EUROPEAN INTEGRATION AND ASYMMETRY IN THE EMS

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Abstract

The empirical literature offers conflicting views of German dominance in the European Monetary System. We examine the validity of the German dominance hypothesis (GDH) by analyzing the responses of the European central banks and the money markets to monetary innovations originating both in Europe (European asymmetry) and abroad (international asymmetry). Our results reconcile the conflicting views in the literature. The GDH is confirmed when the analysis is conducted with intervention rates before the German unification. Results support European asymmetry with short rates before 1990 but not international asymmetry. After 1990 the GDH is not supported by either set of rates.

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The European Monetary System (EMS) was conceived as a system that would offer its members flexibility and parity in the design and implementation of monetary policies. Many observers, however, have argued that the EMS has not worked as intended, since Germany has tended to dominate the creation of policy at the expense of its partners. In this view, the 1992 and 1993 crises in European exchange markets arose because Germany followed a one-sided policy that conflicted with the internal policies of the other EMS members. In this paper we examine the validity of these views by analyzing how European central banks and money markets responded to monetary innovations originating both in Europe and abroad.

Earlier reaserchers have used the terms *asymmetry* and *dominance* to describe the relationships between the EMS members and Germany. Dominance exists when two forms of asymmetry (European and international) occur simultaneously. *European asymmetry* (in the strict sense) arises when there is unidirectional causality from German variables to the EMS variables. Other countries cannot affect monetary policy in Germany but Germany can influence their policies. In essence, these countries give up their monetary independence to follow German monetary policy. *International asymmetry,* a stronger version of these interactions, arises when monetary disturbances originating in the rest of the world (ROW) can affect EMS countries only through their effects on Germany. Under international asymmetry, there is no causal relation between the ROW and the non-German EMS countries.

Support for the asymmetry argument was originally provided by a game theoretic analysis of the problem (Giavazzi and Pagano 1988, Melitz 1988). According to this approach, countries with nonindependent central banks and an inflationary reputation can gain credibility if they give up their monetary independence and lock their currencies with a strong currency. In this Pareto-

superior setup, countries would acquire credibility without undergoing a painful adjustment process.

The empirical literature, however, presents conflicting views of the EMS asymmetry. Most empirical studies are based on analyses of monetary variables such as short-run interest rates and/or exchange rates and monetary aggregates. One line of the literature backs up the results of the game-theoretic approach and argues that the EMS has functioned as an asymmetrical system in which Germany has imposed her policies on her partners. Most empirical studies have employed Granger causality tests with interest rates and/or reaction functions (Giavazzi and Giovannini 1989, Artus et al. 1991). More recently, bilateral cointegration tests were used with Granger causality tests (e.g., Karfakis and Moschos 1990). Henry and Weidmann (1994) show evidence in favor of the German dominance hypothesis using a recursive error correction model on daily interest rate data. Other studies, like Herz and Roger (1992), support asymmetry in the context of a two-country macroeconomic model.

The other line of the empirical literature refutes asymmetry and the German dominance hypothesis, arguing that although Germany has been a strong player in the EMS, it has been affected by her partners' policies as well. The main proponents of this view also apply causality tests on interest rates (Cohen and Wyplosz 1989, Katsimbris and Miller 1993), on reaction functions (Fratianni and von Hagen 1990, von Hagen and Fratianni 1990), or use principal components analysis (Koedijk and Kool 1992).

Our analysis differs from most of the existing studies in two ways. First, unlike the previous literature that relies mainly on short rates, we use both intervention rates and short rates to capture the monetary authorities' behavior and the markets' perception of it. We show that

short rates may simply give a measure of international integration of financial markets and not mimic exactly central bank behavior.

Second, we adopt a cointegrated VAR (CVAR) analysis to investigate Granger-causality among the three European countries (Germany, France and Italy) and the United States. Previous studies that conducted tests in a multi-country context with monthly data have tended to ignore the error correction term(s) in the VAR analysis. Finally, we investigate the impulse responses of these countries to innovations in each other's monetary policy and to innovations in the ROW's monetary policy (represented by the United States).

Our findings show that the choice of the interest rate and correct modeling of long-run equilibrium conditions are crucial in testing European and international asymmetry. More specifically, we find that until 1990, the German dominance hypothesis (GDH) is confirmed when the analysis is conducted with intervention rates but not with short rates. More specifically, European asymmetry is strongly supported by the data for intervention rates and to some extent for short rates, while international asymmetry does not hold for short rates. After 1990, the evidence does not confirm European asymmetry for any interest rate, and therefore, the GDH is rejected. Our findings thus reconcile the conflicting views in the literature while, justifying policymakers' concerns about German dominance.

The rest of the paper is organized as follows: Section I describes the data and the methodology. Section II presents the cointegrating vectors, section III is devoted to the Granger-causality tests, and impulse response analysis of the system, and section IV concludes the paper.

I. Data and Methodology

Our aim is to infer from the data how monetary authorities react to monetary innovations coming from other countries. Previous studies dealing with monetary policy have typically tracked changes in a monetary aggregate, or in one-month rates or three-month rates. Sims (1992) argues that if monetary authorities accommodate changes in money demand, monetary aggregates cannot correctly represent shifts in monetary policy. Sims, therefore, advocates the use of interest rates as indicators of monetary policy for the United States. The same approach has been adopted subsequently by Grilli and Roubini (1993), who take short-term interest rates as the policy instrument to analyze the effect of monetary policy shocks on exchange rates in the group of Seven countries.

Studies that choose short rates over intervention rates argue that monetary authorities have, in the past, often changed their intermediate targets. Therefore, a single intervention rate cannot capture monetary policy whereas short rates can describe it reasonably well. In fact, in the first half of the 1980s, most countries started to use intervention rates to steer the market rates. But by the latter half of the 1980s, repurchase rates had become the major policy tool for intervention in most European countries.

The switch in policy tools becomes apparent with a closer look at the evolution of central bank operating procedures in these three countries.[1] In Germany, a large balance of payments deficit in the 1980s caused bank reserve demand to soar. In response to this increased demand for central bank credit, the Bundesbank stepped up its use of securities repurchase operations. The

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[1]See Kneeshaw and Van den Bergh (1989). Uctum (1992) discusses the evolution of the operating procedures in conjunction with the development of the money markets in Germany, France, and Italy. Clarida and Gertler (1995) present a comprehensive analysis of the German monetary policy.

volume of security purchases by the Bundesbank under resale agreements became quickly higher than the volume of Lombard and special Lombard loans. After 1985, the use of Lombard credit (through which the Bundesbank acted as a lender of last resort) practically ceased except for rare circumstances.

A similar convergence in instruments and operating procedures is observed in both France and Italy. France was characterized by a rigidly segmented financial market throughout the 1970s. After joining the EMS in 1979, France went through a restructuring of its financial system that allowed the use of indirect instruments to affect interest rates. Interbank operations of the Bank of France under the form of "pensions" (temporary transactions in securities and bills) were in effect throughout the 1970s. Since 1986, however, they became the principal instrument of the central bank to control liquidity in the money market.

Repurchase operations have been conducted in Italy since 1979 in conjunction with administrative control of total domestic credit. After 1983, however, the credit ceiling was abolished and monetary authorities relied mainly on indirect instruments to affect monetary aggregates. In particular, from 1985 onwards the Bank of Italy effectively guided short rates through repurchase operations.

The role of repurchase rates in conducting monetary policy has thus been increasing over the last decade. However, financial market response to central bank decisions, reflected in short rates, is also an important aspect of monetary policy. We will, therefore, include in our study both sets of rates and compare and contrast the monetary authorities' reactions with those of the markets.

The repurchase (or intervention) rate that we use for Germany is the rate on open market

operations of the Bundesbank under repurchase agreements in securities. During periods when no repurchase operations were conducted, we interpolated the repurchase rate by using the Lombard rate.[2] For France, it is the rate on outright purchase of short-term private paper, and for Italy, the rate on temporary sales or purchases of securities by the Bank of Italy. Following Bernanke and Blinder (1992), we use the federal funds rate for the United States because it is considered a good predictor for monetary policy in general. The one-month rate is the PIBOR for France, the one-month bank loan rate for Germany, and the treasury bill rate for Italy.[3]

The data are monthly[4] and cover the period 1982.01 to 1993.11.[5] The sources for the data can be found in the appendix. We conduct the analysis by splitting the sample into two at the date of German unification. We chose this date because major interventions to reduce speculation in foreign exchange markets occurred and fluctuations bands widened after 1990.

