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European Policy Convergence and the EMS

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Abstract

In this paper we analyze the degree of policy convergence of EMS member countries relative to that of some non-EMS countries. Interestingly, we find convergence for the nominal and real exchange rates and money supplies of the EMS members but not for the non-EMS countries. We also provide some evidence to support the "German leadership hypothesis" in the context of intra-EMS monetary policy convergence.

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Summary

The European Monetary System (EMS) has exerted a short-run stabilizing effect on intra-EMS exchange rates, both real and nominal. The welfare gains from this increased high-frequency stability are, however, uncertain. Studies, for example, of the effect of high-frequency exchange rate volatility on trade are generally inconclusive. Long-run volatility--that is, the tendency for fundamental misalignments to arise within a group of exchange rates--seems to be of greater welfare significance. In addition, it seems probable that the achievement of convergent real exchange rates would require convergent monetary policies.

This paper seeks to obtain a measure of the extent of convergence of real and nominal exchange rates and monetary policy in the long run between EMS members and to compare this to the pattern among several non-EMS countries (Canada, Japan, and the United Kingdom).

The analysis indicates that there is long-run convergence of nominal and real exchange rates, as well as of the growth rates of money supply (and, by implication, monetary policy), for the three EMS countries examined (France, Germany, and Italy), but not for the three non-EMS countries. This finding raises the question whether policy convergence has been achieved in a broadly symmetric fashion or whether one or more EMS members have emerged as policy leaders during 1979-88. In particular, there seems to be evidence that Germany has emerged as the dominant player within the EMS, setting its monetary policy largely autonomously while other members of the exchange rate mechanism (ERM) have attempted to converge on the German standard.

A test of this "German leadership hypothesis" draws on the previous econometric analysis and testing for temporal precedence between the money-supply series. If the German leadership hypothesis is correct, then, loosely speaking, movements in the German money supply should precede movements in the other countries.

The econometric results do, indeed, reveal quite strong evidence in favor of the German leadership hypothesis. It is particularly interesting that while changes in the German money supply causes changes in the French money supply, lagged values of the French money supply are jointly insignificant in explaining the current magnitude of the French money supply. This finding broadly accords with evidence which suggests that foreign exchange intervention to support intra-EMS parities is predominantly undertaken by non-German members and, morever, that while intervention is systematically sterilized in Germany, this is much less commonly done in other EMS countries; if this were the case, this would be one way in which German monetary policy could be transmitted throughout the EMS area.

I. Introduction

One of the salient features of the recent period of floating foreign exchange rates has been the high real and nominal volatility of the major exchange rates (Dornbusch and Frankel 1987). The experience of the European Monetary System (EMS) since 1979, by contrast, is often cited as an example of the benefits conferred by a system of managed currencies. 1/ As Artis (1990a) notes, a "stylized result" pertaining to the EMS is that it has exerted a short-run, or high-frequency, stabilizing effect on intra-EMS rates, both real and nominal (see e.g., Ungerer et. al., 1983, 1986; Artis and Taylor 1988). This is illustrated informally in Table 1, which suggests that France and Italy have each enjoyed a markedly lower degree of real and nominal deutschmark exchange rate volatility, measured on a monthly basis, than have Canada, Japan and the U.K., and that, moreover, this stability does not appear to have been bought at the expense of abnormally high real dollar exchange rate volatility. 2/ The welfare gains of this increased high-frequency stability are, however, uncertain. Studies, for example, of the effect of high-frequency exchange rate volatility on trade are generally inconclusive. 3/ Low-frequency volatility--i.e., the tendency for fundamental misalignments to arise within a group of exchange rates--seems, on the other hand, likely to be of greater welfare significance (Williamson 1983, 1985). In addition, it seems probable that the achievement of convergent real exchange rates would require convergent monetary policies. Informal evidence which is suggestive of (short-run or high-frequency) policy convergence within the EMS area is given in Table 2, which suggests that the growth of the narrow money stock in each of the three major EMS economies have each shown a tendency to converge toward one another during the period of operation of the ERM. Table 2 also shows that the contemporaneous correlation of French and Italian money growth with German money growth has also increased over the period. Although the contemporaneous money growth correlations remain small in magnitude, we would argue that they can provide at most anecdotal evidence, given the dynamic nature of the macroeconomic structure; what is required is a measure of low-frequency convergence, i.e., whether or not money supplies show a tendency to move together over long periods of time. In this paper we seek to obtain measures of the extent of real and nominal exchange rate and monetary policy long-run convergence between EMS members and compare this to the pattern among certain non-EMS countries. Our low-frequency convergence tests are conducted by an application of the multivariate cointegration technique recently proposed by Johansen (1988).

