THE KOREAN ECONOMIC REVIEW
Volume 8, Number 1, Summer 1992.

THE EUROPEAN MONETARY SYSTEM: AN ASYMMETRIC SYSTEM OR A COOPERATIVE SYSTEM?

BANG NAM JEON*

I. INTRODUCTION

Europe 1992 and the success of the European Monetary System (EMS) have renewed interest in greater monetary integration in the 12-member countries of the European Communities (EC). A unified monetary policy is believed to enhance Community-wide welfare by forcing member countries to adopt a common anti-inflationary stance and by reducing the costs of exchange rate fluctuations and uncetainty. Economic and monetary convergence in member in the EC is an indispensable precondition for a move along the road of monetry union: a single currency and central bank in the unified EC.[1]

The EMS, launched in March 1979, has been considered to be a prime factor contributing to the improved monetary stability in Europe by achieving the harmonization of monetary policies within the Community. Inflation rates have fallen further and converged more rapidly in the EMS countries than in the rest of the Community. Exchange rate and interest rate variabilities are lower within the EMS countries than for other economies.[2] The adjustment burden has been taken, in most part, by monetary policy, which has converged during the EMS period.

Although the EMS has been given credit by consensus in promoting monetary convergence, there are two different evaluations on the patterns of convergence. Some economists and policymakers evaluate the EMS as an asymmetric system. This evaluation is based on observations that most monetary convergence has come

*The author is Assistant Professor of Economics, at Drexel University, Philadelphia, PA 19104.

[1]The EC has adopted a three-phase plan, prepared by Jacques Delors, toward the European Monetary Union (EMU). The first phase, launched officially on July 1, 1990, calls for greater economic convergence by increasing economic and monetary cooperation among member nations. The second phase creates new Community-wide institutions including a central banking system, called the Europen System of Central Banks (ESCB). The third and last phase plan institutes a single currency and a single monetary policy decided and implemented by the ESCB.

[2]For a self-evaluation of the performance of the EMS during its first decade in achieving economic and monetary policy convergence, see Commission of the European Communities (1989).

about because of a tightening in high inflation countries, converging to the low inflation country, Germany. This view of German dominance in the EMS argues that Bundesbank monetary policy has provided an anchor for the EMS, leading the other members to surrender their monetary policy autonomy to the Bundesbank.

The opposite view on the pattern of monetary convergence in the EMS countries is that the EMS is a cooperative system in which the burden of the adjustments to the converging path has been shared by all the EMS members. Although high inflation rates in some EMS member countries have converged to the lower end countries since the inception of the EMS in March 1979, it has been observed occasionally that there is some symmetry in monetary adjustments. For example, temporary monetary loosening has been seen in strong currency countries in times of EMS strain, for instance, at the end of 1987. In addition, each EMS member nation is expected to maintain monetary policy autonomy, choosing its own course of monetary stance in the cooperative EMS.

The purpose of this paper is to provide further evidence on the characterization of the EMS: asymmetric or cooperative. Whether the EMS is an asymmetric system or a cooperative system has important implications on the EC's strategy toward the European Monetary Union(EMU). Section II describes and investigates the time-series property of data. Section III examines the bilateral relationships between monetary policy in Germany and the other EMS countries. Section IV performs a multivariate analysis of monetary policies in the EMS countries as a system. The summary and policy implications of this study on the future path to the EMU are provided in Section V.

II. DATA

Data employed in this study are monetary bases in the EMS countries during the EMS period. As indicated by Mastropasqua et al (1988) and Fratianni and von Hagen (1990), changes in the monetary base well represent a central bank's actions on monetary policy. Quarterly data of the monetary base for the period from 1979. II to 1991. I were collected from the IMF's *International Financial Statstics.* We examine both the nominal and real monetary bases for Belgium, Denmark, France, Germany, Italy, and the Netherlands which are the member countries of the exchange rate mechanism (ERM) of the European Monetary System.[3]

[3]The United Kingdom and Portugal have recently jointed the ERM. Due to data limitations (the real monetary base), Ireland is not included in this study. In addition, the size of the Irish economy along with Luxemburg is not significant in the EMS. The 1982 real GNP-based weights(%) are Belgium 4.55, Denmark 2.97, France 28.84, Germany 34.42, Ireland 0.99, Italy 21.07, and the Netherlands 7.22. Luxemburg and Belgium share a currency. In addition, as Fratianni and von Hagen (1990) argued, using quarterly data seems to be more relevant than monthly or other high frequency data to examine the pattern of monetary policy interactions and long-run convergence in the EMS.

