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WAS THERE MONETARY AUTONOMY IN EUROPE ON THE EVE OF EMU? THE GERMAN DOMINANCE HYPOTHESIS RE-EXAMINED

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In this paper we re-examine the German dominance hypothesis, as a way to assess whether the loss of monetary autonomy in Europe associated with EMU had been significant**.** We use Granger-causality tests between the interest rates of Germany and all the countries participating in the European Monetary System, with the sample period running until December 1998. Our results would support a weak version of the hypothesis, with Germany playing a certain "leadership" or special role in the EMS, although she would not had been strictly the "dominant" player.

JEL classification codes: F33, F36, E50

Key words: European monetary union, German dominance hypothesis, Granger-causality

I. Introduction

Beginning on January 1st 1999, when a common currency, the euro, was adopted, and the European Central Bank started its operations, 12 European countries formed a monetary union (the Economic and Monetary Union,

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EMU). More recently, EMU can be said to be fully in force, once the euro began to circulate and replaced the old national currencies after January 1st 2002.

As it becomes obvious, EMU means the loss of monetary independence of the participating countries, which might be seen as a cost, at least at first sight. Things are not so simple, however. It is well known that, according to the so-called "inconsistent trinity" principle, a fixed exchange rate, full capital mobility, and the independence of monetary policy are not mutually compatible. And this situation roughly applied to the European economies before EMU, which shared a quasi-fixed exchange rate system (the European Monetary System, EMS), especially so following the elimination of capital controls after the Single European Act in 1990-92. This fact led to the countries participating in the EMS to realize that they were gradually losing the control of their monetary policies in favor of the Bundesbank, the central bank of Germany, i.e., the country presumed to act as a leader in the EMS. Hence, EMU could emerge as an economic response to that situation, allowing those countries to regain some control over monetary policy thanks to the creation of an European Central Bank, in which they could have a vote (Wyplosz, 1997).

The possible dominant role of Germany within the EMS, prior to the start of EMU, will be the subject of this paper. This could be of interest in order to assess whether the loss of monetary autonomy in Europe associated with EMU has been significant; which, in turn, could be taken as an argument in favor of EMU itself. The empirical methodology makes use of Granger-causality tests between the monthly interest rates of Germany and all the countries participating at any time in the exchange rate mechanism (ERM) of the EMS, with the sample period running until December 1998.

The rest of the paper is structured as follows. A brief review of the previous literature on the subject, together with the contributions of the paper, is provided in Section II. The econometric methodology and empirical results are discussed in Section III. Finally, the main conclusions are presented in Section IV.

II. Review of the Literature

In general terms, prior to EMU a broad consensus emerged in Europe which would justify the argument that the EMS had worked in an asymmetric way, with Germany assuming the leading role and the remaining countries passively adjusting to German monetary policy actions. In turn, these countries would have benefited from behaving in such a way, since they would have taken advantage of the firmly established anti-inflation credibility of the Bundesbank (see, e.g., Giavazzi and Pagano, 1988; or Mélitz, 1988). This discussion ultimately lies in the so-called $n - 1$ problem faced by fixed exchange rate systems, since there are only $n - 1$ exchange rates among the n countries participating in an exchange rate agreement. Therefore, in such a situation, either one country becomes the leader and sets monetary policy independently (with the other countries following it), or all countries are allowed to decide jointly over the implementation of monetary policy (De Grauwe, 2000).

The first empirical studies on the subject seemed to confirm the hypothesis of German dominance into the EMS (see, e.g., Giavazzi and Giovannini, 1987, 1989, or Karfakis and Moschos, 1990). However, these conclusions were not confirmed in further research, most of it consisting of tests for Granger-causality between German and other countries' interest rates at a monthly or quarterly frequency (see, among others, Cohen and Wyplosz, 1989; von Hagen and Fratianni, 1990; Koedijk and Kool, 1992; Katsimbris and Miller, 1993; or Hassapis, Pittis and Prodromidis, 1999). In this way, a milder support for the hypothesis was found in the above quoted papers; namely, that the other countries' interest rates depended on the German ones, but also conversely, even though in a lower extent in terms of both size and persistence. Finally, some results along these lines were also reported in other studies using high frequency (i.e., daily) data on interest rates (see Gardner and Perraudin, 1993; Henry and Weidmann, 1995; and Bajo, Sosvilla and Fernández, 2001), so that it might seem that Germany would have played a special role in the EMS, although calling it "dominance" would be too strong.