1/ In this paper we shall treat the terms "European Monetary System" (EMS) and "Exchange Rate Mechanism" (ERM) as broadly interchangeable. Strictly speaking, the U.K. is in fact a member of the EMS although she does not participate in the ERM, which is the system of managed floating.

2/ See section 4 for a discussion of data sources and methods. See Artis and Taylor 1988 for a more detailed analysis.

3/ The evidence is reviewed in Artis and Taylor 1988.

II. Convergence Measures and the Relevance of the Cointegration Framework

The EMS has a formal objective of stabilizing nominal exchange rates and an informal commitment, which is perhaps more long term, to maintain the competitiveness of its member countries: otherwise, members are continually tempted to break with the union in order to make up for losses in competitiveness. Such twin objectives of nominal and real exchange rate stability can only be achieved, other things equal, if member countries are prepared to countenance a harmonization of monetary policies. 1/ Thus, if the EMS has been successful we should observe a tendency for the real and nominal exchange rates and nominal money supplies of EMS members to move together over time and little or no such tendency to be evident among the exchange rates of non-EMS countries. 2/

If a set of variables is cointegrated (e.g., real exchange rates of EMS member currencies against the dollar) then, although each series may be individually non-stationary, there must exist at least one linear combination which is stationary. This linear combination can be thought of as a long-run relationship towards which there is a continual tendency of the variables to adjust--in other words, the series tend to move together over time (see Engle and Granger 1987; Cuthbertson, Hall and Taylor 1990 for further details).

III. A Multivariate Cointegration Technique

A time series is said to be integrated of order one--denoted I(1)-if it must be first-differenced to induce stationarity. If there exists a linear combination of two or more I(1) series which is itself stationary, then the series are cointegrated. For N I(1) series it is possible for there to be up to $N-1$ stationary linear combinations or cointegrating vectors (Engle and Granger 1987). Consider an $Nx1$ vector of I(1) variables X which has an autoregressive representation with Gaussian errors ϵ_t 3/:

$$X_t = \pi_1 X_{t-1} + \pi_2 X_{t-2} + \ldots + \pi_k X_{t-k} + \epsilon_t, \quad t=1,2,\ldots,T. \tag{1}$$

1/ It is well known that Britain attempted to "shadow" the deutsche mark in late 1987 into early 1988. It is equally well known that she abandoned this policy because of a reluctance to subordinate monetary policy to the exchange rate target (see e.g., Artis 1990b).

2/ Artis and Nachane (1990) examine long run co-movements of inflation rates among EMS and non-EMS countries, using cointegration techniques. While their results do not rule out long-run inflation convergence within the EMS, they are unable to distinguish this from a general "global disinflation" effect.

3/ Phillips (1987) suggests that the Johansen technique may also be applicable in the presence of heterogeneously distributed error processes. In our empirical analysis, an intercept term and seasonal dummies were included in the VARs, as in Johansen and Juselius 1990.

Table 1. Average Monthly Absolute Percentage Changes In Exchange Rates 1979-1988*

	(Nominal Exchange Rates)					
	France	Germany	Italy	Canada	Japan	U.K.
Against U.S. Dollar	2.804	2.738	2.518	0.975	2.781	2.753
Against German Mark	0.774	-	0.704	2.592	2.314	2.150
	(Real Exchange Rates)					
	France	Germany	Italy	Canada	Japan	U.K.
Against U.S. Dollar	2.685	2.792	2.549	1.041	2.775	2.820
Against German Mark	0.933	-	0.807	2.637	2.218	2.162

*Average absolute monthly change in the logarithm of the exchange rate multiplied by 100. Data period is March 1979 through December 1988.

Table 2. Average Money Growth Rates and Correlations, 1979-1984 and 1985-1988*

(Average Percentage Monthly Money Growth Rates)						
France	Germany	Italy	Canada	Japan	U.K.	U.S.
.93(.53)	.44(.68)	1.21(.51)	.08(1.14)	.38(.53)	1.01(1.48)	.67(.72)

(Correlation Matrix of Monthly Money Growth Rates Among EMS Countries)			
	France	Germany	Italy
France:	1		
Germany:	-.11 (.07)	1	
Italy:	.81 (-.003)	-.01 (.03)	1

*Narrow definition of the money supply used. Growth rate calculated as the monthly change in the logarithm of the money supply multiplied by 100. In each case the first figure given relates to data for the period March 1979 through December 1984 and the figure in parenthesis relates to data for the period January 1985 through December 1988.

