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Additional Evidence on EMS Interest Rate Linkages

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Abstract

This note examines interest rate linkages within the EMS. Cointegration tests suggest the existence of a long-run equilibrium relationship between German and other EMS interest rates. Bivariate VAR analysis finds that Granger-causality either stems from German to other European interest rates (Belgium, France, Spain, and the U.K.) or is bidirectional (Denmark and the Netherlands). When allowance is made for the influence of U.S. interest rates, the pattern of Granger causality is predominantly bidirectional.

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Contents

Summary

There has been a lively academic discussion on the importance of German interest rates in setting interest rates in European Monetary System (EMS) member countries. The dominant position of German interest rates has been supported by findings of greater short-run exchange rate stability and a decreased response of deutsche mark cross rates with other EMS currencies to changes in the U.S. dollar-deutsche mark exchange rate; zero risk premium between the U.S dollar and the deutsche mark but a nonzero risk premium between the deutsche mark and other EMS currencies; unidirectional Granger causality from German to other EMS interest rates; and unidirectional Granger-Sims causality from the German broad money supply to that in other EMS members.

However, Germany's dominant position has been rejected by arguments that the EMS as a whole had a strong anti-inflationary bias; evidence that developments in U.S. interest rates were also important in explaining EMS interest rate linkages; and tests showing the German monetary base was not important determining that of other EMS members.

This paper examines interest rate linkages within the EMS using cointegration techniques, which suggest the existence of a long-run equilibrium relationship between German and most other EMS interest rates. This finding may be attributable to integrated financial markets and the discipline of a formal exchange rate mechanism, although for part of the sample period some members had a looser exchange rate relationship and/or used capital controls. Bivariate VAR analysis suggests that Granger causality moves from German to other EMS interest rates or was bidirectional. When allowance is made for the influence of U.S. interest rates, the pattern of Granger causality is predominantly bidirectional. This result is consistent with the arbitrage activity that is to be expected from efficient capital markets.

I. Introduction

There has been a lively academic discussion on the question of how important German interest rates are in the setting of interest rates in European Monetary System (EMS) member countries. 1/ The dominant position of German interest rates has been supported by a number of empirical results purporting to show evidence of: greater short-run exchange rate stability and a reduction in the response of D-Mark cross rates with other EMS currencies to changes in the U.S. dollar/D-Mark exchange rate (Rogoff 1985, Giavazzi and Giovannini 1986, and Artis 1987); zero risk premium between the U.S dollar and the German Mark but a nonzero risk premium between the German Mark and other EMS currencies (Taylor and Artis 1988); uni-directional Granger-causality from German to other EMS interest rates (Karfakis and Moschos 1990, Biltoft and Boersch 1992, and Katsimbris and Miller 1993); and evidence of uni-directional Granger-Sims causality from German broad money supply to that in other EMS members (Kutan 1991).

On the other hand, the dominant position of Germany in the setting of EMS interest rates has been rejected by: arguments that the EMS as a whole had a strong anti-inflationary bias (Padoa-Schioppa 1983, Artis and Taylor 1994); empirical support that developments in U.S. interest rates also were important in explaining EMS interest rate linkages (von Hagen and Fratianni 1990, de Grauwe 1992, Katsimbris and Miller 1993); and tests showing the German monetary base was not an important determinant of that of other EMS members (Fratianni and von Hagen 1990).

A useful framework for the analysis of EMS interest rate linkages was proposed by Fratianni and von Hagen (1990) who argued that German dominance could be established if: (a) monetary policies in the rest of the world did not Granger-cause the policies of other EMS members; (b) no two-way Granger-causality existed between the policies of EMS countries; and (c) German monetary policy Granger-caused policies in other EMS countries. In this note we employ cointegration and Granger-causality techniques within this framework. First, we investigate whether there exist long-run comovements between German and other EMS members' interest rates. Second, we examine whether short-run changes in German interest rates convey information about future movements in other EMS interest rates, and vice versa. Third, we examine the role of U.S. interest rates in EMS interest rate linkages.

In this setting, German dominance of EMS interest rate movements implies: (a) uni-directional Granger causality running from German interest rates to other EMS interest rates; and (b) that the impact of the rest of the world's monetary policy (represented here by developments in U.S.