As stated in the Introduction, in this paper we re-examine the German dominance hypothesis, as a way to assess whether the loss of monetary autonomy in Europe associated with EMU has been significant. The paper contributes to the existing literature in the following respects:

a. The sample period covers until just the eve of EMU, i.e., December 1998. This allows us to include the most recent events in European monetary history, such as the German reunification, the monetary turmoil at the end of 1992, the broadening of the EMS fluctuation bands in August 1993, and the rather quiet period leading to the birth of EMU. Regarding previous studies on the subject, those with a more recent sample period are Hassapis, Pittis and Prodromidis (1999), who use quarterly data until the end of 1994, and Bajo, Sosvilla and Fernández (2001), who use daily data until February 1997.
b. The analysis is extended to all the countries participating at any time in the ERM of the EMS. So, unlike previous studies (with the only exception of Bajo, Sosvilla and Fernández, 2001), that consider only the founding members of the EMS (i.e., Germany, France, Italy, Belgium, the Netherlands, Denmark, and Ireland), our analysis also includes those countries which later joined the ERM of the EMS (i.e., Spain, the UK, and Portugal).
c. Granger-causality in a cointegration setting is properly tested. That is, an error-correction mechanism (ECM) is included into every equation to be estimated when cointegration is found, which allows us to distinguish between short-run and long-run Granger-causality.[1] Also, and following Katsimbris and Miller's (1993) suggestion, Granger-causality relationships between German and the other countries' interest rates have been investigated both in a bivariate and a trivariate setting, in order to avoid possible spurious results due to the omission of some relevant variable. As usual, the US interest rates is the additional variable added to the analysis.

[1] Katsimbris and Miller (1993) were the first to notice this point, usually overlooked in the available empirical studies on this subject.

d. Finally, and given the importance of the choice of lag lengths in Granger-causality tests, these have been selected by means of an appropriate method. In particular, we have used Hsiao's (1981) sequential approach, specifically designed to avoid imposing often false or spurious restrictions on the model. Notice that, unlike the VAR approach performed in other studies (i.e., Hassapis, Pittis and Prodromidis, 1999), our procedure implies that, for any pair of variables tested for Granger-causality between them, the number of lags of the right-hand side variables is not constrained to be the same.

III. Econometric Methodology and Empirical Results

The econometric methodology used in this paper is based on Granger-causality tests (Granger, 1969). As is well known, the results from these tests are highly sensitive to the order of lags in the autoregressive process. In this paper, we will identify the order of lags for each variable by means of Hsiao's (1981) sequential approach, which is based on Granger's concept of causality and Akaike's final prediction error criterion.

Suppose we have two stationary variables, X_t and Y_t, which we would like to test for Granger-causality. Consider the models:

$$X_t = \alpha + \sum_{i=1}^{m} \beta_i \; X_{t-i} + u_t \tag{1}$$

$$X_t = \alpha + \sum_{i=1}^{m} \beta_i \; X_{t-i} + \sum_{j=1}^{n} \gamma_j \; Y_{t-j} + v_t \tag{2}$$

The following steps are then used to apply Hsiao's procedure:

i. Take X_t to be a univariate autoregressive process as in (1), and compute its final prediction error (FPE hereafter) with the order of lags *i* varying from 1 to *M*. Choose the lag that yields the smallest FPE, say *m*, and denote the corresponding FPE as $FPE_X(m, 0)$.
ii. Treat X_t as a controlled variable with *m* lags, add lags of Y_t to (1) as in (2),

and compute the FPEs with the order of lags j varying from 1 to N. Choose the lag that yields the smallest FPE, say n, and denote the corresponding FPE as $FPE_X(m, n)$.

iii. Compare $FPE_X(m, 0)$ with $FPE_X(m, n)$. If $FPE_X(m, 0) > FPE_X(m, n)$, then Y_t is said to Granger-cause X_t, whereas if $FPE_X(m, 0) < FPE_X(m, n)$, then X_t would not be Granger-caused by Y_t.

Finally, steps (i) - (iii) should be repeated with Y_t as the dependent variable in order to test whether or not X_t Granger-causes Y_t.

Recall the earlier assumption that X_t and Y_t were stationary variables. However, if they are integrated of order one (i.e., first-difference stationary), I(1), and are cointegrated, (1) and (2) need to be amended to:

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \delta \; z_{t-1} + u_t \qquad (3)$$

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \delta \; z_{t-1} + v_t \qquad (4)$$

where z_t is the ECM (Engle and Granger, 1987). Notice that if X_t and Y_t are I(1) but are not cointegrated, the coefficient δ in (3) and (4) would be equal to zero.