We examine the GDH from two perspectives. We first consider the European system as a whole, and partition it into two subsystems consisting of German rates and non-German rates (French and Italian). We explore the impact responses and long-run coefficients of the system, and conduct multivariate Granger-causality tests. We then consider individually each country's

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[2]No repurchase rate was reported in the months of March, April, May and June 1983, February, April and May 1989, June, July, August and November 1992, and February, April, May and June 1993.

[3]The interest rate on Treasury paper is considered to be more representative of market conditions than any other bank rate because of the large size and short maturity of the Italian public debt.

[4]We chose not to exclude critical dates such as Italy's entry into, and subsequent exit from, the narrow band of the European Exchange Rate Mechanism because our results were not affected qualitatively by the exclusion of these periods

[5] It may be argued that for high frequency variables, such as interest rates, daily data may be more appropriate. This decision depends on how the objective of the monetary authority is perceived. If the objective is to affect the real economy, monthly swings in interest rates resulting from an innovation should matter more than daily fluctuations in them. If, on the other hand, the objective is to manage day-to-day exchange rate fluctuations, then daily data is more relevant.

response to a domestic or foreign innovation by analyzing their impulse responses.

In the first part, we proceed to exogeneity tests in two steps, following Chow (1993). We first determine the cointegrating relations among variables using Johansen's Maximum Likelihood (ML) method (Johansen 1991). We then estimate a system of equations including the long-run equilibrium error term(s), using the seemingly unrelated regression method (SUR).

In the second part, we analyze the impulse responses of central banks and markets to a monetary innovation originating from one of the countries. We conduct these tests under the assumption that the United States is an independent economy that is not affected instantaneously by European innovations under any Wold ordering. We report only the reactions to innovations of the leaders. This amounts to assuming that the innovating country initiates the shock to the system independently. The advantage of this assumption is that it allows us to attribute the maximum response by noninnovating countries to the innovating one and, therefore, is independent of the ordering.

II. Stationarity and Cointegration

For the standard asymptotic theory to be valid, the variables used in a vector autoregression (VAR) must be stationary or transformed into stationary variables. If they are integrated of order one, or I(1), and not cointegrated, then a VAR in first-differences is appropriate. If they are cointegrated then the lagged equilibrium errors should be included as regressors (Engle and Granger 1987, Campbell and Perron 1991). In this case, the series' permanent trends adjust according to an equilibrium constraint and their transitory components fit into a dynamic specification in the class of error-correction models.

The nonstationarity of interest rates in a short sample is now a widely recognized fact. The ADF test results (Dickey and Fuller 1979) shown in Table 1 conform to the general results in the literature. During the sample period considered, the intervention rates (R_G, R_F, R_I), the short rates (M_G, M_F, M_I), and the federal fund rate (FF) seem to be I(1). When the sample is split into two, the evidence still suggests that most rates are nonstationary in both subsamples. However, the federal fund rate and the French repurchase rate seem to be integrated of second order, which may be a small sample result. Since the French rate is close to be I(1) at a 10 percent confidence level and the federal fund rate is nonstationary over the whole sample, we will assume that all series are I(1) in the second subsample as well.

Trends in interest rates during the last decade indicate that all intervention rates show a significant convergence throughout the 1980s, despite the volatility in the Italian repurchase rate (Chart 1, top panel). Convergence among the three European countries continued during the early 1990s while the federal fund rate diverged from the group between 1989 and 1992. The chart shows that convergence of short rates is also a salient feature of the 1990s (Chart 1, bottom panel). In fact, compared to repurchase rates, convergence seems to be more balanced. The Italian short rate shows less fluctuation during this period, while the French rate follows the German rate less closely. The evolution of these rates suggests strongly that they are cointegrated.

The question of whether these rates are cointegrated is checked traditionally with the ADF test. Two rates are said to be cointegrated if their spread is stationary. The GDH is then tested by looking at the spreads with the German rates. Several studies have also explored the stationarity of trivariate systems consisting of the German rate and two other rates. However,

despite the established fact that during the last decade European rates have been moving together, in these bivariate or trivariate systems the ADF test is often not powerful enough to prove that this long-run relation exists between interest rates. We conducted a four-variate ADF test, and the test results are displayed in Table 2. The long-run relations between German rates and other rates are in general nonstationary, except for the short rates in the first subperiod. Results are robust to the choice of the dependent variable, suggesting that a more powerful test should be used.

Cointegration of interest rates can be checked more formally with the Johansen Maximum Likelihood (ML) Test procedure (Table 3). In the first subsample there is evidence of two cointegrating vectors among the repurchase rates and one cointegrating relation among short rates (Table 3a).[6] In the second subsample test results point to one cointegrating relation in each set of rates (Table 3b). However, to infer causal linkages between interest rates we need to look further into the dynamic relations and the long-run relations.

III. Exogeneity Tests: an Error Correction Model-VAR Approach

In this section we estimate and test the error correction model (ECM) as a system of equations with the cointegrating vectors obtained from the Johansen ML procedure. In the first subsample, the evidence generally supports the GDH in the case of repurchase rates. However, in the case of market rates, although results tend to confirm European asymmetry, the international

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[6]We used several information criteria to choose the lag structure of the model. Given the inconclusive nature of these tests we opted for 2 lags, as suggested by the Schwartz Criterion (SC) over higher orders supported by the Akaike Criterion (AIC). The reasons for this choice were twofold: first, the higher order lagged variables were rarely significant; second, not restricting the higher order lagged variables to zero did not improve the forecast to offset the additional sampling variability introduced by the unrestricted model

asymmetry is rejected. In the second subsample European asymmetry is not supported by the data for either set of rates, and therefore the GDH is rejected.

Denoting the cointegration errors with z_j, the ECM-VAR representation can be written as

$$\Delta x_t = \sum_{j=1}^{n} \mu_j z_{j,t-1} + \sum_{i=1}^{m} A_i \Delta x_{t-i} + u_t \qquad (1)$$

where u_t is a vector of orthogonalized VAR innovations, and A is an (m x m) matrix of coefficients. The variable x_t stands for the vector of intervention (repurchase) rates and short rates, denoted as R_k and M_k, respectively, with k=G, F, I, US representing German, French, Italian and the U.S. rates. The number of cointegrating vectors and the number of lags are designated by n and m, respectively, both determined in the previous section. The case where μ=0 corresponds to no cointegration and a representation of the VAR in first differences.

We test the GDH by investigating both the direct and indirect effects of innovations. Equation 1 can be expressed in matrix form as

$$\Delta X_t = \Gamma Z_{t-1} + A(L)\Delta X_t \qquad (2)$$

A moving average representation of the model can be obtained by inverting I-A(L) to give

$$\Delta X_t = C(L) Z_{t-1} + B(L) u_t \qquad (3)$$

where $B(L)=[I-A(L)]^{-1}$, and $C(L)=B(L)\Gamma$.

We can now define our problem as testing the significance of Δx_t's response to changes in u_t, conditional on z_{t-1}, where x, u and z may refer to variables of a single country or a group of

countries, depending on the partitioning of the A matrix. To calculate the critical value of the χ^2 test statistics we follow the procedure outlined by DeKock and Nadal-Vicens (1995). Suppose we would like to test the significance of country i's response to an innovation coming from country j, $\delta(\Delta x_i)/\delta u_j=0$. With the moving-average representation of the model the null hypothesis is $B_{ij}=0$, which can be expressed in terms of the partitioned A matrix as

$$A_{kj}(L)A_{ik}(L)+A_{ij}(L)(I-A_{kk}(L))=0 \qquad (4)$$

where $k \neq i,j$.

Equation 4 is a necessary and sufficient condition for the null hypothesis to hold. We can derive a weak sufficient condition from the third fundamental axiom of probability and calculate the corresponding critical value:[7]

$$P[A_{kj}(L)=0 \text{ and } A_{ij}(L)=0] \text{ or } P[A_{ik}(L)=0 \text{ and } A_{ij}=0] \quad (5)$$

For each interest rate we estimate a four-equation system with seemingly unrelated regression (SUR) to take into account the contemporaneous correlation of the disturbances across equations. We first present the impact and the long-run equilibrium responses obtained from regressing the lagged variables on contemporaneous variables. We then turn to the analysis of short-run dynamics.

