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LEADER OF THE PACK?

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Leader of the Pack?
German Monetary Dominance in Europe Prior to EMU*

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Abstract

In this paper, the monetary policy independence of European nations in the years before European Monetary Union (EMU) is investigated using cointegration techniques. Daily data is used to assess pairwise relationships between individual EMU nations and 'lead' nation Germany, to assess the hypothesis that Germany was the dominant European nation prior to EMU. By and large our econometric investigations support this hypothesis, and lead us to conclude that the only European nation to lose monetary policy independence in the light of monetary union was Germany.

1 Introduction

On January 1, 1999, eleven countries adopted the euro as their common currency, transferring monetary policy responsibility to the newly established European Central Bank (ECB). It is generally perceived that by giving up monetary sovereignty, these countries relinquished monetary policy as an instrument of domestic policy. Was this loss of sovereignty however necessarily concurrent with a loss of monetary policy independence? The general perception of participation in such a monetary union is that national economies forsake monetary policy independence, and discussions are framed in terms of this cost. However, prior to European Economic and Monetary Union (EMU), many European nations were characterised as Bundesbank watchers, following the German central bank's policy movements. An important question is thus whether today's EMU nations enjoyed any monetary policy independence pre-euro? Because if not, then these countries had no independence to lose through monetary union, and have arguably gained policymaking influence through representation in the common central bank's monetary policy committee.

As a working definition of monetary policy independence we propose a country's ability to set its own monetary policy via interest rates. Hence, the absence of adjustment to any steady-state relationship between that country's interest rate and other countries' interest rates might be interpreted as evidence in favour of policy independence: in setting interest rates, events within the economy alone influence policy. Both the null hypothesis of independence and the alternative hypothesis of lack of independence cover a whole realm of possibilities. A country is deemed independent if it can tailor its monetary policy according to domestic developments; this might be either because macroeconomic developments in other countries experiencing different output cycles have no or little impact on the domestic economy or because it employs sufficient capital controls to ensure it is not bound by capital movements in its setting of monetary policy. Conversely, a central bank might move in tandem with other central banks because their economies are experiencing

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common shocks, such as oil price shocks or a global financial crisis; any 'dependence' uncovered in this case may not be suggestive of any dependence on a particular country but simply a reflection of similar policy responses to similar economic developments. However, a perfect synchronisation of business cycles between countries that would induce identical optimal monetary policy responses (whatever this might be) of their respective central banks is rather unlikely.[1] Hence the existence of and speedy adjustment to a steady-state relationship with another countries' interest rate is evocative of monetary policy dependence nonetheless.

All of this holds implications for any econometric analysis seeking to uncover dependence patterns. Time-series econometrics has developed rapidly over the years to cope with the criticisms perhaps best encapsulated in both Yule (1926) and Lucas (1976); those of spurious significance, and of structural change. Naturally, progress is still to be made, but thankfully for the economist, he or she still has value to add: statistical processes must still be used appropriately, and interpreted suitably, meaning that while correlations and possibly causations can be uncovered, there still is a need for caution and consideration. The cointegration framework (Johansen, 1995; Juselius, 2007) allows additional insight beyond establishing steady-state relationships; it gives insight into which variables are adjusting to relationships, and which variables are driving relationships. This allows us to make further inference into the European interest rate relationships we estimate. Using this framework, we investigate monetary policy independence in the run up to EMU, and while the broad sweep of evidence presented supports the hypothesis of German dominance, and little independence for smaller European economies, we also highlight the somewhat uncomfortable example of Austria which emphasises, as always, the need for caution in interpreting the results of any study.