Now, the previous definitions of Granger-causality for stationary variables can be applied to the case of I(1) variables from (3) and (4). In particular, if $FPE_{\Delta X}(m, 0) > FPE_{\Delta X}(m, n)$, Y_t is said to Granger-cause X_t in the short run; and if δ is significantly different from zero, Y_t is said to Granger-cause X_t in the long run. Conversely, if $FPE_{\Delta X}(m, 0) < FPE_{\Delta X}(m, n)$, X_t would not be Granger-caused by Y_t in the short run; and if δ is not significantly different from zero, X_t would not be Granger-caused by Y_t in the long run. As before, the procedure should be repeated with ΔY_t as the dependent variable so that the hypothesis of short-run and long-run Granger-causality from X_t to Y_t can be tested.

The data used in this paper are the three-month interbank onshore interest rates, at a monthly frequency, of Germany, France, Italy, Belgium, the Netherlands, Denmark, Ireland, Spain, the UK, Portugal, and the US. The previous list includes all the European countries participating at any time in the ERM of the EMS, and coincides with that of the countries joining EMU from the outset, with the exceptions of Denmark and the UK, and the inclusion of Luxembourg, Austria and Finland.[2] The beginning of the sample period is March 1979 (i.e., when the ERM started to operate) for the founding members of the EMS (France, Italy, Belgium, the Netherlands, Denmark, and Ireland), and the month of accession to the ERM for the newcomers: June 1989 for Spain, October 1990 for the UK, and April 1992 for Portugal, with the data for Germany and the US adjusting accordingly in each case. The end of the sample is in all cases December 1998 (i.e., the last month before the starting of EMU), and all the data come from the *Boletín Estadístico* (*Statistical Bulletin*) of the Bank of Spain.

As a first step of the analysis, we tested for the order of integration of the variables by means of two alternative tests. On the one hand, the Phillips-Perron test (Phillips and Perron, 1988), which corrects, in a non-parametric way, the possible presence of autocorrelation in the standard Dickey-Fuller test, under the null hypothesis that the variable has a unit root. And, on the other hand, given the small power of this test under certain stochastic properties of the series, the KPSS test (Kwiatkowski, Phillips, Schmidt and Shin, 1992), for which the null hypothesis is that of stationarity, unlike the standard Dickey-Fuller-type tests. According to the results shown in parts A and B of Table 1, for the Phillips-Perron test the null hypothesis of a unit root was not rejected in all cases, at the same time that the null of a second unit root was always rejected; in turn, for the KPSS test, the null hypothesis of stationarity was always rejected.

[2] Notice that Luxembourg, a founding member of the EMS, is not included in the sample since she already formed a monetary union with Belgium before EMU. Also, Austria and Finland, who participated in the ERM of the EMS since January 1995 and October 1996, respectively, are not included given the small number of observations available.

Table 1.A. Unit Root Tests. Phillips-Perron Test

Country	Levels			First Differences		
	$Z(t_{\tilde{\alpha}})$	$Z(t_{\alpha^*})$	$Z(t_{\hat{\alpha}})$	$Z(t_{\tilde{\alpha}})$	$Z(t_{\alpha^*})$	$Z(t_{\hat{\alpha}})$
Germany	-2.07	-1.26	-0.59	-11.29[a]	-11.23[a]	-11.23[a]
Belgium	-3.52[c]	-1.09	-0.81	-12.78[a]	-12.72[a]	-12.71[a]
Denmark	-2.68	-1.05	-1.19	-10.52[a]	-10.51[a]	-10.48[a]
Spain	-2.47	-0.05	-2.15[b]	-8.87[a]	-8.86[a]	-8.32[a]
France	-3.59[b]	-1.03	-0.73	-11.39[a]	-11.29[a]	-11.28[a]
Netherlands	-2.09	-1.29	-0.95	-12.88[a]	-12.86[a]	-12.85[a]
Ireland	-3.13	-1.61	-1.21	-12.40[a]	-12.39[a]	-12.36[a]
Italy	-3.19	-0.39	-0.82	-12.39[a]	-12.22[a]	-12.19[a]
Portugal	-3.12	-1.07	-2.61[a]	-7.71[a]	-7.69[a]	-7.28[a]
UK	-2.18	-3.24[b]	-2.75[a]	-5.47[a]	-5.27[a]	-5.05[a]
US	-3.23	-1.85	-1.12	-10.86[a]	-10.86[a]	-10.85[a]

Notes: $Z(t_{\tilde{\alpha}})$, $Z(t_{\alpha^*})$ and $Z(t_{\hat{\alpha}})$ are the Phillips-Perron statistics with drift and trend, with drift, and without drift, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively. The critical values are taken from MacKinnon (1991).