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[7]The third axiom is $P(A \cup B)=P(A)+P(B)-P(A \cap B)$, which says that the probability of a union of two events, A and B, is the sum of the probabilities of each event less the probability of the joint event that both occur.

1. Contemporaneous correlations

A comparison of the two subsamples shows that, in general, interest rates are contemporaneously correlated mainly in the second period, while the long-term conditions affect them in both subperiods (Table 4). The evidence on contemporaneous correlations thus suggests that (i) coordination of policies becomes explicit after 1990 (top panel), and (ii) short-run fluctuations in interest rates tend to be affected by long-run equilibrium relations (bottom panel). A second point that emerges from Table 4 is that German short rates and, to some extent repurchase rates, are both significantly correlated with the federal fund rate throughout the sample period. Consistent with the GDH, French rates show no contemporaneous link with the U.S. rate. In contrast, Italian rates are correlated with the federal fund rate, suggesting a departure from the international asymmetry hypothesis.

2. The ECM relations

Long-run equilibrium relations display yet another pattern (Table 4, bottom panel). In the first subperiod, significant responses of intervention rates to the ECM term (with the exception of the Italian rate) compensate for the lack of contemporaneous correlation. This finding suggests that countries are taking into account foreign monetary policies and interest rates are moving together in the long run. After 1990, both sets of rates respond significantly to the long-run equilibrium relation. Thus, the evidence on impact and long-run effects is consistent with coordinated monetary policies since the 1980s, and increased integration of financial markets since 1990s.

3. Wald tests for Granger-causality

In this subsection, we proceed to the analysis of the data with Wald tests (block exogeneity tests), which are the multivariate version of the Granger-causality test. The GDH will be supported by the data in the short run if both asymmetry hypotheses hold. European asymmetry implies that Germany Granger-causes both French and Italian rates while the reverse does not hold. International asymmetry means that the federal fund rate Granger-causes the German rate but not the French and Italian rates.

(i) First subsample, 1982-1990: The Wald tests of Granger causality show that until 1990 the Bundesbank appears to have conducted a dominant policy (Table 5). The evidence suggests that the European and international asymmetries and, therefore, the GDH holds unambiguously for repurchase rates. Until 1990, the German intervention rate is not Granger-caused by French and Italian repurchase rates, while both repurchase rates are Granger-caused by the German rate. The federal fund rate Granger-causes German intervention rate but not the French and the Italian rates.

By contrast, test results do not unambiguously support German dominance for short rates in the first subsample. There is not only some evidence that the German short rate is affected by the European rates, but international asymmetry is clearly rejected: All three countries' short rates are Granger-caused by the federal fund rate, reflecting the openness of money markets which is a violation of the second assumption of the GDH.

(ii) Second subsample, 1990-1993: Test results indicates that, while international asymmetry continues to hold for intervention rates, there is weak evidence that the German repurchase rate is not Granger-caused by the French and Italian repurchase rates, and that the

German repurchase rate is Granger-cause the French and Italian rates. A closer look at the data is required to go beyond these surprising results. .

First, consider the causality running from the German rate to the non-German rates. In the previous section we had seen that after 1990, there was a strong and significant contemporaneous correlation between the French and German intervention rates, and a strong reaction of the Italian rate to the error-correction term (Table 4, middle and bottom panels). Thus, lack of Granger causality going from the German rate to other rates is likely due to the fact that, after 1990, the French intervention rate became highly responsive to a German innovation, while the Italian rate becomes sensitive to the long-run error term.

Next, consider the causality running from the non-German countries to Germany. The hypothesis that these rates do not Granger-cause the German rate is tested with a joint significance test of the direct effects and the indirect effect. The indirect effect is that from a French or Italian innovation to the German rate via the federal fund rate. It has a very low significance that leads to a high P-value of the overall Wald test. If the indirect effect is removed, and the test is conducted on the direct effect from non-German intervention rates to the German intervention rate, the evidence does not reject the hypothesis that the German rate is affected by the two other countries. We can conclude, therefore, that European asymmetry in intervention rates, and hence the GDH, is not likely to be supported by the data after 1990.

The same evidence carries to short rates and the GDH is rejected by the data if the tests are conducted on the direct effects. Although Wald tests suggest that European asymmetry is supported by the data, the result is weakened when the indirect effect from non-German rates to the German rate via the federal fund rate is removed. Granger causality then runs in both

directions and the German short rate is somewhat affected by European rates, which violates the first assumption of the GDH.

International asymmetry does not appear to be verified by the data because of a significant impact of the US rate on non-German short rates. However, it turns out that this impact is caused by the indirect effect from the federal fund rate to the non-German rates via the German short rate. The highly significant response of the European rates to the German rate substantially reduces the P-value of the Wald test. Removing this indirect channel restores the Granger-noncausality between the federal fund rate and the non-German short rates.

In summary, the evidence confirms the GDH in the case of the intervention rates in the first subsample. Our findings, however, lend only weak support for European asymmetry for short rates in the first subsample. It seems that the Bundesbank has been acting as the leader throughout the 1980s, and this behavior is reflected in the market rates to some extent. However, the GDH is rejected for short rates because the evidence does not support international asymmetry, which suggests that short rates were not insulated from the effect of U.S. monetary policy. In the second subsample, the evidence in favor of the GDH is considerably weaker because the first assumption of the GDH, European asymmetry, is not confirmed by the data.

4. Impulse Responses

In this section we proceed to the dynamic analysis of central banks' and the markets' responses to a change in domestic and foreign policies. In the previous section we analyzed, as a block, the response of non-German countries to European and U.S. innovations. In this section, we consider each country's response individually.

We show that, consistent with the Granger-causality tests, throughout the 1980s, the German dominance originates more from central bank behavior than from market reactions. Before 1990 asymmetry appears clearly among intervention rates and to a lesser extent among short rates. After German unification, however, all signs of asymmetry seem to disappear. Germany becomes highly sensitive to a French innovation, and somewhat to an innovation coming from the Italian money market. International asymmetry holds until 1990 for intervention rates but not for the short rates, reflecting the exposure of the money markets to the US monetary policy. After 1990, impulse responses do not show any significant US impact on the European countries.

European asymmetry

(i) First subsample, 1982-1990: Until the German unification German rates responses to innovations coming from France or Italy are insignificant. France seems to "follow" German monetary policy, while Italy acts "exogenously" to all European shocks (Chart 2).

First, compare the effect of a 1 percent rise in the German rate with the effect of a similar rise in the French and Italian rates (chart 2). The impact effect shows that the instantaneous reaction of the monetary authorities (Chart 2, left panel), and that of the markets (Chart 2, right panel) to European innovations is very small and insignificant. However, asymmetries arise during the adjustment period toward the long run. French monetary authorities reduce the interest differential quickly by raising the repurchase rates faster than the Germans. The French short rates exhibit a similar behavior in following the German short rates.

The medium-run response of the German intervention rate to a French innovation is

insignificant, suggesting that German monetary authorities are not seeking to reduce the interest differential with France. By contrast, the market rate increases somewhat after about five periods of a sustained rise in the French rate. The lack of a significant relation between the German and Italian intervention rates is even more striking in the sense that neither country responds to the other's innovation.

Because Italy is a fervent supporter of the European Monetary Union, the lack of Italian response to Germany at first seems surprising. Several institutional factors, however, might explain this finding. First, unlike France, Italy throughout the 1980s was not in the narrow fluctuation band (2.5 percent) of the exchange rate mechanism, but in the 6 percent band. Therefore, a large part of the German innovation was absorbed by the exchange rate in Italy and the domestic interest rate in France. Second, a large budget deficit places constraints on the use of monetary tools to counteract a foreign shock, reducing the Italian repurchase rate's responsiveness to foreign rates.