Cointegrating vectors play the role of steady-state relationships, and hence if such relationships exist between countries, and furthermore one country adjusts to this relationship, while another does not, then this is evidence in favour of monetary dependence of the adjusting country on the non-adjusting one. Edison and MacDonald (2003), who use a similar methodology, refrain from making monetary policy independence conclusions based on their work due to the difficulty of drawing inference on policy dependence from international interest rate movements. It could be argued that countries are simply responding to common shocks, perhaps induced by a third party. However, our modelling methodology enables us to detect the direction of dependence, and hence by considering pre-EMU economies in isolation we are able to detect the direction of interest rate movements in Europe, and hence identify whether or not Germany was leading them. Hence a lack of independence in the case of Europe is sufficient to argue our point relating to Germany's dominance in policymaking, and the subsequent gains and losses from monetary union, regardless of the nature of those shocks. It is surely the case that each country in our sample was affected by idiosyncratic shocks during the sample period, but if cointegration exists between each country rate and the German rate, then these shocks must have been of secondary importance to the country, as their dependence on Germany dictated that they must adjust to what was happening in Germany. This approach means that if we find countries that do not adjust (we include the UK as a test case), then there are at least three noteworthy implications: the country is impacted by idiosyncratic shocks that distinguish it from Germany; these shocks are large and require remedial action; and this country has the independence to react to these shocks in the appropriate manner. If however, none of these implications apply to a European country, that country can reasonably be described as dependent on Germany in monetary policy terms.

An important, if simple, contribution to the literature is made in our paper by adding a time trend to the cointegrating relationships in our models. If, as must have happened in order for EMU to have begun, convergence took place, then this convergence needs to be factored into cointegrating relationships. Convergence can simply be captured by entering a linear time trend into our cointegrating space; this acts as a wedge between the two country interest rates that over time decreases as the two interest rates begin to move more and more closely together. Furthermore, if no clear convergence occurred (perhaps in the case of countries whose interest rate are very close to Germany's throughout our samples), then this time trend may be insignificant and then can be restricted to zero. Thus we believe there is little cost to adding a time trend into our models as the cointegration theory is developed to allow such deterministic terms and

[1]While there is dispute regarding the extent of output correlations across the euro area, there is a consensus that EMU members are far from displaying perfectly correlated business cycles. See, for instance, Hughes Hallett and Richter (2008); Montoya and Haan (2008); Gouveia and Correia (2008); and Afonso and Furceri (2007). Even if cycles were perfectly correlated, it is unlikely that central banks would use the identical policy model for setting interest rates.

still generate accurate results, while the benefit is potentially great: cointegrating relationships that would otherwise have been missed may be uncovered with the addition of this term.

The remainder of the paper is organised as follows. The next section reviews the literature on monetary policy independence. We then discuss our econometric strategy, and present our results. The final section concludes.

2 Monetary Policy Independence Measurement in the Literature

This paper builds out of two literatures, those of international economics and applied time series analysis, broadly speaking. Considering firstly the theoretical literature, monetary policy independence is framed within the context of what is described as an "impossible trinity": a country is unable to maintain open capital markets, a fixed exchange rate and an independent monetary policy simultaneously. This implies a "possible duality", where only two of the three can be maintained at the same time. Recently, however, doubts have been raised on this conventional view that exchange rate flexibility provides insulation for the conduct of monetary policy. That is, in a world of globalised financial markets even countries with flexible exchange rate regimes might be limited in the independent conduct of monetary policy - possibly even if they employ capital controls. In this paper we do not specifically investigate the validity of the impossible trinity hypothesis or the factors that influence monetary policy independence.[2] Instead, we concentrate on whether countries that were part of the European Monetary System (EMS) did or did not enjoy monetary policy independence.

The topic of monetary policy independence has been investigated empirically by a number of authors, mostly in a European context. Edison and MacDonald (2003) consider how much discretion was available to European countries that entered the exchange rate mechanism (ERM) as part of the EMS had during the 1980s and 1990s. They find that EMS member countries that had adopted credible monetary policies also had some leeway to pursue an independent monetary policy - even with fixed exchange rates - at least over certain time horizons. They find that, for example, the Netherlands had over a year in which it could deviate from German interest rates. Likewise, Von Hagen and Fratianni (1990) reject a strict form of German dominance in the EMS and argue that capital and exchange controls as well as the possibility of parity realignments within the ERM acted as "safety valves" to disanchor monetary policies of the other EMS member countries from the relatively restrictive policy course of the Bundesbank.[3]

The hypothesis of German monetary dominance within the EMS is upheld by Volz (2006) who estimates monetary policy rules for European countries and the US for the period ranging from August 1971 to December 1998, i.e., from the breakdown of the Bretton Woods system to the launch of the euro. His results suggest that the monetary policy decisions of all EMS member countries were driven to a large extent by the interest rate policy of the German Bundesbank. Artus et al. (1991) also corroborate the asymmetrical functioning of the EMS and the dependence of ERM countries on German short-term interest rates.[4]