Next, we tested for cointegration between the German interest rate and the interest rates of the other European countries in our sample, both in a bivariate and trivariate setting, in the latter case including the US interest rate as an additional variable. To this end, we made use of Shin's (1994) approach, which is based on the application of the KPSS test on the residuals from the (bivariate or trivariate) cointegrating regressions estimated by the method proposed by Stock and Watson (1993). This method consists of estimating a dynamic long-run regression that includes leads and lags of the first differences of the explanatory variables, and provides a robust correction to the possible presence of endogeneity among these variables, as well as of serial correlation of the estimated errors.

Table 1.B. Unit Root Tests. KPSS Test

Country	Levels	
	η_μ	η_τ
Germany	0.42[c]	0.14[c]
Belgium	1.27[a]	0.11
Denmark	1.26[a]	0.14[c]
Spain	0.94[a]	0.05
France	1.20[a]	0.11
Netherlands	0.68[b]	0.15[b]
Ireland	1.42[a]	0.08
Italy	1.27[a]	0.08
Portugal	0.77[a]	0.09
UK	0.48[b]	0.22[a]
US	1.23[a]	0.17[b]

Notes: η_μ, and η_τ are the KPSS statistics with trend, and without trend, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively. The critical values are taken from Kwiatkowski et al. (1992).

The results of the cointegration test appear in Table 2. Recall that the null hypothesis in the Shin test is that of cointegration instead of no cointegration, unlike other more standard tests. As can be seen, the only interest rates appearing to be cointegrated with the German ones, both in the bivariate and the trivariate case (i.e., when the US interest rates are included into the cointegration equation), would be those of Spain and the UK; even though in the case of Portugal cointegration would be rejected just at a 10% significance level. Notice that the data for these three countries cover a remarkably shorter period as compared to the founding members of the EMS. In this sense, as Caporale and Pittis (1995) observe, the integration of the financial markets of the EMS countries would have been a gradual process, leading to a slow convergence process of interest rates towards the German levels.[3] Hence, as long as a greater convergence should have been achieved for the last years of the sample period, this might help to explain the finding of cointegration just in the case of the newcomers to the EMS.

Table 2. Shin Cointegration Test

Country	Bivariate	Trivariate
Belgium	1.25[a]	0.53[a]
Denmark	1.13[a]	0.38[b]
Spain	0.18	0.10
France	1.14[a]	0.49[a]
Netherlands	0.76[a]	0.29[b]
Ireland	1.18[a]	0.45[a]
Italy	1.12[a]	0.43[a]
Portugal	0.26[c]	0.20[c]
UK	0.10	0.12

Notes: The test refers to the C_μ statistic on the DOLS residuals. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively. The critical values are taken from Shin (1994).

Now, we are able to perform Granger-causality tests in a cointegration framework, and the results for the bivariate case are shown in Table 3. German interest rates appear to Granger-cause all the other EMS interest rates, the opposite being also true in all cases but that of Ireland. Notice, however, that, when bilateral Granger-causality is found, the decrease in FPEs is greater when German interest rates are added to the equations explaining the other interest rates than in the opposite case. On the other hand, German interest rates would cause those of Spain and the UK in the long run, but not the other

[3] Some evidence along these lines for the Spanish case can be found in Camarero, Esteve and Tamarit (1997).

way round. These results would suggest that, despite the presence of some degree of symmetry in the EMS, the influence of Germany on the other EMS countries would have been greater than the other way round.