The discussion in the late 1970s about the relative merits of "gradualism" and "shock therapy" may shed further light on the evidence presented in Chart 2. At that time, it was argued that monetary authorities could afford a gradualist disinflationary policy if they enjoyed a reputation for credibility in a stable economy. However, in uncertain economies where the monetary authority did not have an established anti-inflationary reputation, a disinflationary policy would have to be implemented immediately.

The behavior of the German and Italian central banks and the economic environment in which they were operating fits well with this line of argument. As the impulse response functions show, during the last decade Germany has had a more gradualist policy than its counterparts. The

Bundesbank follows an incremental policy that continues for about six periods and then reverses the policy even more gradually toward the initial impact level, while a shock in the money market is persistent and lasts longer. By contrast, the Italian central bank follows a more abrupt policy: it reverses its policy immediately after the impact effect and converges to a lower new long-run level.

The French monetary authorities' position stands between these two cases. They follow a gradualist policy for about two trimesters and then reverse their policy toward the new long run, which is about 30 percent lower than the initial impulse of 100 basis points. The French short rates converge to their new long-run values more quickly than the repurchase rates.

We can thus conclude that over the 1980s, European asymmetry in the exchange rate mechanism stemmed mainly from the behavior of central banks, which is proxied by intervention rates, and less from money markets. German monetary authorities acted as "leaders" in Europe and thus took little account, if any, of the behavior of the "followers".

(ii) Second subsample, 1990-1993: After German unification, differentials between interest rates are reduced. The spread between intervention rates narrows considerably, indicating that monetary policies become more coordinated, while the spread between short rates also narrows because markets are more integrated and market participants presumably take into account the coordination of policies (Chart 3).

The response of the Bundesbank to a French monetary policy shock represents the sharpest contrast between the two subperiods (Chart 3, left panel).. It changes from a lagged insignificant response to one that eliminates the differential between the intervention rates, underscoring the pivotal role of the French franc in the exchange rate mechanism. German short

rates are also more responsive than before to a French disturbance, but the difference is not as dramatic as for the intervention rate (Chart 3, right panel).

The impact response of the French rate to a German innovation becomes large and significant. In Italy, markets react to a German innovation more quickly than the central bank. Overall, central banks in both countries react to German monetary policy more than previously and reduce the interest differential in intervention rates with Germany. After a German innovation, however, the differential between French and German short rates remains larger in the long run, suggesting that French rates are a little less strongly tied to German rates than before. This finding can be mainly explained by the fact that after 1992, with larger fluctuation bands, the exchange rate partly absorbs the adjustment to a German innovation.

After German unification, Italy improves its record and acts less "exogenously". The reaction of Italian short rates to an innovation coming from a leader equals the reaction of other followers' short rates in magnitude, and the Italian repurchase rate responds to foreign innovations more than previously. In particular, Italian short rates exhibit an unprecedented responsiveness to a German shock. However, Italian innovations increase only the reaction of French rates and continue not to affect German rates.

International asymmetry

For the GDH to be verified, international asymmetry must also hold. We consider the hypothesis that a monetary disturbance originating from the ROW directly affects the German rate with little or no effect on French and Italian rates. The evidence seems to support international asymmetry with intervention rates during the 1980s but not with short rates.

(i) *First subsample, 1982-1990*: This subsection confirms that data supports international asymmetry for the intervention rates. The German intervention rate reacts strongly and persistently to a 1 percent rise in the federal fund rate, while the response of the French and Italian repurchase rates are much weaker and insignificant, both at impact and in the long run (Chart 4, upper-left panel).

By contrast, a 1 percent U.S. innovation has a strong and permanent effect on European short rates (Chart 4, lower left panel). The impact responses of French and German short rates are of about the same magnitude and significant. Italy reacts with a lag and its response becomes somewhat significant after 3 periods. All three countries converge toward their respective new long runs that are higher than the U.S. rate.

The evidence thus supports international asymmetry throughout the sample period, in the case of intervention rates. Since a similar conclusion has been reached for European asymmetry in the previous subsection, it is thus possible to argue that the GDH holds in the first subsample and is reflected in the behavior of central banks rather than the markets.

(ii) Second subsample, 1990-1993: In this subsection we argue that there is a less strong case for international asymmetry in the case of short rates (Chart 4, right panel). The results are particularly striking because of a complete breakdown of the international linkage with the United States. The response of both intervention and short rates to a 1 percent rise in the federal fund rate totally disappears. The reason for this result is, of course, the divergence between European and the U.S. policies that occurred after 1990. While Germany kept interest rates high to finance unification, the Fed started a stepwise decline in rates to stimulate the economy. From these results it would be difficult to make an inference about international asymmetry.

IV. Conclusion

In this study we analyzed the German dominance hypothesis, consisting of European and international asymmetry in the EMS through the last decade. We considered Germany, France, and Italy and conducted analysis with both official intervention rates and short rates, which describe, respectively, the official and the market reactions to monetary innovations. We have shown that incorporation of long-term equilibrium relations into the analysis is essential to interpret the dynamic system correctly.

Our findings suggest that the Bundesbank was acting as the leader and conducting monetary policy "exogenously" until 1990, but cooperated with its European partners thereafter. Markets also reflected the Bundesbank's leadership within Europe but, unlike the intervention rates, short rates were not insulated from U.S. monetary policy. The German dominance hypothesis is confirmed when the analysis is conducted with intervention rates before German unification. Our results support European asymmetry with short rates until 1990 but not international asymmetry. After the German unification the German dominance hypothesis is rejected for both sets of interest rates. These findings thus reconcile the conflicting views in the literature, while, at the same time, justifying concerns raised by policymakers about the German dominance.

It has been argued that Germany continued to be the dominant economy after 1990 but in a more subtle way. In fact, the cooperative behavior of Germany may simply reflect its willingness to bail out countries that, having accepted German dominance, went into recession because of the German unification shock. This argument is observationally equivalent to the

system working symmetrically, and could provide a fruitful extension to this paper. The extension would entail construction of a reaction function for each central bank derived from its operating procedure. Estimation of these reaction functions with high frequency data would give further insight into the interest linkages during the post-unification period.

Data Appendix

1. Intervention rates

R_F= the rate at which the Bank of France makes its interventions in the money market as outright purchase of short-term private paper.
Source: Banque de France, Quarterly Bulletin, T 26.

R_G= average rate on open market operations of Bundesbank under repurchase agreements in securities.
Source: Bundesbank, Monthly Report TV.6.

R_I= interest rates on temporary sales (or purchases) of securities by the Bank of Italy, average rate.
Source: Banca d'Italia, Bolletino T A24 & suppl.

2. Short-run rates

M_F= one-month Paris interbank offer rate.
Source: Banque de France, Statistiques Monetaires Provisoires.

M_G= one-month loan rate quoted by Frankfurt banks.
Source: Bundesbank, Monthly Report TV.6.

M_I= secondary market treasury bonds yield.
Source: Banca d'Italia, Bollettino T E6 & suppl.

FF= Federal funds rate.
Source: USECON (HAVER)

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Table 1: Unit Root Tests*

	Variable	1982-1993	1982-1990	1990-1993
Intervention Rate France	$R_F(t)$	-1.50	-2.17	-0.78
	$R_F(t)-R_F(t-1)$	-8.89	-5.74	-3.34
Intervention rate Germany	$R_G(t)$	-2.23	-1.27	0.71
	$R_G(t)-R_G(t-1)$	-6.00	-4.25	-3.68
Intervention rate Italy	$R_I(t)$	-3.78	-3.14	-2.03
	$R_I(t)-R_I(t-1)$	-9.08	-5.96	-3.90
Fedfund rate	F(t)	-1.50	-3.36	-0.84
	F(t)-F(t-1)	-6.09	-4.93	-2.87
Short rate France	$M_F(t)$	-2.19	-1.31	-0.88
	$M_F(t)-M_F(t-1)$	-9.85	-7.26	-4.07
Short rate Germany	$M_G(t)$	-2.47	-1.69	0.71
	$M_G(t)-M_G(t)$	-8.90	-4.75	-3.80
Short rate Italy	$M_I(t)$	-2.19	-1.42	-1.12
	$M_I(t)-M_I(t)$	-6.64	-6.92	-3.44

* The 95% McKinnon critical values are -3.44 for the ADF test with trend for the full sample, -3.45 for the ADF test with trend and two lags for the first subsample and -3.52 for the second subsample. The 90% critical value is -3.38 for the second sample. FF, R and M are federal funds rate, intervention and short rates, subscript G and , F and I stand for Germany, France and Italy, respectively.