1/ The EMS was instituted in March 1979. The exchange rate mechanism (ERM) is at the heart of the EMS. Countries participating in the ERM agreed to maintain their bilateral exchange rates within ± 2.25 percent of a central rate. In an exception, Italy negotiated a wider band of ± 6 percent at the outset of the system but moved to the narrow band in January 1990, an example subsequently followed by the U.K., Spain and Portugal. Spain entered the ERM in June 1989, the U.K. in October 1990, and Portugal in April 1992, all at the wider band of ± 6 percent.

interest rates) on EMS interest rates is dominated by movements in German interest rates. Our results suggest that there are systematic interest rate relationships in the long-run between German and other EMS interest rates, and that in the short-run the interest rate linkage either stems from German to other European interest rates or is bidirectional. When allowance is made for the influence of U.S. interest rates on EMS interest rate linkages, there is less evidence of unidirectional causality stemming from German interest rates.

II. Methodology

Engle and Granger (1987) show that if two series are integrated of order 1, I(1), Granger causality must exist in at least one direction in, at least, the I(0) variables. In the case where two series are cointegrated of order I(1), a VAR model can be constructed in terms of the levels of the data or in terms of their first differences with the addition of an error-correction term to capture the short-run dynamics and to reduce the possibility of identifying "spurious causality". Inclusion of the error-correction term introduces an additional channel through which Granger-causality can be detected. According to Granger (1988), independent variables "cause" the dependent variable either if the error-correction term carries a significant coefficient or the first difference independent variables are jointly significant.

The testing procedure involves three steps. The first step is test the order of integration of the natural logarithm of the interest rate series. This can be done by computing the augmented Dickey-Fuller (ADF) test statistics which test for the presence of unit roots under the alternative hypothesis that the interest rates series are stationary around a fixed time trend.

Conditional upon the outcome, the second step is to test for cointegration of the interest rate series using the Johansen and Juselius (1990) maximum likelihood approach. If cointegration exists, then either uni-directional or bidirectional Granger-causality must exist in at least the I(0) variables. In fact, there is a strong presumption that domestic and foreign interest rates are cointegrated based on the presumed stationarity of the expected exchange rate and the risk premium. As such, the test for cointegration uses the regression equation:

$$I_g = \alpha + I_e\theta + \epsilon \qquad (1)$$

where I_g and I_e are the German and relevant EMS country interest rates, respectively, and θ is not restricted to 1, reflecting such factors as interest income taxation and possible measurement errors.

The third step is to carry out a standard Granger causality test augmented with an appropriate error-correction term derived from the long-run cointegrating relationship in equation (1). For valid inferences to be derived, such tests need to be undertaken on I(0) variables. Assuming the levels of the interest rate series are I(0) (and cointegrated), the appropriate formulation of a Granger-type test of causality (which must be applied to the stationary series) is:

$$\Delta I_{gt} = \alpha_0 + EC_{t-i} + \sum_{i=1}^{n} \beta_i \Delta I_{gt-i} + \sum_{i=1}^{n} \delta_i \Delta I_{et-i} + \epsilon_t, \quad (2)$$

$$\Delta I_{et} = \alpha_0 + EC_{t-i} + \sum_{i=1}^{n} \tau_i \Delta I_{et-i} + \sum_{i=1}^{n} \phi_i \Delta I_{gt-i} + \mu_t \quad (3)$$

where Δ is the difference operator, I_g and I_e are as previously defined, EC_{t-i} is the error-correction term derived from the long-run cointegrating relationship, and ϵ_t and μ_t are zero-mean, serially uncorrelated random error terms. In equation (2) causality implies I_e "Granger-causing" I_g provided that some δ_i is not zero. Similarly, in Equation (3) I_g is "Granger-causing" I_e if some ϕ_i is not zero. Note that if the German and respective EMS interest rate are not cointegrated, then the error-correction term is dropped from equations (2) and (3) in the Granger-causality tests. To implement the Granger-causality test, F-statistics are calculated under the null hypothesis that all the coefficients of δ_i, ϕ_i, respectively, equal zero. As the results from Granger-causality tests are sensitive to the selection of lag length, results are presented from equations using the minimum final prediction error (FPE) criterion suggested by Akaike (1969) to determine the appropriate lag length.

III. Data and Results

Our empirical analysis uses monthly short-term interest rates from the International Financial Statistics data tape for Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, the United Kingdom (U.K.), and the U.S. 1/ Data are from April 1979 to August 1992, which covers the inception of the EMS until the month before the so-called "Black Wednesday" of September 16, 1992.