Table 3. Granger-Causality Tests: Bivariate Models

Country	FPE {*m*, 0}	FPE {*m*, *n*}	ECM	Causality $X \rightarrow G$	FPE {*m*, 0}	FPE {*m*, *n*}	ECM	Causality $G \rightarrow X$
Belgium	0.099	0.096	---	YES	0.349	0.312	---	YES
	{12, 0}	{12, 12}			{5, 0}	{5, 5}		
Denmark	0.099	0.098	---	YES	0.358	0.338	---	YES
	{12, 0}	{12, 8}			{4, 0}	{4, 5}		
Spain	0.031	0.027	-0.005	YES	0.134	0.105	-0.043[b]	YES
	{4, 0}	{4, 4}	(-0.519)		{4, 0}	{4, 7}	(-2.203)	
France	0.099	0.094	---	YES	0.261	0.204	---	YES
	{12, 0}	{12, 10}			{6, 0}	{6, 6}		
Netherlands	0.099	0.096	---	YES	0.097	0.091	---	YES
	{12, 0}	{12, 10}			{12, 0}	{12, 5}		
Ireland	0.099	0.100	---	NO	0.627	0.615	---	YES
	{12, 0}	{12, 1}			{6, 0}	{6, 1}		
Italy	0.099	0.099	---	YES	0.309	0.300	---	YES
	{12, 0}	{12, 10}			{11, 0}	{11, 4}		
Portugal	0.030	0.029	---	YES	0.427	0.403	---	YES
	{1, 0}	{1, 2}			{5, 0}	{5, 4}		
UK	0.029	0.028	-0.030	YES	0.063	0.051	-0.076[a]	YES
	{4, 0}	{4, 2}	(-1.594)		{4, 0}	{4, 5}	(-2.785)	

Notes: *m* and *n* denote the lags for the dependent variable and the additional regressor, respectively, leading to the smallest FPE in each case; the maximum number of lags tried has been 12. *X* and *G* denote every country in the first column of the table, and Germany, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively, for the *t*-statistics of the ECMs (in parentheses).

Next, we turn to the trivariate case in Table 4. Beginning with causality between German interest rates and those of the other EMS countries, the results, shown in part A of Table 4, are quite similar to those in Table 3. The only exception would be that bilateral Granger-causality is now found for Ireland too; also, the German interest rates do not appear to Granger-cause the Spanish ones in the long run. Again, the German interest rates add more explanatory power to the equations explaining the other interest rates than in the opposite case.

In order to get a more complete picture, we have also tested for Granger-causality between the US interest rates and those of the EMS countries other than Germany, as well as between German and US interest rates, with the results appearing in parts B and C of Table 4, respectively. As can be seen, the US interest rates would Granger-cause all the other interest rates, other than those of Denmark, Ireland, and the UK; however, long-run Granger-causality would appear in the UK case. In turn, the interest rates of all the EMS countries, with the only exception of Spain, would Granger-cause the US interest rates in the short run. On the other hand, bilateral short-run Granger-causality is found between German and US interest rates in most cases; the exceptions would be when the interest rates of Spain, the UK and Portugal are included in the regressions, since Granger-causality only appears from German to US rates in the first two cases, and no Granger-causality is detected in the latter.

Overall, the results in parts B and C of Table 4 shed some additional light, and complement those previously obtained in part A of the same table. Although strongly influenced by the German ones, the interest rates of the EMS countries would appear involved in a more complex web of interdependences, as a result of the high degree of capital mobility existing across the world economy. In particular, they would appear to be mutually connected to the US interest rates, both directly and indirectly through the German ones.

Finally, we have also tested for structural change in all the estimated equations shown in Tables 3 and 4, by means of the Chow test. The dates

Table 4.A. Granger-Causality Tests: Trivariate Models. Causality between German and EMS Interest Rates

Country	FPE [m, p}	FPE [m, n, p}	ECM	Causality $X \rightarrow G$	FPE [m, p}	FPE [m, n, p}	ECM	Causality $G \rightarrow X$
Belgium	0.089	0.086	---	YES	0.255	0.229	---	YES
	{12, 10}	{12, 1, 10}			{10, 12}	{10, 4, 12}		
Denmark	0.089	0.086	---	YES	0.352	0.340	---	YES
	{12, 10}	{12, 1, 10}			{4, 8}	{4, 5, 8}		
Spain	0.030	0.029	0.022	YES	0.131	0.116	-0.052	YES
	{4, 1}	{4, 2, 1}	(1.327)		{4, 1}	{4, 7, 1}	(-1.465)	
France	0.089	0.081	---	YES	0.247	0.211	---	YES
	{12, 10}	{12, 10, 10}			{6, 12}	{6, 6, 12}		
Netherlands	0.089	0.086	---	YES	0.096	0.092	---	YES
	{12, 10}	{12, 1, 10}			{12, 7}	{12, 5, 7}		
Ireland	0.089	0.086	---	YES	0.632	0.621	---	YES
	{12, 12}	{12, 1, 12}			{6, 2}	{6, 1, 2}		
Italy	0.089	0.088	---	YES	0.311	0.299	---	YES
	{12, 10}	{12, 9, 10}			{12, 1}	{12, 4, 1}		
Portugal	0.031	0.030	---	YES	0.394	0.345	---	YES
	{1, 1}	{1, 2, 1}			{5, 7}	{5, 12, 7}		
UK	0.031	0.030	-0.028	YES	0.050	0.048	-0.191[a]	YES
	{4, 1}	{4, 3, 1}	(-0.621)		{4, 1}	{4, 5, 1}	(-3.708)	