Table 2:Unit Root Tests on Residuals*

		1982-1990	1990-1993
Intervention rates	u_t	**-2.50**	**-2.82**
	u_t-u_{t-1}	**-5.70**	**-3.30**
Short rates	v_t	-3.60	-2.67
	v_t-v_{t-1}	-7.42	-3.14

* The regression equation is $\Delta x_t = \beta_t x_{t-1} + \sum_{i=1} \beta_t \Delta x_{t-i} + \epsilon_t$, where ϵ=u, v, and x=R, M, and the dependent variable is the German rate. The 95% McKinnon critical values for the ADF test with trend and two lags are -2.89 for the first subsample, and -2.94 for the second subsample.

Table 3a: Johansen Cointegration LR Test: 1982-1990*

Intervention Rates				
Eigenvalue	**Likelihood Ratio**	**5% critical value**	**1% critical value**	**Number of vectors**
0.28	65.57	47.21	54.46	None
0.17	32.40	29.68	35.65	At most 1
0.09	13.73	15.41	20.04	At most 2
0.04	3.80	3.76	6.65	At most 3
Cointegrating vectors				
$0.06FF-0.02R_G-0.02R_F-0.05R_I=0$				
$-0.04FF+0.10R_G+0.01R_F-0.02R_I=0$				
Short Rates				
Eigenvalue	**Likelihood Ratio**	**5% critical value**	**1% critical value**	**Number of vectors**
0.21	52.44	47.21	54.46	None
0.14	29.29	29.68	35.65	At most 1
0.10	13.93	15.41	20.04	At most 2
0.04	3.77	3.76	6.65	At most 3
Cointegrating vector				
$-0.10FF+0.03M_G-0.10M_F+0.02M_I=0$				

Table 3b: Johansen Cointegration LR Test: 1990-1993

Intervention Rates				
Eigenvalue	**Likelihood Ratio**	**5% critical value**	**1% critical value**	**Number of vectors**
0.60	56.36	47.21	54.46	None
0.28	19.49	29.68	35.65	At most 1
0.14	6.37	15.41	20.04	At most 2
0.01	0.21	3.76	6.65	At most 3
Cointegrating vector				
$-0.01FF-0.17R_G-0.04R_F-0.02R_I=0$				
Short Rates				
Eigenvalue	**Likelihood Ratio**	**5% critical value**	**1% critical value**	**Number of vectors**
0.72	72.55	47.21	54.46	None
0.34	21.78	29.68	35.65	At most 1
0.11	5.27	15.41	20.04	At most 2
0.01	0.38	3.76	6.65	At most 3
Cointegrating vector				
$0.01FF+0.16M_G-0.13M_F-0.02M_I=0$				

*FF, R and M are federal funds rate, intervention and short rates, subscript G and , F and I stand for Germany, France and Italy, respectively.

Table 4:Contemporaneous correlations matrix and long-run equilibrium (ECM) relations

I. Contemporaneous Correlations									
	Fedfund	**R_G**	**R_F**	**R_I**		**Fedfund**	**M_G**	**M_F**	**M_I**
1. 1982.01-1990.07									
U.S.	1					1			
Germ.	0.05	1				0.21*	1		
France	-0.03	0.03	1			0.08	0.11	1	
Italy	0.06	-0.08	0.18†	1		-0.00	0.19*	0.07	1
2. 1990.08-1993.11									
US	1					1			
Germ.	-0.24†	1				-0.30*	1		
France	-0.08	0.56**	1			0.08	0.40**	1	
Italy	-0.32*	-0.03	0.15	1		-0.26†	0.29†	0.57**	1
II. Long-run Equilibrium relations									
	Fedfund	**R_G**	**R_F**	**R_I**		**Fedfund**	**M_G**	**M_F**	**M_I**
1. 1982.01-1990.07									
μ_1	-0.09*	0.06*	-0.06**	-0.02		-0.15**	0.04	0.01	0.05
μ_2	-0.00	-0.06**	0.01	-0.02					
2. 1990.08-1993.11									
μ_1	-0.00	-0.03**	0.01	-0.11*		0.00	0.01†	-0.07**	0.04†

†, * and ** denote significance at 10, 5 and 1 percent levels, respectively. R and M are intervention and short rates, subscript G, F, and I stand for Germany, France and Italy, and μ is the cointegrating vector.

Table 5: Wald Tests for Granger Causality in the GDH*
P values

European Asymmetry					
	Intervention Rates			**Short Rates**	
	$R_E \rightarrow R_G$	**$R_G \rightarrow R_E$**		**$M_E \rightarrow M_G$**	**$M_G \rightarrow M_E$**
1982.01-1990.7	0.21	0.00		0.09	0.04
1990.08-1993.11	0.11	0.36		0.17	0.00
	0.02†			0.09†	
International Asymmetry					
	Intervention Rates			**Short Rates**	
	$FF \rightarrow R_G$	**$FF \rightarrow R_E$**		**$FF \rightarrow M_G$**	**$FF \rightarrow M_E$**
1982.01-1990.07	0.04	0.25		0.03	0.04
1990.08-1993.11	0.00	0.24		0.09	0.07
					0.36‡

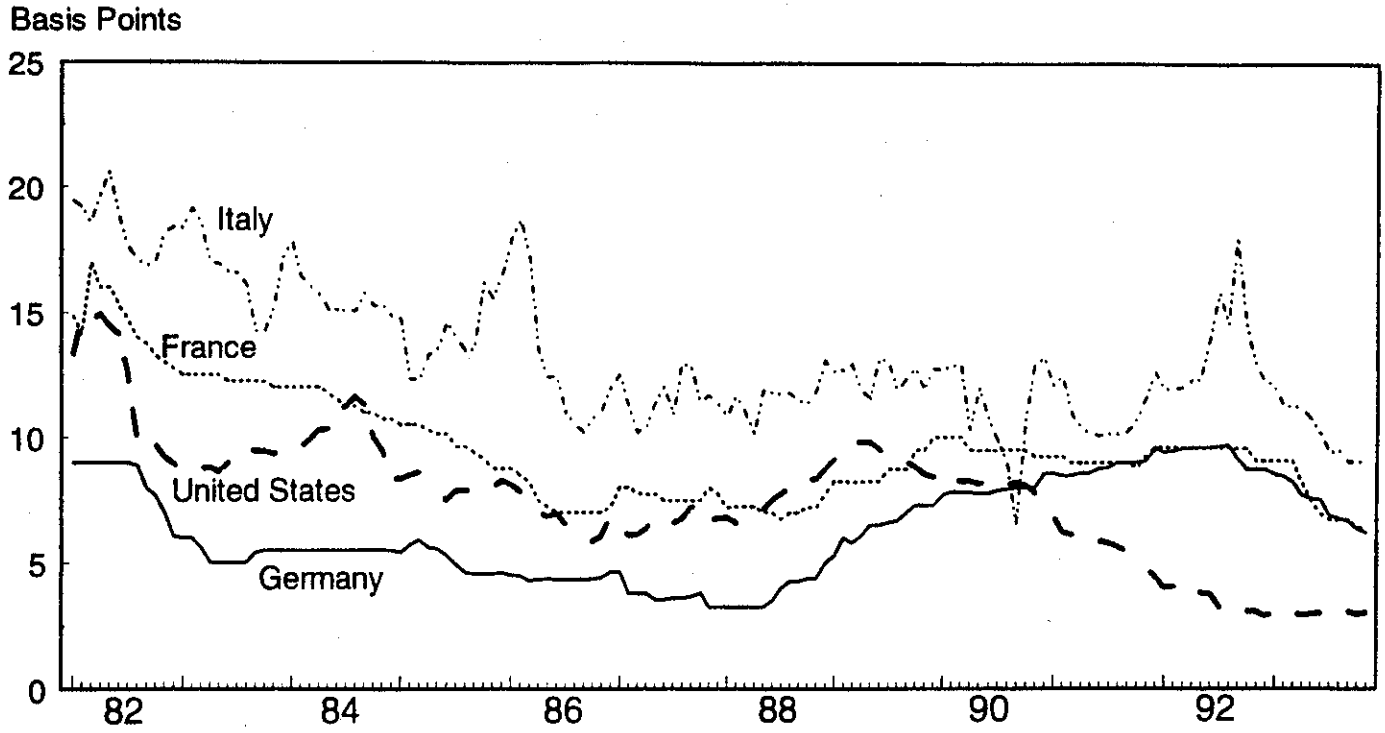
* FF, R and M are federal funds rate, intervention and short rates, subscript G and E stand for Germany, and both Italy and France, respectively. The null hypothesis is: the probability that X Granger-causes Y is zero.