Table 1 presents the ADF test statistics for the log levels and first differences of the interest rate series. From the results, the null hypothesis that the levels of the series contain unit roots cannot be rejected; however, on first-difference data the results reject the hypothesis of a unit root in all cases --i.e., in level form the interest rate series are I(1) but in first difference form they are I(0). Trace statistics for the cointegration of German and other EMS interest rates are

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1/ The interest rate series are one month money market rates with the exception of Spain and Italy, for which the one month treasury bill rate was used; a suitable interest rate series was not available to include Portugal in the estimates.

Table 1. Unit Root Test Results

	Levels	First differences
Belgium	-2.0712	-3.7718*
Denmark	-3.2792	-4.0811*
France	-1.9153	-3.6968*
Germany	-2.3314	-3.6968*
Ireland	-3.0500	-4.6664*
Italy	-2.7152	-3.7427*
Netherlands	-2.4398	-3.7365*
Spain	-1.6600	-5.0071*
U.K.	-2.0544	-4.3148*
U.S.	-2.6038	-4.8465*

Notes: The augmented Dickey-Fuller test is based on the following regression:

$$\Delta x_t = \alpha_0 + \alpha_1 T + \alpha_2 x_{t-1} + \sum_{i=1}^{n} \mu_i \Delta x_{t-i} + \epsilon_t$$

where Δ is the difference operator, T is a linear time trend, and ϵ is a stationary random error. The null hypothesis is that x_t contains a unit root against the alternative that it is stationary around a deterministic trend. An asterisk denotes significance at the 5 percent level.

presented in panel (a) of Table 2. The hypothesis of a single cointegrating vector is not rejected at the 5 percent level of significance in the case of German interest rates and those of Belgium, Denmark, France, the Netherlands, and the U.K., and at the 10 percent level in the case of Italy. On the basis of such results we conclude that these interest rate series are cointegrated and therefore causally related. These results contrast sharply with those of Karfakis and Moschos (1990) and Katsimbris and Miller (1993), who found no evidence of cointegration using residual based (Engle and Granger 1987) cointegration analysis. The finding of cointegration should not be a surprise given integrated capital markets and the discipline of a formal exchange rate mechanism, even though for part of the sample period some members had a looser exchange rate relationship and/or made use of capital controls. Causality test results from estimates of equations (2) and (3) are presented in Table 3. In the case where cointegration is indicated, the Granger-causality tests include the error correction term. The F-statistics find evidence of Granger-causality stemming from German interest rates to interest rates in Belgium, France, Spain, and the U.K., and evidence of bidirectional causality between German interest rates and those in Denmark, the Netherlands and Italy. No Granger-causality is found between German and Irish interest rates.

Katsimbris and Miller (1993) and de Grauwe (1991) argue that U.S. interest rates have an important causal influence on EMS interest rates. Our results find little evidence of a cointegrating relationship between the U.S. and EMS interest rates and that in the short-run U.S. interest rate developments did not change the pattern of EMS interest rate linkages markedly. Panel (b) of Table 2 gives trace statistics for the cointegration of U.S. interest rates on EMS interest rates, including Germany. Only in the cases of Belgium and France is the hypothesis of a single cointegrating vector not rejected at the 5 percent level. Results from trivariate Granger-causality tests, which include U.S. interest rates as a lagged dependent variable, and the error correction term in the cases of Belgium and France, are presented in Table 4. U.S. interest rates appear to convey information about short-run linkages between German and other EMS interest rates in the cases of Belgium, Denmark, France, Italy, and the Netherlands. The F-statistics indicate unidirectional Granger-causality stemming from German interest rates in two cases (France and Spain) rather than four previously, bidirectional causality in five cases (Belgium, Denmark, Ireland, Italy. and the Netherlands) as opposed to three previously, and again no causal relation between German and U.K. interest rates. In sum, the inclusion of U.S. interest rates shift the balance of the Granger causality test toward bidirectional causality. This result is consistent with the arbitrage activity which is to be expected from efficient capital markets.

Table 2. Johansen-Juselius Cointegration Test Results

	R=0	R<1
(a) German interest rates and those of:		
Belgium	27.6243*	2.0064
Denmark	26.7568*	2.4305
France	17.4126*	3.6825
Ireland	13.0312	2.6805
Italy	14.6680+	1.8792
Netherlands	22.3424*	1.5841
Spain	7.0457	1.3076
U.K.	33.7545*	2.4198
(b) U.S. interest rates and those of:		
Belgium	16.0689*	1.4667
Denmark	15.3440	0.9594
France	17.0033*	0.4799
Germany	3.6329	1.2577
Ireland	12.3686	0.8079
Italy	3.5417	0.9492
Netherlands	4.0326	0.8114
Spain	5.6018	1.1156
U.K.	16.5525	1.3652

Notes: The cointegration tests are conducted using the maximum likelihood procedure with a maximum lag of 2. r denotes the number of significant cointegrating vectors. The Johansen-Juselius statistics test the hypothesis of at most one and zero cointegrating vectors, respectively. A trend was included in the vector autoregressions. * and + denote significance at the 5 percent and 10 percent levels, respectively.

