are close to 0. This implies that one cannot reject the hypothesis that the EMS has worked in an asymmetric way, i.e. expectations of future realignments were completely absorbed by interest rate increases in the offshore segment of the EMS members outside Germany. By the same token, the German offshore market was completely insulated from these expectational disturbances.

As argued earlier, these reactions in the offshore markets should not necessarily lead to the conclusion that the EMS has worked asymmetrically. We also have to analyze the behavior of the domestic interest rates. The relative separation of the offshore and domestic money markets, produced by the existence of capital controls (or other regulations, such as dual markets in Belgium), may have allowed the weak currencies to insulate their domestic money markets from speculative disturbances.

In table 3, we present the results of estimating the interest rate equations (4) and (5) using domestic interest rates.

Table 3 : Estimation of equations (4) and (5); Domestic interest rates (Treasury Bill rates)

	b_K	e_B	e_F	e_I	e_N	R^2	DW
Belgium	0.11 (0.04)					0.17	2.19
France	0.11 (0.01)					0.44	2.47
Italy	-0.01 (0.02)					0.03	2.02
Netherlands	0.59 (0.10)					0.43	2.17
Germany		0.00 (0.02)	-0.04 (0.01)	-0.01 (0.01)	-0.24 (0.11)	0.22	2.07

Note : The numbers in parenthesis are the standard errors of the coefficient. The French domestic interest rate is the commercial paper rate.

The results of Table 3 can be interpreted as follows. The coefficients of the forward premium (b_K) are considerably reduced compared to the results concerning the offshore interest rates. This is especially the case with the weak currencies (BF, FF, and lira), that also use capital controls. In the cases of France and Belgium, this coefficient is now on the order of 0.11. This means that an expected devaluation of say 10% (as measured by the forward premium) leads on average to an upward pressure on the domestic (three-month) interest rate of only 1.1 percentage points in these countries. In the case of Italy, the coefficient is not significantly different from zero, implying that the Italian authorities have typically been able to completely insulate their domestic interest rate from speculative disturbances. Thus, one can conclude that although the weak currency countries' offshore interest rates have had to adjust almost one for one with each speculative crisis, this has not been the case with the domestic interest rates which have been largely unaffected by these speculative crises. It also follows that the EMS has worked de facto in a relative symmetric way, allowing both Germany and the weak currencies to insulate their money markets from speculative disturbances. Germany achieved this by sterilization policies, the other countries by capital controls (or, as in the case of Belgium, by a dual exchange market system).

The case of the Netherlands, which has not used capital controls, is different compared to the countries which used capital controls. Table 3 indicates that the Dutch coefficient b_K is significantly lower than 1 (but not significantly different from 0). At the same time, the coefficient e_N, which measures the effect of expected realignments of the DM/guilder rate on the German interest rate, is significantly negative. This suggests that in an environment of free capital mobility, neither the Netherlands nor Germany was able to completely insulate its domestic interest rate from speculative shocks involving the DM/guilder rate. The surprising thing is that Germany could not completely insulate its money market from these disturbances.

One interesting issue which arises here relates to the recent decision to eliminate capital controls within the system. The evidence of this section indicates that the use of sterilization policies by Germany, and capital controls by France and Italy have allowed the EMS to be a system which is de facto relatively symmetric (at least when a speculative disturbance occurs). If one of the instruments, i.e. capital controls, cannot be used anymore, this will have important implications for the interest rate adjustments following speculative crises. It is too early to tell whether this will make the system more asymmetric than in the past, however. One can expect that when large speculative movements occur, this will put more upward

pressure on the domestic interest rates of the weak currencies. It is also likely, however, that the downward pressure on the German interest rate (and the upward pressure on the German money stock) will be more intense than in the past when capital controls could be used by the weak currency countries.

II. The Interdependence of Interest Rates in the EMS

In the previous section, evidence was provided indicating that national authorities in the EMS have been able to insulate their domestic interest rates from speculative disturbances. This conclusion, however, does not mean that the members' interest rate policies have been determined independently from each other. The ability to insulate one's domestic interest rates from short-term speculative disturbances does not imply that countries are able to follow independent interest rate policies in the long run[7].