† Shows the effect with the United States as an exogenous player (no indirect effect of the French and Italian rates on the US rate).

‡ Shows the direct effect, without the indirect effect of the German rates on the French and Italian rates.

Chart 1: Intervention Rates, Short Rates, and the Fedfund Rate

A. Intervention Rates



B. Short Rates

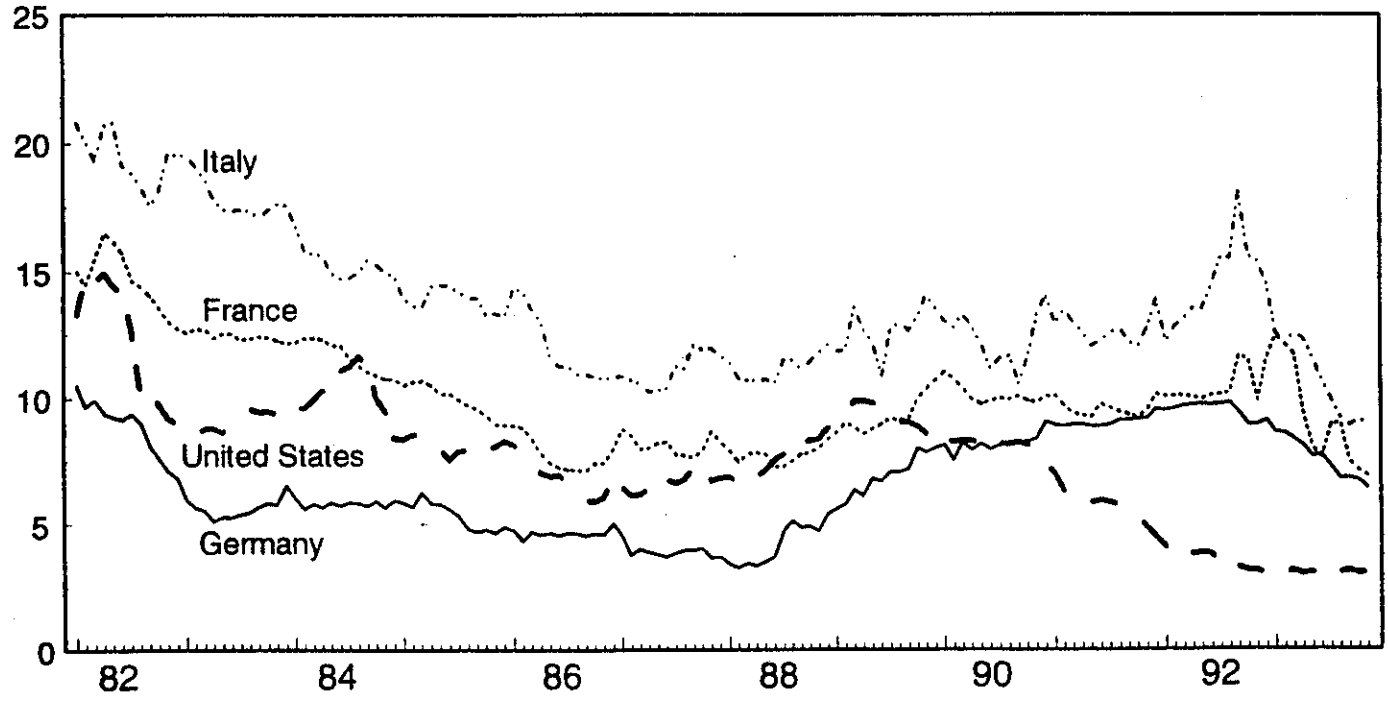
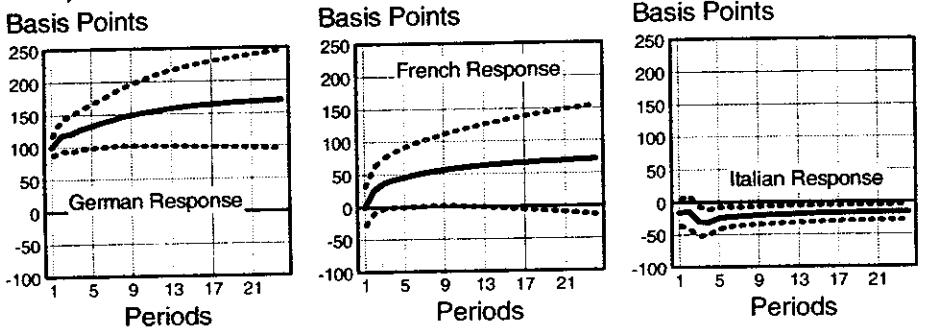


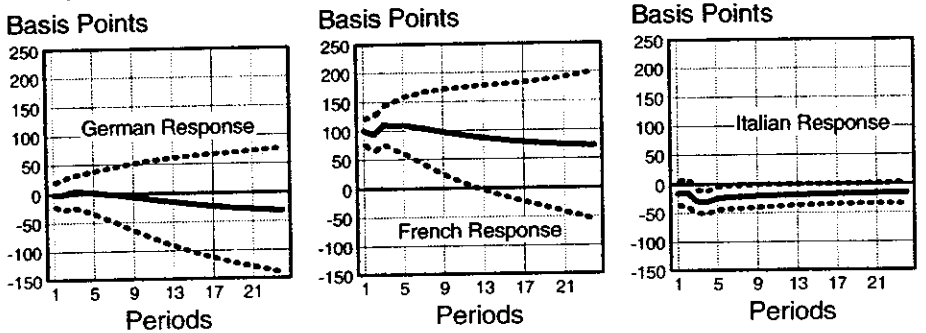
Chart 2: Cumulated Impulse Responses of European Rates to an Intra-European Innovation.* 1982:01-1990:07