For the fair comparison and investigation of monetary interaction among the EMS members, all data are normalized at the beginning of the sample period (1979. II-1.0) and then the natural logarithms are taken.

As a pretest of data, we first test the hypothesis that the individual series follow unit root processes. The presence of a unit root in auto-regressive representations indicates that the time series is nonstationary. The tests of the null hypothesis of unit root nonstationarity are performed by using the testing procedure proposed by Dickey and Fuller (1979, 1981): the Dickey-Fuller(DF) and augmented Dickey-Fuller (ADF) tests. We also conduct the Phillips and Perron (1988) tests for unit roots, which are robust to a wide variety of serial correlation and time-dependent heteroskedasticity.

The (augmented) Dickey-Fuller test is based on the regression:

$$\Delta m_{i,t} = \beta_{i,o} + \beta_{i,1} m_{i,t-1} \ (+ \sum_{j=2}^{n} \beta_{i,j} \ \Delta m_{i,t-j+1}) + e_{i,t}, \tag{1}$$

where Δ is the first-difference operator, m_i is the natural logarithms of the normalized monetary base in the EMS country i, and i = 1 (Belgium), 2 (Denmark), 3 (France), 4 (Germany), 5 (Italy), and 6 (the Netherlands). The null hypothesis that $m_{i,t}$ is a nonstationary series is rejected when $\beta_{i,1}$ is significantly negative.

The results of tests for unit roots in the monetary base for the EMS countries are reported in Table 1. Nonstationarity cannot be rejected for the levels of most of the nominal and real monetary bases in the EMS countries at the 5 percent significance level based on the Dickey-Fuller test, and cannot be rejected in any case according to the Augmented Dickey-Fuller test. However, the null hypothesis of unit root nonstationarity is strongly rejected for the first-differenced series of the monetary base in the EMS countries. The Phillips-Perron tests reported in Table 1 provide the same results. These results imply that all monetary base series in the EMS countries are integrated of order 1. I(1).

III. THE BIVARIATE ANALYSIS: GERMAN DOMINANCE

Suppose that the Bundesbank's monetary policy plays a role as anchor for the EMS and that monetary policies of the EMS countries converge to that of Germany. A pair of nonstationary monetary bases in Germany and in one of any other EMS countries are then expected not to drift apart from each other, and to share a long-run equilibrium, cointegration relationship. Cointegrated monetary bases in Germany and the other EMS countries imply that there exist some common stochastic trends in each pair of monetary bases in the two countries.

If two time series $\{m_{i,t}\}$ and $\{m_{j,t}\}$ both are I(1), the linear combination of the two series. $\{Z_t\}$-$\{m_{i,t}\}$-a$\{m_{j,t}\}$, called a cointegrating equation, is also generally believed to follow an I(1) process. By generalizing Granger's definition (1981, 1986), we can state that any combination of time series of $\{m_{i,t}\}$ and

[**Table 1**] Tests for Unit Roots in the Monetary Base in the EMS Countries (1979. II through 1991. I)

	DF test (γ_μ)		ADF test (γ_μ)		Phillips-Perron test ($Z(t_\alpha)$)		($Z(t_{\alpha^*})$)	
	levels	changes	levels	changes	levels	changes	levels	changes
Nominal								
Belgium	−2.83	−25.79	−1.12	−3.48	−2.19	−28.43	−2.98	−36.09
Denmark	−1.41	−7.67	−1.04	−3.45	−0.02	−7.66	−1.43	−7.91
France	−1.66	−15.23	−2.65	−2.77	1.20	−9.59	−2.74	−14.72
Germany	0.09	−12.28	2.75	−2.31	2.87	−9.59	0.36	−13.87
Italy	−1.23	−8.49	−1.89	−1.87	3.68	−4.33	−2.19	−11.52
Netherlands	−0.53	−11.81	0.14	−3.32	2.40	−7.77	−0.75	−14.35
Real								
Belgium	−2.37	−24.28	−1.96	−1.85	0.94	−13.72	−2.78	−19.24
Denmark	−2.12	−7.54	−1.72	−3.39	−1.91	−7.72	−2.12	−7.70
France	−3.45	−14.02	−1.84	−3.75	−3.32	−14.13	−3.29	−13.97
Germany	−0.52	−11.63	1.06	−1.62	−0.58	−10.48	−0.51	−11.24
Italy	0.10	−8.24	−0.79	−1.87	0.25	−8.04	0.18	−8.88
Netherlands	−0.35	−11.60	0.18	−2.93	0.76	−8.97	−0.56	−11.30