Notes: *m*, *n* and *p* denote the lags for the dependent variable, the additional regressor, and the US interest rate, respectively, leading to the smallest FPE in each case; the maximum number of lags tried has been 12. *X* and *G* denote every country in the first column of the table, and Germany, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively, for the *t*-statistics of the ECMs (in parentheses).

Table 4.B. Granger-Causality Tests: Trivariate Models. Causality between US and EMS Interest Rates

Country	FPE {*m*, *p*}	FPE {*m*, *n*, *p*}	ECM	Causality $X \rightarrow US$	FPE {*m*, *p*}	FPE {*m*, *n*, *p*}	ECM	Causality $US \rightarrow X$
Belgium	0.481	0.343	---	YES	0.312	0.281	---	YES
	{12, 5}	{12, 12, 5}			{5, 5}	{5, 11, 5}		
Denmark	0.481	0.418	---	YES	0.338	0.343	---	NO
	{12, 5}	{12, 3, 5}			{4, 5}	{4, 1, 5}		
Spain	0.030	0.031	0.009	NO	0.107	0.092	-0.055	YES
	{1, 1}	{1, 1, 1}	(0.541)		{4, 7}	{4, 3, 7}	(-1.618)	
France	0.481	0.473	---	YES	0.204	0.203	---	YES
	{12, 5}	{12, 4, 5}			{6, 6}	{6, 1, 6}		
Netherlands	0.481	0.321	---	YES	0.091	0.091	---	YES
	{12, 5}	{12, 10, 5}			{12, 5}	{12, 6, 5}		
Ireland	0.481	0.393	---	YES	0.615	0.621	---	NO
	{12, 5}	{12, 11, 5}			{6, 1}	{6, 2, 1}		
Italy	0.481	0.471	---	YES	0.300	0.299	---	YES
	{12 , 5}	{12, 1, 5}			{11, 4}	{11, 1, 4}		
Portugal	0.025	0.024	---	YES	0.403	0.361	---	YES
	{10, 7}	{10, 6, 7}			{5, 4}	{5, 7, 4}		
UK	0.032	0.029	0.056	YES	0.044	0.046	-0.172[a]	NO
	{1, 1}	{1, 2, 1}	(1.502)		{4, 2}	{4, 9, 2}	(-3.537)	

Notes: *m*, *n* and *p* denote the lags for the dependent variable, the additional regressor, and the German interest rate, respectively, leading to the smallest FPE in each case; the maximum number of lags tried has been 12. *X* and *US* denote every country in the first column of the table, and the US, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively, for the *t*-statistics of the ECMs (in parentheses).

Table 4.C. Granger-Causality Tests: Trivariate Models.
Causality between US and German Interest Rates

Country	FPE {*m*, *p*}	FPE {*m*, *n*, *p*}	ECM	Causality $G \rightarrow US$	FPE {*m*, *p*}	FPE {*m*, *n*, *p*}	ECM	Causality $US \rightarrow G$
Belgium	0.475	0.407	---	YES	0.096	0.086	---	YES
	{12, 12}	{12, 12, 12}			{12, 12}	{12, 10, 12}		
Denmark	0.428	0.418	---	YES	0.098	0.090	---	YES
	{12, 3}	{12, 5, 3}			{12, 8}	{12, 10, 8}		
Spain	0.032	0.031	0.009	YES	0.029	0.029	0.016	NO
	{1, 1}	{1, 1, 1}	(0.541)		{4, 2}	{4, 1, 2}	(0.975)	
France	0.487	0.484	---	YES	0.094	0.079	---	YES
	{12, 1}	{12, 5, 1}			{12, 10}	{12, 12, 10}		
Netherlands	0.381	0.320	---	YES	0.096	0.086	---	YES
	{12, 5}	{12, 10, 5}			{12, 10}	{12, 12, 10}		
Ireland	0.402	0.389	---	YES	0.100	0.090	---	YES
	{12, 11}	{12, 2, 11}			{12, 1}	{12, 10, 1}		
Italy	0.474	0.471	---	YES	0.097	0.089	---	YES
	{12, 1}	{11, 4, 1}			{12, 10}	{12, 10, 10}		
Portugal	0.024	0.024	---	NO	0.029	0.030	---	NO
	{10, 2}	{10, 1, 2}			{1, 2}	{1, 1, 12}		
UK	0.030	0.029	0.056	YES	0.030	0.031	-0.021	NO
	{1, 2}	{1, 3, 2}	(1.502)		{4, 1}	{4, 1, 1}	(-0.554)	