I: Invervention Rates

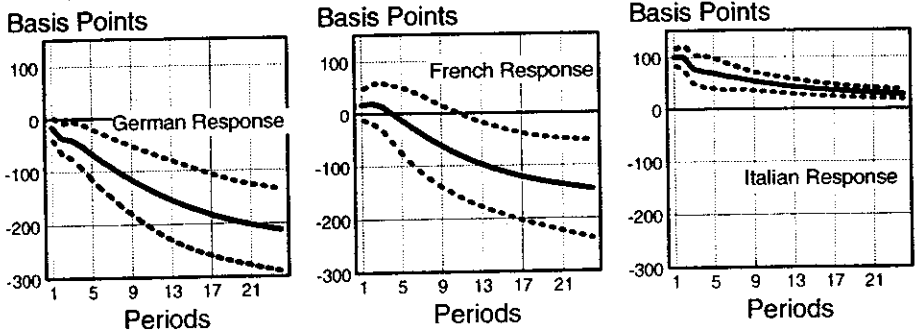
A) German Innovation



B) French Innovation

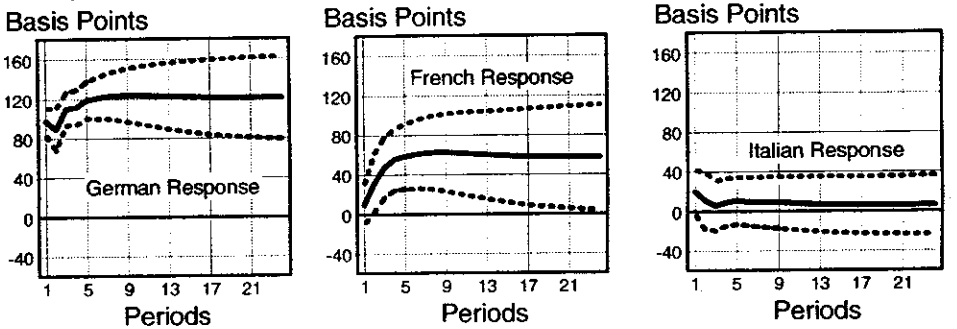


C) Italian Innovation

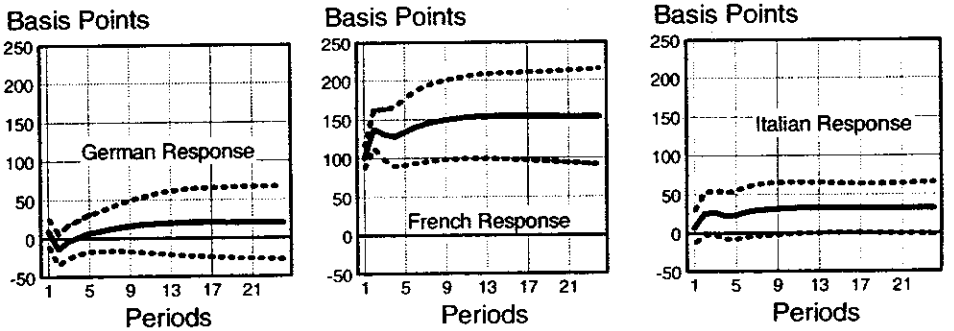


II: Short term Rates

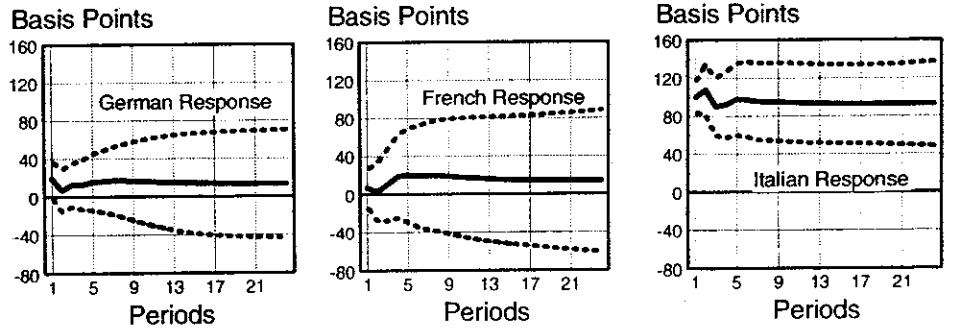
A) German Innovation



B) French Innovation



C) Italian Innovation

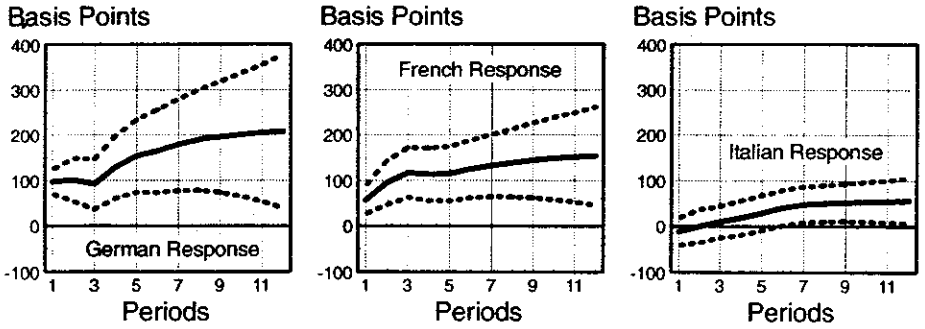


* All data normalized for series volatility. Impulse responses are constructed with estimates from 4-variable monthly CVARS with 2 lags at 24-month horizon

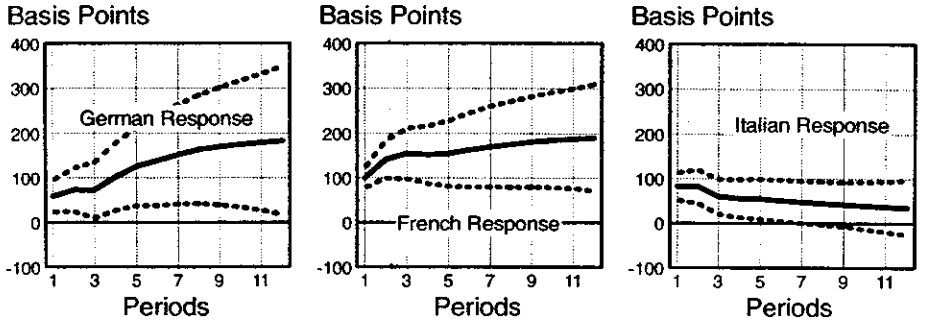
Chart 3: Cumulated Impulse Responses of European Rates to an Intra-European Innovation.* 1990:08-1993:11