Notes: The data are natural logarithms of the normalized (1975. II-1.0) quarterly monetary bases in the EMS countries for the period 1979. II through 1991. I. 'changes' denote the first-differenced series of the levels of monetary bases. Test statistics the nominal monetary bases are reported under 'Nominal', and those for the real monetary bases, deflated using the CPI, are reported under 'Real'. The ADF test uses four lags of the dependent variable. The critical values for γ_μ (the DF and ADF tests) and $Z(t_\alpha{}^*)$ are −2.93 and −3.58, and those for $Z(t_\alpha)$ are −1.95 and −2.62 at the 5 percent and 1 percent levels, respectively, for $T=50$. (Fuller 1976, p. 373)

$\{m_{j,t}\}$, each of which is I(d), denoting "integrated of order d." is also I(d). However, it is possible that $\{Z_t\}$-I(d-b), where b is any positive integer that is not larger than d. Then $\{m_{i,t}\}$ and $\{m_{j,t}\}$ must have a very special relationship, both series having similar low-frequency or long-run components that cancel out to produce a new stationary series of $\{Z_t\}$. The two time series, $\{m_{i,t}\}$ and $\{m_{j,t}\}$, are said to be "cointegrated of order (d, b)" and the coefficient a in the cointegrating equation is called the cointegrating vector. For $d=b=1$, the I(1) processes of the two different time series do not drift too far apart and they move with the long-run equilibrium path.

Table 2 presents the results of testing for cointegration between the monetary base in Germany and that in each of the other EMS countries. The estimates of the cointegrating regressions and the results of applying the DF and ADF tests to the residuals from the cointegration regressions are reported. Cointegration requires stationary residuals. For the nominal monetary base, the tests fail to reject the null hypothesis of noncointegration at the 5 percent significance level, in all cases except the Belgium-Germany pair. For the real monetary base, the null of noncointe-gration is rejected for pairs of France-Germany and Italy-Germany, while

[**Table 2**] Tests for Cointegration between the Monetary Base in Germany and that in other EMS Countries (1979. II through 1991. I)

Country	*a*	*b*	D-W	DF	ADF(4)
Nominal					
Belgium	-0.009	0.273	1.85	-6.28	-2.12
Denmark	0.169	1.871	0.50	-2.60	-2.28
France	0.237	1.269	0.31	-1.95	-1.60
Italy	0.314	2.204	0.44	-2.67	-1.96
Netherlands	0.092	1.291	0.60	-2.71	-2.26
Real					
Belgium	-0.287	-0.404	0.32	-3.18	-2.22
Denmark	0.092	1.156	0.52	-2.63	-2.39
France	0.002	0.262	1.02	-3.84	-2.36
Italy	0.014	0.897	1.01	-3.94	-1.66
Netherlands	0.133	1.269	0.46	-2.68	-2.45

Notes: For the description of data, see Table 1. *a* and *b* denote the OLS estimates from cointegration regressions of monetary bases in the EMS countries on a constant *(a)* and the monetary base in Germany *(b)*. D-W is the Durbin-Watson statistics for the cointegration regressions. DF and ADF(4) denote the Dickey-Fuller and the augmented Dickey-Fuller (with four lags) tests for a unit root in the residuals from each cointegration regression. The critical values of the D-W, DF, and ADF tests of cointegration are 0.78, -3.67, and -3.29, respectively, at the five percent level for $T = 50$. (Engle and Yoo 1987)

other country pairs do not show the cointegration relationship. It seems difficult to generalize that Germany's monetary base shares a long-run equilibrium relationship with those in the other EMS countries.[4]