The long-run static 1/ equilibrium corresponding to (1) is

$$\pi X = 0. \tag{2}$$

where the long-run coefficient matrix π is defined:

$$I - \pi_1 - \pi_2 - \ldots - \pi_k = \pi. \tag{3}$$

π is an NxN matrix whose rank determines the number of distinct cointegrating vectors which exist between the variables in X. Define two Nxr matrices, α and β, such that

$$\pi = \alpha\beta' \tag{4}$$

The rows of β' form the r distinct cointegrating vectors such that, if β_i' is the ith row of β':

$$\beta_i' X_t \sim I(0) \tag{5}$$

Johansen demonstrates that the likelihood ratio test statistic for the hypothesis that there are at most r distinct cointegrating vectors is

$$LR = T \sum_{i=r+1}^{N} \ln(1-\hat{\lambda}_i) \tag{6}$$

where $\hat{\lambda}_{r+1}, \ldots, \hat{\lambda}_N$ are the $N-r$ smallest squared canonical correlations between the X_{t-k} and ΔX_t series, corrected for the effect of the lagged differences of the X process (for details of how to extract the $\hat{\lambda}_i$'s see Johansen 1988, 1989; Cuthbertson, Hall and Taylor 1990). Johansen (1988) shows that LR, as defined in (6), will have a non-standard distribution under the null hypothesis. He does, however, provide approximate critical values for this statistic, generated by Monte Carlo methods. 2/

1/ Dynamic steady state equilibrium simply involves the addition of a term in the constant vector of steady-state growth rates to (2), which we omit here for expositional purposes; this does not affect the subsequent discussion.

2/ The critical values recorded in Johansen's 1988 paper are for a VAR without an intercept term or seasonal dummies. Since these were included in our empirical analysis, we used the critical values for (6) reported in Johansen 1989 and Johansen and Juselius 1990.

Table 3. Unit Root Tests*

	Nominal Exchange Rates			Real Exchange Rates			Money Supplies		
Country	s_t	Δs_t	$\Delta^2 s_t$	c_t	Δc_t	$\Delta^2 c_t$	m_t	Δm_t	$\Delta^2 m_t$
France	-1.53	-10.48	-26.54	-1.72	-11.32	-56.93	-1.25	-25.01	-46.05
Germany	-0.96	-10.34	-25.60	-1.60	-10.86	-52.83	0.67	-11.73	-20.19
Italy	-1.75	-10.05	-26.48	-1.32	-10.90	-54.15	-1.42	-14.91	-27.95
Canada	-1.33	-11.83	-26.54	-0.74	-11.94	-54.13	-0.91	-12.63	-30.34
Japan	0.30	-9.74	-22.26	-0.83	-10.46	-46.53	-0.37	-17.65	-27.72
U.K.	-1.26	-9.95	-23.76	-1.25	-9.83	-46.93	1.61	-13.29	-27.88
U.S.	-	-	-	-	-	-	0.32	-13.89	-25.20

*All data are in natural logarithms. The reported numbers are modified Dickey-Fuller statistics for the null hypothesis that the sum of the coefficients in the autoregressive representation of the variable sum to unity (Phillips 1987). In constructing these statistics we have allowed for up to third-order serial correlation and used a Bartlett lag window to ensure positive definiteness (Newey and West 1987). The null hypothesis is that the series in question is I(1). Approximate critical value at the 5 percent level is -2.89, with rejection region $\{\theta | \theta < -2.89\}$ (Fuller 1976).

IV. Empirical Results and Discussion

In this paper, we analyze bilateral U.S. dollar nominal and real exchange rates for three major EMS currencies (the French franc, German mark and the Italian lira) and three major non-EMS currencies (the Canadian dollar, the Japanese yen and the British pound) and nominal money supplies for all these currencies (including the U.S. dollar). 1/ The data sample runs from the inception of the Exchange Rate Mechanism (ERM) of the EMS in March 1979 and ends in December 1988. 2/ All data are observed monthly and are taken from the International Financial Statistics (IFS) data tape of the International Monetary Fund. Real exchange rate measures were obtained by deflating nominal exchange rates by relative producer prices. 3/

A prior consideration concerns the order of integration of the time series since the above discussion is predicated on the assumption that they are I(1). Following the suggestion of Dickey and Pantula (1987), we tested sequentially for two, one and zero unit roots using the modified Dickey-Fuller test (Phillips 1987). On the basis of these computed statistics (Table 3), we can in no case reject the null hypothesis that each data series contains a single unit root--i.e., that they are each I(1).