In this section, we apply Granger causality tests to determine the nature of this interdependence. The statistical procedure can be described as follows. First, the change in the interest rate of an EMS member country K is explained by its own past and by the past (changes) in the US interest rate. Second, we add to the previous equation the past changes of the interest rate in country J. We then test whether the addition of country J's interest rate adds significant explanatory power using a

likelihood ratio test. More formally, we have the following equations (VARs) :

$$\Delta r_K = \sum_{i=1}^{n} \alpha_{iK} \Delta r_{K,t-i} + \sum_{i=1}^{n} \beta_{iK} \Delta r_{A,t-i} \qquad (6)$$

$$\Delta r_K = \sum_{i=1}^{n} \alpha_{iK} \Delta r_{K,t-i} + \sum_{i=1}^{n} \beta_{iK} \Delta r_{A,t-i} + \sum_{i=1}^{n} \gamma_{iK} \Delta r_{J,t-i} \qquad (7)$$

where Δr_K and Δr_J are the changes in the interest rates of countries K and J, respectively, Δr_A is the change in the interest rate of the US. r_J is said to "Granger cause" r_K if equation (7) adds significant explanatory power compared to equation (6). This can be tested using a likelihood ratio test.

It should be stressed that the tests performed here measure the extent to which a particular EMS interest rate affects other EMS interest rates, given the US influence on these interest rates.

The tests are performed using short-term and long-term domestic interest rates. The length of the lags in equations (6) and (7) was set at six months. (Longer lags were experimented with, without affecting the results). The likelihood ratio's for the tests on the short-tem domestic interest rates are presented in Table 4. In Table 5, the same is done for the long-term interest rates (government bond yield).

Table 4 : Tests of causality (Likelihood Ratios), Short-term interest rates

From country J	to country K	Likelihood Ratio
Germany	France	64.0*
France	Germany	13.8*
Germany	Italy	5.8
Italy	Germany	12.0
Germany	Belgium	28.2*
Belgium	Germany	14.2*
Germany	Netherlands	16.4*
Netherlands	Germany	7.4
France	Italy	14.2*
Italy	France	9.2
France	Belgium	22.0*
Belgium	France	18.8*
France	Netherlands	38.0*
Netherlands	France	8.6

Note : The Likelihood Ratio is X^2 distributed. The numbers with an asterisk exceed the critical value (12.6) at the 5% confidence interval. In these cases one cannot reject the hypothesis that country J's interest rate Granger causes country K's interest rate.

Table 5 : Tests of causality (Likelihood Ratios), Long-term interest rates

From country J	to country K	Likelihood Ratio
Germany	France	7.9
France	Germany	17.5*
Germany	Italy	13.9*
Italy	Germany	3.9
Germany	Belgium	7.1
Belgium	Germany	2.5
Germany	Netherlands	10.2
Netherlands	Germany	5.9
France	Italy	11.8
Italy	France	8.4
France	Belgium	9.2
Belgium	France	7.7
France	Netherlands	5.3
Netherlands	France	7.3

Note : The Likelihood Ratio is X^2 distributed. The numbers with an asterisk exceed the critical value (12.6) at the 5% confidence interval. In these cases one cannot reject the hypothesis that country J's interest rate Granger causes country K's interest rate.

We first discuss the results involving the short-term interest rates. The upper part of Table 4 shows the results of the causality tests involving Germany. Although Germany appears to be important to explain the interest rates of France, the Netherlands and Belgium, we also find that the

French and the Belgian[8] interest rates are significant in explaining the German interest rate.

The bottom part of Table 4 shows the causality tests involving France. We find two-way causality between France and Belgium, and also from France to the Netherlands.

The case of Italy is interesting. The Italian interest rate is "Granger-caused" by France but not by Germany. In addition, the Italian interest rate does not seem to affect the French and the German interest rates. Thus, it appears that the Italian money market has been relatively insulated from EMS influences.