Notes: *m*, *n* and *p* denote the lags for the dependent variable, the additional regressor (Germany or the US), and every country in the first column of the table, respectively, leading to the smallest FPE in each case; the maximum number of lags tried has been 12. *G* and *US* denote Germany and the US, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively, for the *t*-statistics of the ECMs (in parentheses).

chosen are: November 1990 (the German reunification), September 1992 (the beginning of the turbulent period affecting the EMS), and August 1993 (the broadening of the fluctuation bands in the EMS), and the tests are only performed for the interest rates of the EMS founding members, given the reduced number of observations available for the newcomers. As can be seen in Table 5, most of the tests fail to reject the null hypothesis of stability. The most relevant exceptions would be the Danish and French cases, where some signs of structural change in Granger-causality from Germany would be detected following the German reunification and the monetary turmoil at the end of 1992, both in the bivariate and trivariate models; however, the null hypothesis is rejected in most cases just at a 10% significance level.[4]

To summarize, bilateral Granger-causality has been found between the interest rates of Germany and the other countries participating at any time in the ERM of the EMS (with the only exception of Ireland in the bivariate case). However, the increase in explanatory power is always greater when German interest rates are added to the equations explaining the other interest rates than the other way round. In addition, the EMS countries' interest rates would also appear to be mutually connected to the US interest rates, both directly and indirectly through the German ones. Therefore, our results would point to a certain "leadership" or special role of Germany within the EMS, although we could not talk of "dominance" in a strict sense.

To conclude this section, it could be useful to apply to our results the terminology introduced by Hassapis, Pittis and Prodromidis (1999). Denoting, respectively, Germany, the US, and the EMS countries by *G*, *US*, and *X* as in Table 4, these authors identify, for the trivariate case, four possible versions of the German dominance hypothesis:

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[4] Notice that these results might appear somewhat puzzling, given our previous results on cointegration (see Table 2 above) and the finding in Bajo, Sosvilla and Fernández (2001) of a reinforcement of German leadership following the German reunification. Perhaps the small number of observations available for the second half of the different subsamples might help to explain the failure in rejecting the null of structural stability.

Table 5. Tests of Structural Change

A. Causality between German and EMS Interest Rates (Bivariate Models)

Country	$X \rightarrow G$			$G \rightarrow X$		
	1990:11	1992:09	1993:08	1990:11	1992:09	1993:08
Belgium	0.5252	0.4756	0.3123	1.1132	1.0152	0.8799
Denmark	1.3472	1.3029	0.5235	1.3876	1.7864[c]	0.2547
France	0.5022	0.4016	0.3828	1.5967[c]	1.8587[c]	1.4990
Netherlands	0.5558	0.4961	0.3222	0.7498	0.5879	0.2816
Ireland	0.3362	0.2346	0.1506	1.5070	1.5177	0.2638
Italy	0.3457	0.3019	0.2628	0.9628	0.4445	1.2499

B. Causality between German and EMS Interest Rates (Trivariate Models)

Country	$X \rightarrow G$			$G \rightarrow X$		
	1990:11	1992:09	1993:08	1990:11	1992:09	1993:08
Belgium	0.3466	0.3181	0.2992	1.1920	1.1150	0.9706
Denmark	0.4071	0.3763	0.2876	1.5338[c]	1.9298[b]	0.3422
France	0.7199	0.6993	0.6706	1.4200[c]	1.9734[a]	1.1229
Netherlands	0.3303	0.3130	0.2925	0.5400	0.3988	0.2417
Ireland	0.3410	0.3162	0.2948	1.3750	1.6119[c]	0.2319
Italy	0.3982	0.2810	0.4058	1.0061	1.1471	0.4841