As a preliminary to the Johansen analysis, we must also determine the lag depth of the VAR: the procedure employed was to find the lag depth at which the Akaike Information Criterion (Akaike 1974) was minimized and then to test down to the minimum number of jointly significant lags 4/,

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1/ All data were converted to natural logarithms.

2/ Since the ERM has only been in existence since 1979, a longer data sample clearly could not be obtained and the advantages of increasing the frequency of observation over this period would seem slight (Shiller and Perron 1985, Perron 1987). Although the desirability of a longer data span in the context of testing for unit roots and cointegration (on which see below) cannot be denied, it might be noted that such tests are well known for their lack of power; thus, on the assumption that test power will be reduced further in small samples (in which the long-run, or low-frequency, properties of the data may only be dimly reflected), any rejections of the null hypothesis of unit roots and/or non-cointegration that do occur will hold *a fortiori*.

3/ Exact sources are: exchange rate - IFS line *ae* (*ag* for the U.K.); money supply - IFS line 34; producer price index - IFS line 63. Base periods are irrelevant as all variables were transformed to logarithms in the empirical analysis. Also, the fact that our real exchange rate measure may be a noisy proxy for the "true" measure of competitiveness will not affect the cointegration analysis so long as the measurement errors are assumed to be stationary.

4/ There is evidence to suggest that minimizing the Akaike Information Criterion may lead to overparameterization (Sawa 1978).

Table 4. Cointegration Tests*

	$H_0: r \leq 2$	$H_0: r \leq 1$	$H_0: r = 0$	VAR lag length
(Nominal Exchange Rates)				
EMS Group	2.69	10.18	35.30	13
Non-EMS Group	0.87	6.02	18.88	1
5 Percent Critical Values	9.09	20.17	35.07	
(Real Exchange Rates)				
EMS Group	1.29	8.36	37.34	13
Non-EMS Group	0.17	8.91	27.39	1
5 Percent Critical Values	9.09	20.17	35.07	

	$H_0: r \leq 3$	$H_0: r \leq 2$	$H_0: r \leq 1$	$H_0: r = 0$	VAR lag length
(Nominal Money Supplies)					
EMS Group		3.59	15.69	41.76	6
5 Percent Critical Values		9.09	20.17	35.07	
Non-EMS Group	2.14	5.73	11.35	24.39	13
5 Percent Critical Values	9.09	20.17	35.07	53.35	

*r denotes the maximum number of cointegrating vectors. The 5 percent critical values are taken from Johansen 1989. The vector autoregressions included a constant and seasonal dummies in each case.

stopping only if the restrictions induced serial correlation in the residuals.

Table 4 presents results of our cointegration test procedures applied to the EMS and non-EMS country groupings, for nominal and real exchange rates and nominal money supplies. 1/ The interesting finding which emerges from these results is that a unique cointegrating vector is in every case indicated, at the 5 percent significance level, for the ERM grouping, whilst there is a general failure to reject the null hypothesis of non-cointegration for the non-ERM grouping. 2/ These results indicate long-run convergence of nominal and real exchange rates, as well as money supplies, for the three EMS countries examined, but not for the non-EMS countries. Long-run stabilization of both nominal and real exchange rates requires a degree of policy convergence at a similar frequency, and this is evidenced by the cointegration of money supplies for the EMS countries. This finding itself raises a subsidiary question as to whether policy convergence has been achieved in a broadly symmetric fashion or whether one or more EMS members have emerged as policy leaders over this period. In particular, there seems to be anecdotal evidence that Germany has emerged as the dominant player within the EMS, setting its monetary policy largely autonomously while other ERM members have attempted to converge on the German standard 3/ (Artis 1990a). We close this section with a simple test of the "German leadership hypothesis" which draws on the previous econometric analysis.

The finding of a unique cointegrating vector for nominal monies amongst the EMS grouping implies that Granger-causality must run in at least one direction amongst them (Granger 1986; Engle and Granger 1987). If the German leadership hypothesis is correct, then Granger-causality should presumably run from German to Italian and French money but not vice versa: loosely speaking, movements in the German money supply should temporally precede movements in the others. This can be formally tested by testing for

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1/ Hakkio and Rush (1989) and MacDonald and Taylor (1989) examine the cointegration of nominal spot exchange rates from the efficient markets perspective. In neither of these papers is the multivariate cointegration technique of the present paper employed.

2/ Hakkio and Nachane (1990) fail to detect pairwise cointegration between the nominal dollar-deutsche mark rate and the dollar exchange rates of other EMS currencies against the dollar. This finding is not inconsistent with out finding of a unique cointegrating vector between dollar-lira, dollar-mark and dollar-franc rates; in fact, pairwise cointegration among these rates would entail the existence of at least three cointegrating vectors in the EMS grouping.