To further investigate monetary policy interaction between Germany and the other EMS countries by allowing for short run dynamics, we conduct the Granger causality tests to evaluate whether the Bundesbank's monetary policy affects the other EMS members' monetary policies or vice versa. The unit-root test and cointegration test results presented earlier indicate that the cointegration relationships shared by Germany and some EMS countries can be specified with error-correction representations. The error-correction representations can be interpreted as more comprehensive tests than the Granger causality tests, by allowing for a causal linkage between two variable stemming from a common trend or equilibrium relationship through the error-correction terms. (Granger 1986, 1988, Engle and Granger, 1987)

Our causality tests are, therefore, based on the following regression:

[4]In the bivariate analysis of interest rate linkages within the EMS. Karfakis and Moschos (1990) found that cointegrating tests failed to reject the null hypothesis of noncointegration between the German and each of the other EMS members' interest rates.

$$\Delta m_{i,t} = \alpha_{i,0} + \sum_{p=1}^{P} \alpha_{i,p}\, \Delta m_{i,t-p} + \sum_{q=0}^{Q} \alpha_{G,p+q+1}\, \Delta m_{G,t-q} + \lambda_{i,1}\, E1_{i,\,t-1} + \text{Dummy } 83 + S1 + S2 + S3. \tag{2}$$

$$\Delta m_{G,t} = \beta_{G,0} + \sum_{p=1}^{P} \beta_{G,P}\, \Delta m_{G,\,t-p} + \sum_{q=0}^{Q} \beta_{i,\,p+q+1}\, \Delta m_{i,\,t-q} + \lambda_{G,2}\, E2_{G,\,t-1} + \text{Dummy83} + S1 + S2 + S3. \tag{3}$$

where m_i and m_G, the monetary base in an EMS country i and Germany, respectively, have been identified as I(1) and cointegrated time series for some pairs, and $El_{i,\,t-1}$ and $E2_{G,\,t-1}$ are the lagged residuals from the cointegration regression:

$$E1_{i,t} = m_{i,t} - \gamma_{i,0} - \gamma_{i,1} m_{G,\,t} \tag{4}$$

$$E2_{G,t} = m_{G,t} - \delta_{G,0} - \delta_{G,1} m_{i,t} \tag{5}$$

Dummy83 is included to account for the major exchange rate realignment in March 1983 in the EMS, and seasonal dummies S1, S2, and S3 are included to take into account of seasonal factors in the quarterly data. The error-correction terms, $E1_{i,\,t-2}$ and $E2_{G,\,t-1}$, are included for the regression equations for Belgium (nominal), France (real), and Italy (real) where the cointegration relationships were found.

Table 3 reports our findings for causality, based on error-correction models and the Granger causality regressions. Causality running from Germany to the Netherlands is found in both the nominal and real monetary bases through the Granger terms, while causality from Germany to France for the real monetary base is found through the error-correction terms. The reverse causality is also found, for example, running from Belgium to Germany for the nominal and real monetary bases. The evidence of the contemporaneous causality can be found only for the causality from Germany to the Netherlands.[5] The lack of the contemporaneous causality in all other country pairs implies that the possibility of the weak bilateral causality due to the completion of the adjustment process within one quarter period seems not to be large.

On the whole, the evidence supporting the notion of German dominance in the EMS is weak. The evidence is consistent with the findings by Mastropasqua et al (1988), Fratianni and von Hagen (1990), and von Hagen and Fratianni (1990). The influence of the German monetary base on some other EMS countries' monetary bases can be found (for example, in France and the Netherlands), but

[5]There has already been the Dutch-German quasi monetary union in the past decade. Under a *de facto* monetary union between the two countries, the Dutch monetary policy has followed closely the policy of the Bundesbank. For the detail, see Commission of the European Communities (1991), pp. 269-279.

[**Table 3**] Test Statistics for Causality between the Monetary Base in Germany and that in the Other EMS Countries (1979. II through 1991. I)