Fratzscher (2002) augments the cointegration analysis employed by Edison and MacDonald with a GARCH model to account for possible conditional heteroskedasticity in interest rate data at the daily frequency. Fratzscher also extends the standard interest rate model with exchange rate differentials, although these are assumed (without testing) to be exogenous to the estimated system. Fratzscher appears to find little evidence for monetary autonomy in various regions of the world: European countries except Germany did not enjoy much policy independence within the ERM, his results suggest, while East Asian and Latin American countries that loosened exchange rate linkages with the US over the last twenty years similarly failed to display any less interest rate dependence on the US. Fratzscher concludes that even under flexible exchange rate arrangements it becomes even more difficult to pursue independent monetary policy.

Frankel et al. (2004), who scrutinise a large sample of developing and industrialised countries, similarly

[2] This we actually do in a sister paper. See Reade and Volz (2009).

[3] De Grauwe (1989) comes to similar conclusions.

[4] Crespo Cuaresma and Wojcik (2006) investigate monetary policy independence for three new EU member states (Czech Republic, Hungary and Poland), concluding that all of them enjoy only little monetary independence, although their currency regimes (Czech Republic: managed float; Hungary: ERM2; Poland: de facto free float) should grant considerable leeway.

find little monetary policy independence for all but the largest industrial countries. They find that while floating regimes afford greater monetary independence than fixed regimes, floating regimes provide only temporary monetary independence. Their results suggest that while the speed of adjustment of domestic rates towards the long run, one-for-one relation with international interest rates is generally lower under floating than under fixed exchange rate regimes, even central banks that let their currency float cannot exert autonomous monetary policy. Besides the Fed, the central banks of Japan and Germany (now the euro zone) appear to be the only monetary authorities that can independently choose their own interest rates in the long run. Like Fratzscher, Frankel *et al.* conclude that for European countries prior to the introduction of the euro, Germany's interest rates and not US interest rates became a focal point. Indeed, they observe that interest rates in European countries had become completely insensitive to US interest rates but fully sensitive to German interest rates, an observation that is also made by Chinn et al. (1993). This last point to some extent contradicts the findings of Edison and MacDonald, who maintain that without US interest rates cointegration cannot be uncovered between European rates.

Turning to the applied time-series analysis literature, the multivariate cointegration methodology of Johansen (1995) and Juselius (2007) provides a framework in which the problems of non-stationarity (Yule, 1926) and exogeneity (Engle et al., 1983) are both accommodated in an error-correction formulation which with its long-run and short-run dichotomy mirrors much economic theory. Notably, in adopting an interest-rate formulation our work tests the existence of uncovered interest parity, as we will detail. In particular, the parallel of cointegrating vectors, or steady state relationships, with many standard economic theory results facilitates attempts at testing the latter. The multivariate approach adopted here follows on from the original groundbreaking work on cointegration by Engle and Granger (1987), and allows us to consider interest rates from different economies in a system without making *a priori* assumptions over which interest rates adjust to and which drive our steady-state interest rate relationships.

There have been wide ranging applications of the cointegrated vector-autoregressive framework to various areas of macroeconomics; examples might be Christensen and Nielsen (2003), Giese (2005) and Juselius and MacDonald (2004), in addition to the already mentioned Edison and MacDonald application to interest rate discretion between European economies pre-EMU.

3 Data and Econometric Strategy

Standard international economic theory describes a number of interest rate parity conditions. In particular, uncovered interest parity dictates that, in the absence of capital controls:

$$r_t = r_t^* + \mathsf{E}_t\left(\Delta e_{t+k}\right), \tag{1}$$

where r_t is the domestic interest rate, r_t^* the foreign interest rate, and e_t is the exchange rate between the two currencies. Because European countries over the period considered were members of the ERM, a fixed exchange rate mechanism, then as an approximation, the latter term in (1) can be set to zero, yielding a one-to-one parity relationship between the domestic and foreign interest rates.[5]

We mimic this parity arrangement by considering European countries in pairs with Germany, hence following simple parity relationships like that described in (1). Edison and MacDonald also include the US; however we do not find this necessary in order to find well specified models for interest rate behaviour, and hence proceed on a European basis. This is not to suggest that the US is unimportant in monetary policy determination within Europe; more, we are seeking to understand European dynamics, and the US is not necessary for that.