3/ A rationale for asymmetric behavior of this kind is provided by, *inter alios*, Melitz (1985, 1988): for non-German members at least, the incentive is provided by the opportunity to pre-commit on an effective and credible counter-inflation policy.

Table 5. Tests of the German Leadership Hypothesis*

Money Supply	H_0:Series not caused by French money	H_0:Series not caused by German money	H_0:Series not caused by Italian money
French	0.76 (0.60)	2.35 (0.04)	1.46 (0.20)
German	0.49 (0.81)	273.83 (0.00)	1.07 (0.38)
Italian	0.42 (0.86)	2.33 (0.04)	33.01 (0.00)

*The statistics are F-tests for the lagged series in question to be jointly insignificant in the equation explaining the money supply series indicated on the left hand side of the table, in the VAR representation for the series. They are distributed as central F with 6 and 82 degrees of freedom under the null hypothesis of joint insignificance. Figures in parentheses are marginal significance levels.

the significance of lagged money supply terms in each of the equations of the VAR representation.

The results of these Granger-causality tests 1/ (Table 5) do indeed reveal quite strong evidence in favor of the German leadership hypothesis, with Granger-causality running from German money to the other two monies, but no other international causation; it is particularly interesting that while German money causes French money, lagged values of the French money supply are jointly insignificant in explaining current French money. This finding is broadly in accordance with evidence which suggests that foreign exchange intervention to support intra-EMS parities is predominantly undertaken by non-German members and, moreover, that intervention is systematically sterilized in Germany but much less commonly in other EMS countries (Mastropasqua *et. al.*, 1988); this is one way in which German monetary policy could be transmitted throughout the EMS area.

1/ The simple Granger-causality tests reported here are for the statistical significance of lagged terms in the VAR expressed in (log-) levels. Since, by the Granger Representation Theorem, this can be interpreted as an unrestricted error correction representation in the presence of cointegration, our simple tests are asymptotically equivalent to testing for the joint significance from zero of lagged first differences and the error correction term in the error correction representation (see Miller and Russek 1990). To see this, consider the first equation of a first-order trivariate error correction representation:

$$\Delta y_t = \alpha\Delta y_{t-1} + \beta\Delta x_{t-1} + \gamma\Delta z_{t-1} + \delta(y-\kappa x-\lambda z)_{t-1} + \epsilon_t$$

where ϵ_t is white noise and $(1, -\kappa, -\lambda)'$ is the cointegrating vector (normalized on y). This can be reparemeterized:

$$y_t = (1+\alpha+\delta)y_{t-1} - \alpha y_{t-2} + (\beta-\delta\kappa)x_{t-1} - \beta x_{t-2} + (\lambda-\delta\lambda)z_{t-1} - \gamma z_{t-2} + \epsilon_t$$

Thus, using the levels regression to test the null hypothesis that x does not Granger-cause y is tantamount to testing the joint hypothesis H_0: $(\beta-\delta k)=0, \beta=0$, which in turn, given $\kappa\neq 0$, is equivalent to H_0: $\beta=0$, $\delta=0$. Likelihood ratio tests (constructed as in Johansen 1988, not reported) in every case rejected the hypothesis that any of the elements of the cointegrating vector were individually statistically insignificant from zero (e.g., H_0: $\kappa=0$ for the above) for the money supply VAR for the EMS countries. The stationarity of the error term, implied by cointegration, implies that this is a statistically valid procedure.

V. Conclusion

This paper has applied state of the art econometric techniques to test for long-run nominal and real exchange rate stabilization and monetary policy convergence among EMS and non-EMS member countries. We have shown that, in comparison with a control group of non-ERM exchange rates, ERM exchange rates, both nominal and real, appear to move together in the long run, thus suggesting that the EMS has been effective in reducing the tendency towards exchange rate misalignment--at least amongst its own members--which has been evident for the major exchange rates in much of the floating rate period (Dornbusch and Frankel 1987).

Our finding of cointegration among EMS members' money supplies suggests, in turn, that this achievement has been obtained via the long-run convergence of monetary policy within the EMS. We also provided some evidence that this convergence has, in practice, been obtained by a convergence on the German standard rather than symmetric policy responses within the EMS, which accords with anecdotal evidence on the *modus operandi* of the system.

Overall, therefore, the evidence presented in this paper suggests that the EMS may have provided a successful antidote to the many disappointments of flexible exchange rates (Dunn 1986, Dornbusch and Frankel 1987).

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