C. Causality between US and EMS Interest Rates (Trivariate Models)

Country	$X \rightarrow US$ 1990:11	1992:09	1993:08	$US \rightarrow X$ 1990:11	1992:09	1993:08
Belgium	0.7614	0.4571	0.4153	1.1452	1.1778	1.0222
Denmark	1.2914	0.8780	0.6659	1.3542	1.6384[c]	0.2384
France	1.1509	0.7850	0.4990	1.5068	1.3741	0.7552
Netherlands	0.6850	0.5462	0.5179	0.5464	0.4176	0.2485
Ireland	0.9324	0.5884	0.4063	1.3750	1.6119	0.2319
Italy	1.2955	0.5716	0.4139	1.0061	1.1471	0.4841

D. Causality between US and German Interest Rates (Trivariate Models)

Country	$G \rightarrow US$ 1990:11	1992:09	1993:08	$US \rightarrow G$ 1990:11	1992:09	1993:08
Belgium	1.0792	0.6449	0.6312	0.5701	0.6168	0.3963
Denmark	1.2914	0.8780	0.6659	0.9298	0.9003	0.4341
France	0.8817	0.4799	0.4143	0.6514	0.6230	0.6146
Netherlands	0.8018	0.6017	0.6175	0.5851	0.5924	0.3112
Ireland	0.8364	0.6048	0.4118	0.6697	0.4268	0.4100
Italy	1.0824	0.4630	0.3363	0.4374	0.4408	0.2775

Notes: *X* , *G*, and *US* denote every country in the first column of the tables, Germany and the US, respectively. (a), (b), and (c) denote significance at the 1%, 5%, and 10% levels, respectively.

i. Strong (i.e., no direct or indirect causality from US): there is Granger-causality $G \rightarrow X$, but not $US \rightarrow X$ and $US \rightarrow G$.
ii. Weak of type 1 (i.e., direct causality from US): there is Granger-causality $G \rightarrow X$ and $US \rightarrow X$, but not $US \rightarrow G$.
iii. Weak of type 2 (i.e., direct and indirect causality from US): there is Granger-causality $G \rightarrow X$, $US \rightarrow X$ and $US \rightarrow G$.
iv. Semi strong (i.e., only indirect causality from US through Germany): there is Granger-causality $G \rightarrow X$ and $US \rightarrow G$, but not $US \rightarrow X$.

Now, from the last columns of parts A, B and C of Table 4, the following typology can be established:

- Strong German dominance: the UK.
- Weak German dominance of type 1: Spain, and Portugal.
- Weak German dominance of type 2: Belgium, France, the Netherlands, and Italy.
- Semi strong German dominance: Denmark, and Ireland.

IV. Conclusions

In this paper we have re-examined the German dominance hypothesis, extending previous findings by other authors to all the countries participating at any time in the ERM of the EMS, with the sample period covering until just the eve of EMU, i.e., December 1998. The empirical methodology makes use of Granger-causality tests between the interest rates of Germany and the other EMS countries, in a proper cointegration framework where the lag lengths of the variables have been chosen by means of Hsiao's sequential approach in order to avoid misleading inferences arising from inconsistent model estimates. The tests have been performed in both a bivariate and a trivariate setting, in this case including the US interest rate as the additional variable.

Summarizing, our results point to a mutual but asymmetrical relationship between Germany and the other countries participating at any time in the ERM of the EMS, since bilateral Granger-causality was found between the interest rates of Germany and those of the other countries, although the German interest rates added more to the explanation of the other interest rates than in the opposite case. Also, a mutual connection between the EMS countries' and the US interest rates would emerge, both directly and indirectly through the German rates. Finally, we hardly found evidence of significant structural changes in the estimated relationships following the German reunification, the monetary turmoil at the end of 1992, and the broadening of the fluctuation bands in the EMS.

Therefore, our results would support a weak version of the hypothesis of German dominance during the working of the EMS, since there would have prevailed a mutual relationship among the monetary policies of all the countries involved, even though that relationship would have been stronger from Germany to the other countries than in the opposite way. Then, Germany would have played a certain "leadership" or special role in the EMS, although she would not have been strictly the "dominant" player.

Regarding the policy implications of the paper, these would provide some mild support to the hypothesis about EMU as an economic response to the loss of monetary autonomy in Europe in favor of Germany, especially after the achievement of full capital mobility in the first nineties (Wyplosz, 1997). Also, the position of the Mediterranean countries (Italy, Spain, and Portugal) faced to EMU does not seem to be too different to that of the "core" European countries, at least in terms of the autonomy of their monetary policies before EMU. The same can be said for Denmark and the UK, two countries that chose not to participate in EMU; in fact, and somewhat ironically, the UK would have been, according to our results, the country most "dominated" by German monetary policy actions.

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