I: Invervention Rates

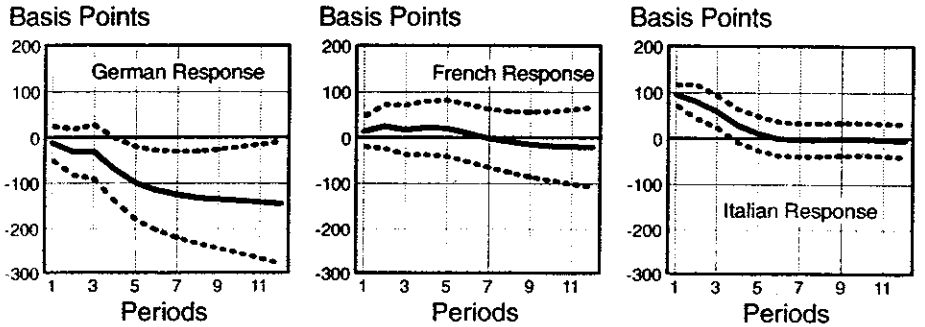
A) German Innovation



B) French Innovation

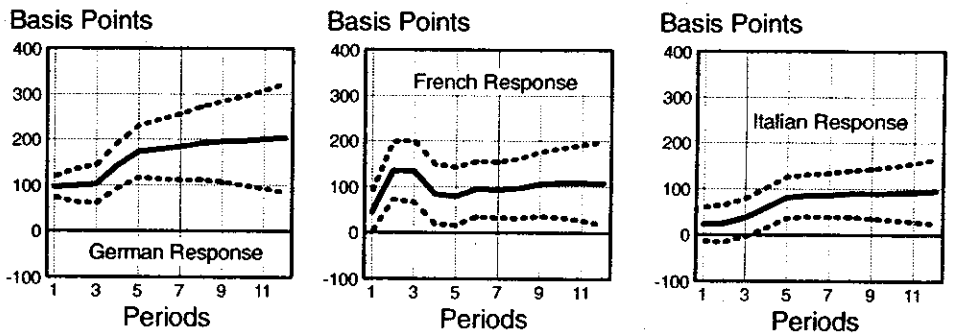


C) Italian Innovation

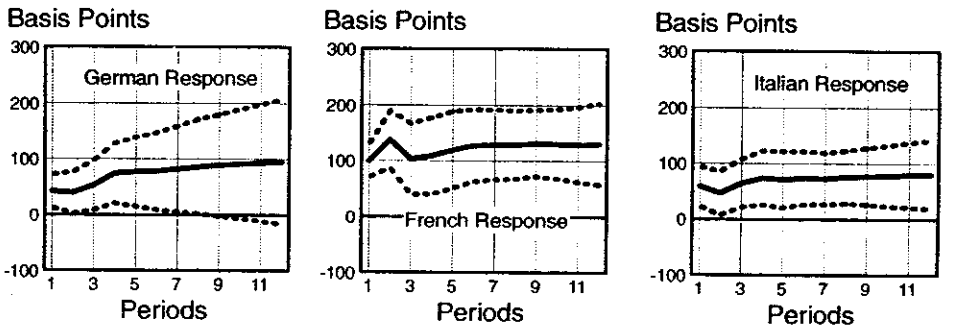


II: Short term Rates

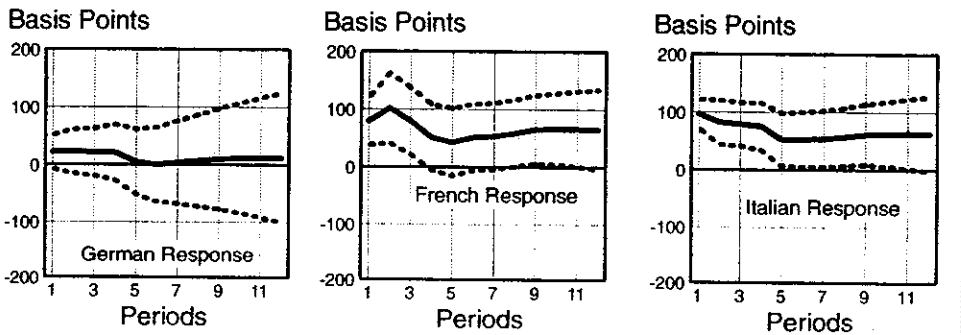
A) German Innovation



B) French Innovation



C) Italian Innovation

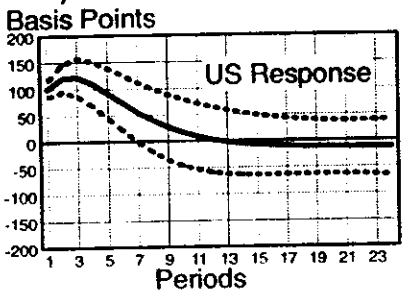


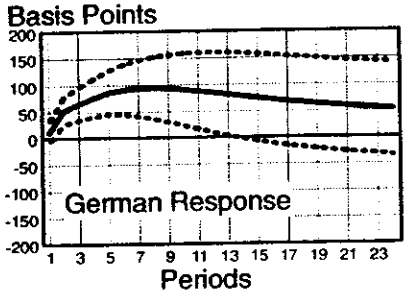
* All data normalized for series volatility. Impulse responses are constructed with estimates from 4-variable monthly CVARS with 2 lags at 24-month horizon

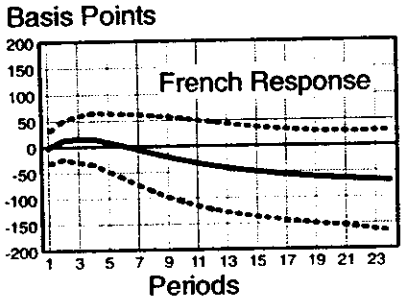
Chart 4: Cumulated Impulse Responses of European and U.S. Short-term Rates to U.S. Innovation

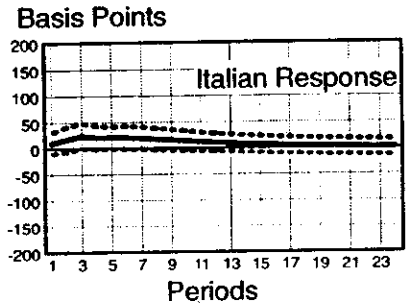
I) 1982:01-1990:07

A) Intervention Rates

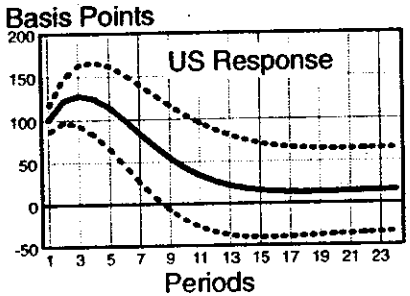


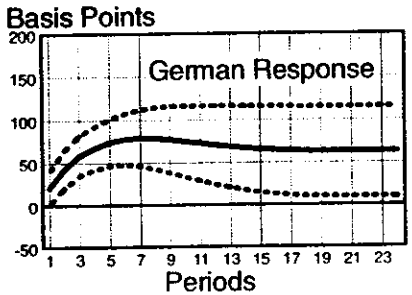


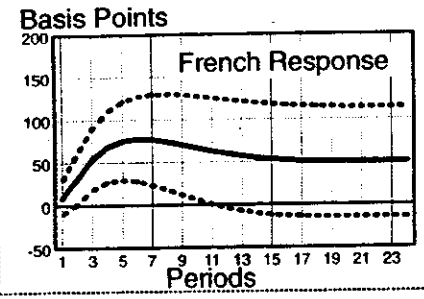


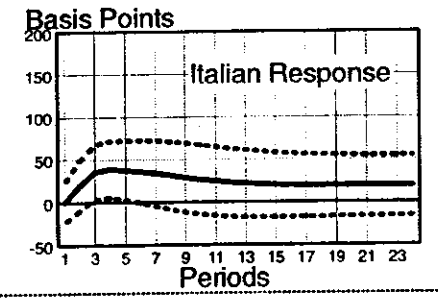


B) Short-term Rates



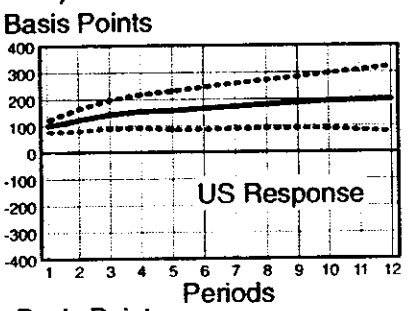


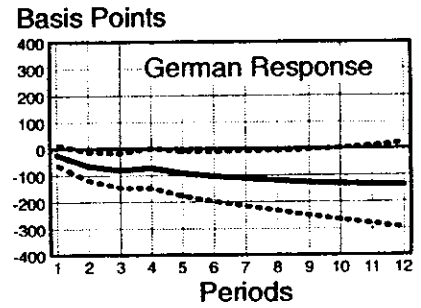


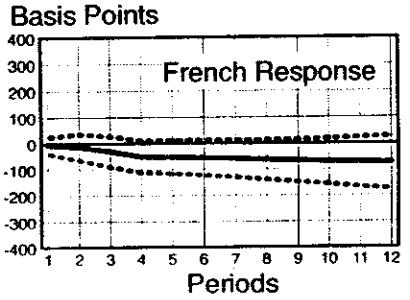


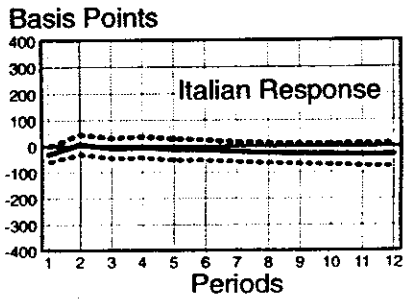
II) 1990:08-1993:11

A) Intervention Rates

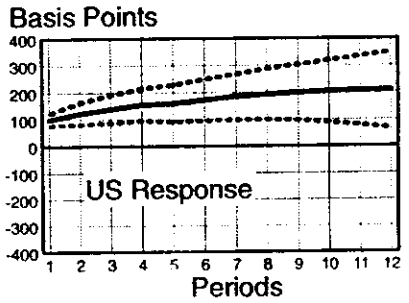


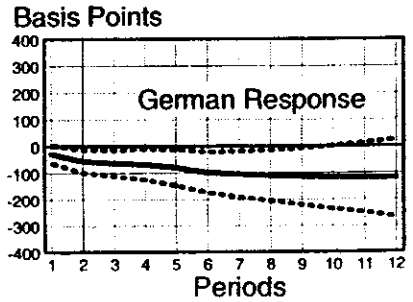


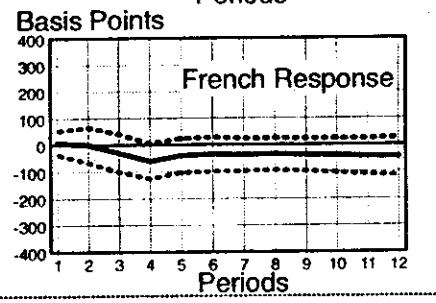


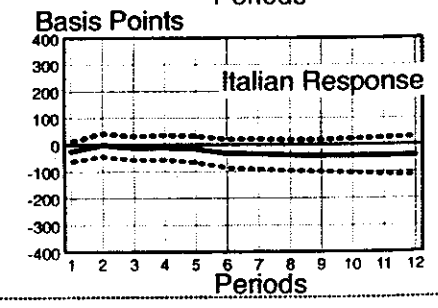


B) Short-term Rates









* All data normalized for series volatility. Impulse responses are constructed with estimates from 4-variable monthly CVARS with 2 lags at 24-month horizon