The tests involving the long-term interest rates (Table 5) lead to somewhat different conclusions. It appears that, given the US influence, there are few cases in which an EMS interest rate adds additional power in explaining other long-term EMS interest rates. Only in two cases is the likelihood ratio significant at the conventional confidence level. Surprisingly, one such case is where the French rate explains the German interest rate. On the whole, however, the long-run interest rates within the EMS are relatively little affected by what happens in the rest of the EMS.

Granger causality tests disregard the contemporaneous dependencies which may exist between the interest rates. It is, therefore, useful to have some information on these contemporaneous correlations. In Table 6, the contemporaneous correlations of the changes in the short-

term domestic interest rates are presented. In general, these appear to be relatively small. Italy, for example, exhibits correlations with both France and Germany which are close to zero.

Table 7 presents the correlations of the changes in the long-run interest rates. The correlations here are substantially higher than in the case of the short-term interest rates. Note especially the high correlation between Germany and the Netherlands, suggesting that these two countries' interest rates have been strongly linked.

The structure of these correlation coefficients, however, both in tables 6 and 7 does not allow us to discover asymmetries in the interdependence of interest rates within the EMS. Further research, concentrating on observations with a higher frequency (e.g. weekly observations) will be necessary to detect asymmetric patterns in the interdependence of interest rates.

Table 6 : Correlation Matrix of contemporaneous changes in interest rates (three-month domestic interest rates).

	B	F	G	I	N	US
B	1					
F	-0.03	1				
G	0.03	0.24	1			
I	0.22	0.05	-0.01	1		
N	-0.04	0.23	0.32	0.10	1	
US	0.23	0.21	0.15	-0.06	0.16	1

Source : Wharton Econometrics.

Table 7 : Correlation Matrix of contemporaneous changes in interest rates (Government Bond yield).

	B	F	G	I	N	US
B	1					
F	0.44	1				
G	0.37	0.53	1			
I	0.14	0.31	0.19	1		
N	0.26	0.54	0.73	0.13	1	
US	0.28	0.35	0.49	0.14	0.56	1

Source : IMF, International Financial Statistics.

III. Conclusions

In this paper we analyzed issues of symmetry and asymmetry in the workings of the EMS. A first way to study the asymmetry consists in measuring how interest rates react to speculative disturbances. We found that in the offshore markets, speculative shocks have usually forced the interest rates of the weak currencies to increase by the full amount of the expected realignments, leaving the DM-interest rate unaffected. The countries of these weak currencies, however, managed to (almost) completely insulate their domestic interest rates from these speculative crises. They achieved this by capital controls and other instruments of market segmentation.

The recent decisions to completely eliminate capital controls by 1990 will certainly affect the nature of these interest rate relations. When speculative crises occur, more upward pressure will be exerted on the domestic interest rates of the weak currencies. It is, however, also likely that these disturbances will put more downward pressure on the German domestic interest rates than has been the case up to now.

A second way to study the asymmetric operation of the EMS is to analyze the nature of the interdependence of interest rates. Using Granger-causality tests, we found that this interdependence is more symmetric than is usually assumed,

involving, for example, an important two-way interdependence between Germany and France.

The evidence provided in this paper is not consistent with the popular view that the EMS has worked as a DM-zone, in which the German monetary authorities set their monetary policies so that the other countries are forced to follow suit. The empirical evidence presented in this paper, suggests that the EMS works in a more symmetric way than is commonly assumed. Our results, therefore, confirm the results of Fratianni and von Hagen, cited earlier, who used the monetary base as indicators of monetary policies.

These findings may have some implications for the future shape of EMS institutions. A recent proposal by Thygesen[9] argues that the asymmetric workings of the EMS necessitates an asymmetric institutional setup of the system, in which Germany would play a special role.

Although it may be desirable that one country takes a leadership position in future EMS institutions, the argument for such an asymmetry should not be based on the present workings of the system. German leadership in monetary policy-making within the EMS may have been weaker than what many observers have told us. This also suggests that the success of the EMS may have relatively little to do with German leadership. As a result, it is doubtful that future EMS institutions should give a special role to Germany in order for these institutions to be robust.