Table 3. Bivariate Causality Test Results

	F-statistic		t-statistic
Country/causality	ϕ	δ	EC
Germany -> Belgium	25.3651**	--	3.8400*
Belgium -> Germany	--	2.4481	-6.9692**
Germany -> Denmark	4.7607*	--	-4.7109*
Denmark -> Germany	--	3.3722*	2.2652*
Germany -> France	5.0787*	--	-1.8821
France -> Germany	--	0.8241	3.1563*
Germany -> Ireland	1.8332	--	--
Ireland -> Germany	--	1.6542	--
Germany -> Italy	1.9030	--	-0.8360
Italy -> Germany	--	0.5912	3.0622*
Germany -> Netherlands	7.0544**	--	-5.2263**
Netherlands -> Germany	--	5.5881*	1.0832
Germany -> Spain	5.4872*	--	--
Germany -> Germany	--	5.1291*	--
Germany -> U.K.	2.9957*	--	-7.6824**
U.K. -> Germany	--	0.5006	1.2858

Notes: The F-statistics are calculated under the null hypothesis that the coefficients of the lagged values of the independent variables (excluding the lagged dependent variables) are zero. ** and * indicate statistical significance at the 1 percent and 5 percent levels, respectively.

Table 4. Trivariate Causality Test Results

Country/causality	F-statistic ϕ	δ	Φ	t-statistic EC
Germany -> Belgium	17.5838**	--	--	-4.5216*
Belgium -> Germany	--	5.1088**	3.1680	0.9054
Germany -> Denmark	2.5008*	--	0.7150	--
Denmark -> Germany	--	2.7844*	2.9571*	--
Germany -> France	6.2034**	--	6.6778**	-2.4928*
France -> Germany	--	1.6579	1.4985	1.7209
Germany -> Ireland	1.8580	--	0.3276	--
Ireland -> Germany	--	1.9669	4.4419*	--
Germany -> Italy	1.5527	--	2.0482	--
Italy -> Germany	--	0.6352	3.0275*	--
Germany -> Netherlands	9.4455**	--	4.1985*	--
Netherlands -> Germany	--	7.4798**	--	--
Germany -> Spain	6.2264**	--	0.0503	--
Spain -> Germany	--	3.6312	2.8207	--
Germany -> U.K.	0.3949	--	0.0067	--
U.K. -> Germany	--	0.2537	3.6727	--

Notes: The error-correction model is given as:

$$\Delta I_{gt} = \alpha_0 + EC_{t-i} + \sum_{i=1}^{n} \beta_i \Delta I_{gt-i} + \sum_{i=1}^{n} \delta_i \Delta I_{et-i} + \sum_{i=1}^{n} \Phi_i \Delta I_{ust-i} + \epsilon_t,$$

and

$$\Delta I_{et} = \alpha_0 + EC_{t-i} + \Sigma\, \tau_i \Delta I_{et-i} + \Sigma\, \phi_i \Delta I_{gt-i} + \Sigma\, \Phi_i \Delta I_{ust-i} + \epsilon_t$$

where I_g is the German interest rate, I_e is the interest rate of the relevant European country, I_{us} is the U.S. interest rate, and EC is the error correction term based on the results from Table 2. The Granger-causality equation is the same system with the error-correction term. The F-statistics are calculated under the null hypothesis that the coefficients of the lagged values of the independent variables (excluding the lagged dependent variables) are zero. ** and * indicate statistical significance at the 1 percent and 5 percent levels, respectively.

IV. Conclusion

This note has examined interest rate linkages within the EMS. Cointegration tests suggest the existence of a long-run equilibrium relationship between German and most other EMS interest rates. This finding may be attributable to integrated financial markets and the discipline of a formal exchange rate mechanism, even though for part of the sample period some members had a looser exchange rate relationship and/or made use of capital controls. Bivariate VAR analysis suggests that Granger-causality stems either from German interest rates to other EMS interest rates or is bidirectional. When allowance is made for the influence of U.S. interest rates, the pattern of Granger causality is predominantly bidirectional. This result is consistent with the arbitrage activity which is to be expected from efficient capital markets.

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