A pervasive issue in time-series econometrics is that of non-stationarity; if both interest rates were non-stationarity, spurious significance might distort any results from a simple OLS regression version of (1),

[5] The ERM incorporated bands within which bilateral exchange rates could fluctuate by $\pm 2.5\%$, until the 1992 ERM crisis, after which the bands were loosened for most remaining participants. The existence of capital controls until the early 1990s also granted some leeway to deviate from interest rate parity.

say:

$$r_t = \beta_0 + \beta_1 r_t^* + \varepsilon_t. \tag{2}$$

A further drawback of (2) is that while it may describe a relationship between the two interest rates, it gives no indication which countries actually adjust to this relationship; the causality could run either way or in both directions. The standard econometric solution to non-stationarity is to to add lags of both interest rates to the model and difference the model until stationarity results. However, potentially important information in the levels of the data would be lost; a common alternative is, and reformulate into an error-correction mechanism:

$$\Delta r_t = \alpha_0 \Delta r_t^* + \alpha_1 \left[\delta_0 - \delta_1 r_{t-1} - \delta_2 r_{t-1}^*\right] + \epsilon_t. \tag{3}$$

In this formulation, the δ_k coefficients represent the long-run equilibrium relationship between the two interest rates, the infinite sum of partial differentials between the two interest rates, and α_0 dictates how r_t, the domestic interest rate, adjusts each period to any disturbance in this equilibrium relationship. The possibility of spurious significance is averted here, provided that the two interest rates form a cointegrating vector with coefficients $[\delta_0, \delta_1, \delta_2]$. Formally, two series that are individually non-stationary (integrated of order one) are described as cointegrating if a linear combination of the two is stationary. Given the discussion of uncovered interest parity above, it seems likely that such relationships will hold constant, even if interest rates individually are non-stationary, or near non-stationary; hence we expect that these interest rate relationships will provide cointegrating vectors.

However, we are still assuming that the direction of causality ends with the domestic interest rate, and in not modelling the foreign interest rate we assume its exogeneity. The solution to this problem is to model both interest rates in a vector autoregression, a bivariate system with data vector $\mathbf{X_t}$, given by:

$$\mathbf{X_t} = \begin{pmatrix} r \\ r^* \end{pmatrix}_t. \tag{4}$$

These two series form a vector autoregression:

$$\mathbf{X_t} = \Pi_0 + \sum_{i=1}^{K} \Pi_i \mathbf{X_{t-i}} + \mathbf{u_t}, \ \mathbf{u_t} \sim \mathsf{N}\left(0, \sigma^2\right). \tag{5}$$

Here, X_t is $p \times T$, while Π_i are $p \times p$ coefficient matrices. If the data are non-stationary, so $X_t \sim I(1)$, then in order for (5) to be balanced (given the stationarity assumption on $\mathbf{u_t}$), it must be rearranged into equilibrium-correction form:

$$\Delta \mathbf{X_t} = \Pi \mathbf{X_{t-1}} + \sum_{i=1}^{K-1} \Gamma_i \Delta \mathbf{X_{t-i}} + \mathbf{u_t}, \tag{6}$$

where $\Pi = \sum_{i=1}^{K} \Pi_i - I$, and $\Gamma_i = -\sum_{j=i+1}^{K} \Pi_j$. Further, if $\mathbf{X_t} \sim I(1)$, then given that $\mathbf{u_t} \sim I(0)$ and $\Delta \mathbf{X_t} \sim I(0)$ then Π must be of reduced rank for (6) to be balanced. If Π is of reduced rank then there exist $p \times r$ matrices α and β such that $\Pi = \alpha\beta'$, and (6) becomes:

$$\Delta \mathbf{X_t} = \alpha\beta' \mathbf{X_{t-1}} + \sum_{k=1}^{K-1} \Gamma_i \Delta \mathbf{X_{t-k}} + \mathbf{u_t}. \tag{7}$$

The $\beta' \mathbf{X_{t-1}}$ terms are cointegrating vectors, the stationary relationships between non-stationary variables, or steady-state relationships. In the interest rate context, they are combinations of interest rates that individually are non-stationary, but together are stationary, with the cointegrating vector being an uncovered parity relationship.