	Nominal				Real			
	Differ-ences	Contempo-raneous	Error-correction	Dummy 83	Differ-ences	Contempo-raneous	Error-correction	Dummy 83
Causality from Germany to EMS								
Germany → Belgium	1.22(0.32)	-0.07	-1.43	1.37	0.50(0.73)	0.64	-	0.93
Germany → Denmark	0.66(0.62)	0.35	-	0.15	0.79(0.54)	0.42	-	0.51
Germany → France	0.73(0.58)	-1.05	-	-1.23	1.28(0.30)	-0.00	-2.23	0.92
Germany → Italy	0.50(0.74)	-1.21	-	-0.96	0.58(0.68)	-0.04	-1.26	1.75
Germany → Netherl.	2.56(0.06)	2.10	-	-1.46	3.37(0.02)	2.18	-	-1.60
Causality from EMS to Germany								
Belgium → Germany	2.77(0.04)	-0.02	1.11	1.95	3.30(0.02)	0.72	-	1.76
Denmark → Germany	0.11(0.98)	0.39	-	1.24	0.14(0.97)	0.47	-	1.64
France → Germany	1.14(0.36)	-1.47	-	0.49	0.40(0.81)	-0.44	0.65	1.84
Italy → Germany	2.18(0.09)	-1.32	-	0.97	2.26(0.09)	-0.82	-1.76	0.69
Nethel. → Germany	1.34(0.27)	1.47	-	1.87	1.44(0.24)	1.44	-	2.54

Notes: For the description of data, see Table 1. The F-statistics measuring the joint significance of the $\alpha_{G,q}$'s and the $\beta_{i,q}$'s in the regression equations(2) and (3), respectively, are reported under 'Differences'. Numbers in parenthesis denote the marginal significance levels of the F-tests with the degrees of freedom of (4.30). The t-statistics for the coefficients of the contemporaneous terms, $\alpha_{G,2}$ and $\beta_{i,2}$, are reported under 'contemporaneous'. The t-statistics for the error-correction terms measure the significance of $\lambda_{i,1}$ and $\lambda_{G,2}$ in equations(2) and (3), respectively. Dummy 83 measures the significance of the suspected structural shift in the EMS due to the major exchange rate realignment in March 1983.

the reverse is also true (Belgium). All the other country pairs do not show statistically significant bilateral monetary policy interaction.

IV. THE MULTIVARIATE ANALYSIS: A COOPERATIVE EMS

In the bivariate analysis (Section III), we show, first, that the unit root nonstationary monetary base in each EMS country does not generally share the long-run equilibrium path with the German monetary base and, second, that there is not strong evidence of the unidirectional causality running from the Bundesbank's monetary policy to other EMS members' monetary policies.

This section investigates whether a system of nonstationary monetary bases in the EMS countries is tied to a single long-run equilibrium path by sharing a common stochastic trend. Existence of common stochastic trends implies that the long-run movements of a set of national monetary bases are determined interactively and that there is a common tie to a long-run equilibrium path of monetary policies within the EMS. Therefore, existence of common stochastic trends in the system of monetary bases in the EMS is believed to provide a strong signal for the cooperative and burden-sharing EMS.

The question of whether there is any evidence to support the existence of common stochastic trends in a system of monetary bases in the EMS countries can be answered by examining the data by applying the multivariate analysis of cointegration to a system of nonstationary EMS country monetary bases.

Suppose $\underline{m}_t$ represents an N-dimensional vector of random variables and all the components are I(d). If there exists a matrix $\underline{\underline{a}}\neq 0$ such that

$$\underset{(r\times 1)}{\underline{\underline{Z}}_t} = \underset{(r\times N)}{\underline{\underline{a}}'}\underset{(N\times 1)}{\underline{m}_t} - I(d\text{-}b),\ d\geq^* b>0, \tag{6}$$

then $\underline{a}$ is an $N\times r$ cointegrating matrix, which is composed of r cointegrating vectors ($r\leq N$).

Johansen (1988) proposed a unified maximum likelihood approach to both the estimation of the number of cointegrating relations and the testing procedure. Consider an N-dimensional vector autoregressive process of order k:

$$II(L)\ X_t = \varepsilon_t,\ \varepsilon_t\text{-Normal i.i.d. } (0,\ \sigma^2) \tag{7}$$

or

$$X_t = II_1\ X_{t-1} + II_2\ X_{t-2} + \ldots + II_k\ X_{t-k} + \varepsilon_t \tag{8}$$

Hence, $II(L) = I\text{-}II_1L\text{-}II_2L^2\ldots.II_kL^k$.

Reparameterizing equation (8) in first difference gives:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i\ \Delta x_{t-i}\text{-}\Gamma_k x_{t-k} + \varepsilon_t, \tag{9}$$

where $\Gamma_i = -I + \sum_{j=1}^{k-1} II_j$, $i=1, \ldots, k$ and $\Gamma_k = -I + II_1 + II_2 + \ldots + II_k$.