APPENDIX

Table A1 : Estimation of equations (4) and (5); offshore interest rates

	Belgium	France	Italy	Netherlands	Germany
constant	0.0 (0.0)	-0.01 (0.01)	0.0 (0.0)	-0.01 (0.01)	-0.01 (0.01)
A_{1K}	0.0 (0.01)	-0.01 (0.01)	0.0 (0.0)	0.00 (0.02)	0.01 (0.03)
A_{2K}	0.0 (0.01)	0.00 (0.0)	0.0 (0.0)	0.01 (0.03)	0.01 (0.03)
B_{0K}	0.18 (0.04)	0.19 (0.04)	0.18 (0.04)	0.18 (0.04)	0.18 (0.04)
B_{1K}	-0.01 (0.04)	-0.02 (0.04)	-0.01 (0.04)	-0.02 (0.04)	-0.02 (0.04)
B_{2K}	0.12 (0.04)	0.12 (0.04)	0.12 (0.04)	0.12 (0.04)	0.12 (0.04)
b_K	1.0 (0.01)	0.99 (0.004)	1.0 (0.005)	0.99 (0.04)	
e_B					0.00 (0.01)
e_F					0.00 (0.01)
e_I					0.00 (0.00)
e_N					-0.02 (0.04)
R^2	0.96	0.99	0.99	0.53	0.20
DW	1.78	1.81	1.81	1.80	1.82

Table A2 : Estimation of equations (4) and (5); domestic interest rates

	Belgium	France	Italy	Netherlands	Germany
constant	-0.0 (0.01)	-0.11 (0.05)	-0.04 (0.01)	-0.05 (0.04)	-0.07 (0.04)
A_{1K}	0.14 (0.10)	-0.02 (0.10)	0.13 (0.10)	0.30 (0.06)	0.00 (0.07)
A_{2K}	0.14 (0.10)	-0.23 (0.09)	-0.10 (0.10)	-0.05 (0.06)	0.12 (0.07)
B_{0K}	0.11 (0.06)	0.10 (0.06)	-0.03 (0.07)	0.06 (0.04)	0.16 (0.04)
B_{1K}	0.14 (0.06)	0.14 (0.06)	-0.07 (0.07)	0.07 (0.04)	-0.01 (0.04)
B_{2K}	-0.01 (0.06)	0.07 (0.05)	0.10 (0.07)	0.02 (0.04)	0.09 (0.04)
b_K	0.11 (0.04)	0.11 (0.01)	-0.01 (0.02)	0.59 (0.10)	
e_B					0.00 (0.02)
e_F					-0.04 (0.01)
e_I					-0.01 (0.01)
e_N					-0.24 (0.11)
R^2	0.17	0.44	0.03	0.43	0.22
DW	2.19	2.47	2.02	2.18	2.07

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FOOTNOTES

1. See Giavazzi and Pagano(1985), Sarcinelli(1986), Katseli(1987).

2. See Fratianni and von Hagen(1988).

3. See Gros and Thygesen(1988) for such a suggestion.

4. For a more rigourous treatment, see Gross(1987).

5. This is the conclusion drawn by Giavazzi and Giovannini(1988), ch. 4, using the same evidence.

6. We assume here that the forward premium is exogenous (predetermined). As can be seen from figures 1 and 2, the large changes in the forward premia in the EMS have occurred during periods of expected realignments. These expectations, are of course influenced by past policies. However, the timing of these speculative crises can be considered as exogenous events. Put differently, when, for example, the forward premium increased from 5% to more than 15% in March 1982, it is unlikely that this was due to an increase in the French interest. The reverse causation in which the French interest rate responds to the change in the forwar premium, seems to be the coorect interpretation.

7. See Gros(1987) who argues that the capital controls in the EMS can only temporarily insulate domestic markets from foreign interest rate movements.

8. The importance of Belgium may seem surprising. It could be due to the close connection between the French and the Belgian interest rates, so that the Belgian rate stands as a proxy for the French interest rate in the causality test from Belgium to Germany.

9. See Thygesen(1988). See also Gros and Thygesen(1988).