We are interested in variables which are integrated of order 1, i.e., X_t-I(1) and ΔX_t-I(0), and the contemporary cointegrating vectors, i.e., $L=1$ in II(L) of equation (7). The coefficient matrix of X_{t-k} in equation (9), Γ_k, turns out to be -II(1):

$$\Gamma_k = -I + II_1 + II_2 + \ldots + II_k = -II(1).$$

A system of coefficients of x_t in equation (7) is now isolated as a coefficient of X_{t-k} in equation (9).

Under the null hypothesis of the existence of at most r independent cointegrating vectors, the maximum rank of Γ_k equals r:

$$H_o\text{: rank } (\Gamma_k) \leq r \leq N.$$

Originally the null hypothesis was rank (II)$\leqslant$r$\leqslant$N. Under H_0, Γ_k may be written as $\alpha\beta'$ where α and β are N$\times$r matrices. The rows of β form the r distinctive cointegrating vectors. In this case $\beta' X_t$ is stationary, although x_t is nonstationary. Johansen shows that the likelihood ratio test statistic for the null hypotheses is

$$-21nQ = -T \sum_{i=r+1}^{N} \ln(1-\lambda_i) - cx^2,$$

where λ_i's are then N-r smallest squared canonical correlations between x_{t-k} and ΔX_t which are corrected for the lagged differences ("concentrated out"). This correction is needed to identify the rank of matrix Γ_k which links X_{t-k} and ΔX_t, as seen in equation (9). The concentrated-out X_{t-k} can be obtained as the residuals from the regression of X_{t-k} on lagged ΔX_t's, and the concentrated-out ΔX_t can be obtained as the residuals from the regression of ΔX_t on lagged ΔX_t's. Multivariate cointegration holds if r$\geqslant$1.

The results of Johansen's multivariate tests for unit roots in the system of the six national monetary bases in the EMS are reported in Table 4. The lag length in the six-dimensional vector autogressive process is taken at two. The use of different lag lengths did not make significant differences in the results. Testing at the 5 percent level of significance, we cannot reject the hypothesis that there is at least one or two independent cointegrating vectors in the system of the six EMS members' nominal and real monetary bases. This implies that the six national monetary bases in the EMS have shared a long-run equilibrium relationship during the EMS period. Because of the institutional changes in the Danish monetary

[**Table 4**] Johansen's Multivariate Tests for Unit Roots in the System of Monetary Bases in the EMS countries (1979. II through 1991. I)

	−21nO				*Quantiles*			
	Nominal		Real		95%	99%	95%	99%
Null Hypothesis	5-country system	6-country system	5-country system	6-country system	5-country system		6-country system	
r$\leqslant$5		0.065		0.019			4.2	5.2
r$\leqslant$4	0.424	9.103	0.284	7.613	4.2	5.2	12.0	15.6
r$\leqslant$3	7.970	19.104	6.978	18.570	12.0	15.6	23.8	28.5
r$\leqslant$2	19.209	32.979	21.269	37.991	23.8	28.5	38.6	44.5
r$\leqslant$1	34.134	55.045	40.624*	63.784*	38.6	44.5	57.2	63.9
r=0	63.940**	97.067**	87.742*	114.980*	57.2	63.9	78.1	86.6

Notes: For data sources, see Table 1. r is the number of cointegration vectors in the The 6-country system is composed of Belgium, Denmark, France, Germany, Italy, and the Netherlands. All the countries but Denmark consist the 5-country system. The 95 percent quantiles in the distribution of the test statistic, -21nQ, are from Johansen (1988, p. 239). The 99 percent quantiles are from Baillie and Bollerslev(1989).
* and ** denote the significance at the 5 and 1 percent levels, respectively.

policy, the monetary base in Denmark shows erratic movements in the 1980s. The 5-country system composed of Belgium, France, Germany, Italy, and the Natherlands, but Denmark, however, does not alter the basic results for the 6-country system.

V. CONCLUSION

This paper investigated the behavior of monetary bases in the EMS countries based on bivariate and multivariate system approaches. In the bivariate analysis, cointegration tests show that the unit root nonstrationary monetary base in each EMS country does not generally share the long-run equilibrium path with the German monetary base. The standard Granger causality tests and error-correction models do not provide strong evidence of the unidirectional causality running from the Bundesbank's monetary policy to other EMS countries' monetary policies.

The multivariate tests for unit roots, however, suggest that there is at least one independent cointegrating vector in the system of the six national monetary bases in the EMS. This implies that the long-run movements of a set of the EMS members' monetary bases are determined interactively and that there are common ties to a long-run equilibrium path of monetary policies within the EMS. Therefore, the results are consistent with the notion that, in general, the EMS is a symmetric and cooperative system in which the burden of the adjustments to the converging path of monetary policies within the EMS has been shared by all the EMS members. The notion of German dominance in EMS members' monetary policies is not supported by the data.

The characterization of the EMS as a cooperative and symmetric system bears important implications on the ongoing process toward the European Monetary Union (EMU). The harmonized, and eventually single, monetary policy in post-EMU Europe should and can be achieved through the cooperative and equal burden-sharing spirit by all the EMS member nations, while acknowledging the important role of the Bundesbank toward the successful implementation of the EMU.

REFERENCES

BAILLIE, RICHARD T. and TIM BOOLERSLEV, 1989, "Common Stochastic Trends in a System of Exchange Rates," *Journal of Finance,* 44, 167-181.

Commission of the European Communities, 1989, *The EMS: Ten Years of Progress in European Monetary Co-operation,* Directorate-General Economic and Financial Affairs, the European Community.

Commission of the European Communities, 1991, *European Economy: One Market, One Money,* Directorate-General for Economic and Financial Affairs, the European Community.

Committee for the Study of Economic and Monetary Union, 1990, *Report on Economic and Monetary Union in the European Community,* the European Community.

DERAVI, M. KEIVAN, and MASSOUD METGHALCHI, 1988, "The European Moneatry System," *Journal of Banking and Finance,* 12, 505-512.

DICKEY, DAVID A. and WAYNE A. FULLER, 1979, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association,* 74, 427-431.

DICKEY, DAVID A. and WAYNE A. FULLER, 1981, "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica,* 49, 1057-1072.

ENGLE, ROBERT F., 1982, "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation," *Econometrica,* 50, 987-1007.

ENGLE, ROBERT F. and C.W.J. GRANGER, 1987, "Cointegration and Error Correction: Representation, Estimation, and Testing," *Econometrica,* 55, 251-276.

ENGLE, ROBERT F. and BYUNG SAM YOO, 1987, "Forcasting and Testing in Co-integrated Systems," *Journal of Econometrics,* 35, 143-159.

FRATIANNI, MICHELE and JUERGEN VON HAGEN, 1990, "German Dominance in the EMS: The Empirical Evidence," *Open Economies Review,* 1, 67-87.

FULLER, WAYNE A., 1976, *Introduction to Statistical Time Series,* New York: John Wiley.

GRANGER C.W.J., 1986, "Developments in the Study of Cointegrated Economic Variables," *Oxford Bulletin of Economics and Statistics,* 48, 213-228.

GRANGER C.W.J., 1988, "Some Recent Developments in a Concept of Causality," *Journal of Econometrics,* 39, 199-211.

JOHANSEN, SOREN, 1988, "Statistical Analysis of Cointegrating Vectors," *Journal of Economic Dynamics and Control,* 12, 231-254.

KARFAKIS, COSTAS J. and DEMETRIOS M. MOSCHOS, 1990, "Interest Rate Linkages within the European Monetary System: A Time Series Analysis," *Journal of Money, Credit, and Banking,* 22, 388-394.

MASTROPASQUA, CRISTINA, STEFANO MICOSSI, and ROBERTO RINALDI, 1988, "Interventions, Sterilization and Monetary Policy in European Monetary System Countries, 1979-87," in F. Giavazzi, S. Micossi, and M. Miller (eds.), *The European Monetary System,* Centre for Economic Policy Research, Banca d'Italia, 252-287.

PHILLIPS, P.C.B. and P. PERRON, 1988, "Testing for a Unit Root in Time Series Regression," *Biometrica,* 75, 335-346.

VON HAGEN, JURGEN, and MICHELE FRATIANNI, 1990, "German Dominance in the EMS: Evidence from Interest Rates," *Journal of International Money and Finance,* 9, 358-375.