The cointegrated vector-autoregressive model in (7) allows a rich analysis of monetary independence: different $\beta' X_{t-1}$ combinations can be tested to see if the data support them; furthermore, the α coefficients will determine whether each interest rate series responds to disequilibrium in the stationary relationship described in $\beta' X_{t-1}$: if $\beta' X_{t-1} \neq 0$ then there exists disequilibrium.

Returning to the domestic and foreign interest rates, the interest parity theory discussed above suggests a rank of one, so imposing this we can use (4) to write explicitly:

$$\begin{pmatrix} \Delta r \\ \Delta r^* \end{pmatrix}_t = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} \begin{pmatrix} \beta_0 & \beta_1 & \beta_2 \end{pmatrix} \begin{pmatrix} 1 \\ r \\ r^* \end{pmatrix}_{t-1} + \sum_{k=1}^{K-1} \Gamma_k \Delta \mathbf{X_{t-k}} + \mathbf{u_t}. \tag{8}$$

If the restriction $\beta_1 = -\beta_2 = 1$ is imposed, then:

$$\begin{pmatrix} \Delta r \\ \Delta r^* \end{pmatrix}_t = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} \begin{pmatrix} r - r^* - \beta_0 \end{pmatrix}_{t-1} + \sum_{k=1}^{K-1} \Gamma_k \Delta \mathbf{X_{t-k}} + \mathbf{u_t}. \tag{9}$$

It may be expected that a large or dominant economy, such as Germany prior to EMU, would not adjust to this cointegrating vector, as it might be expected to exert monetary policy independence; so if we assume r^* to be the larger economy, then $\alpha_2 = 0$. The smaller economy may be expected to adjust, so $\alpha_1 \neq 0$. Furthermore, α_b describes how much of any disequilibrium is corrected each period, as $\alpha = \Delta X_t/(\beta' X_{t-1})$, hence (ceteris paribus) a speed of adjustment can be calculated; the smaller is this coefficient, the more independent is a country's monetary policy, as it devotes less of its attention to correcting to what other interest rates are doing. As such, the α matrix is very informative about the nature of monetary policy independence. A country not adjusting to a cointegrating vector in which it appears is said to 'drive' the system: the level that the country's interest rate is at is not constrained by the cointegrating relationship, but in fact dictates what level that cointegrating relationship takes. Hence, our theory would suggest that Germany, the dominant country, should not adjust to any cointegrating vector found, while the smaller economies should adjust.

We have discussed only interest rate relations where exact parity holds, so $\beta_1 = -\beta_2 = 1$; this says the interest rates move one-for-one in equilibrium; if equilibrium is disturbed by a movement in a country's interest rate (perhaps an adjustment to an external shock to the economy), then the other country's interest rate must move by the same amount to restore equilibrium. Unless the following country adjusts, then capital will flow out of (in to) that country so long as its interest rate remains too low (high). However, β_2 need not be negative unity; a different coefficient suggests that in response to disequilibrium, that country's interest rate must move more or less to restore equilibrium. This perhaps reflects that in times of instability, certain countries are deemed more 'risky' than others, and so to restore equilibrium of capital flows, their interest rate must adjust higher. This risk premium interpretation can also be offered to the constant term, β_0 (Edison and MacDonald, 2003). In the cointegrating vector (3), the domestic interest rate is equal the German interest rate plus a constant term (β_0); we would expect this constant term to be positive in more 'risky' countries. A test of its significance could be interpreted as a test of the existence of a risk premium.[6]

An additional factor for Europe pre-EMU is convergence, at least in the second half of the 1990s. All EMU countries had to ensure convergence of interest rates by the end of 1998, because their currencies were fixed irrevocably at this point.[7] Figure 1 shows that indeed this convergence was achieved by the end of 1998, with Ireland and the Southern European nations being the last to converge. This argues for including a trend term in the cointegration space in our models; without this term, cointegration may be missed since interest rates are converging between the countries, dislodging previous relationships. A trend would not normally be included in a cointegration exercise involving interest rates, since a time trend indefinitely

[6]Naturally, other factors could be at work to determine interest rate differentials, such as capital controls, which were fully abolished in the EU only in the early 1990s.

[7]This does not preclude convergence before this point; given that European countries had been operating in a customs union since the creation of the European Economic Community in 1957, they would be expected to display signs of convergence over a longer horizon.

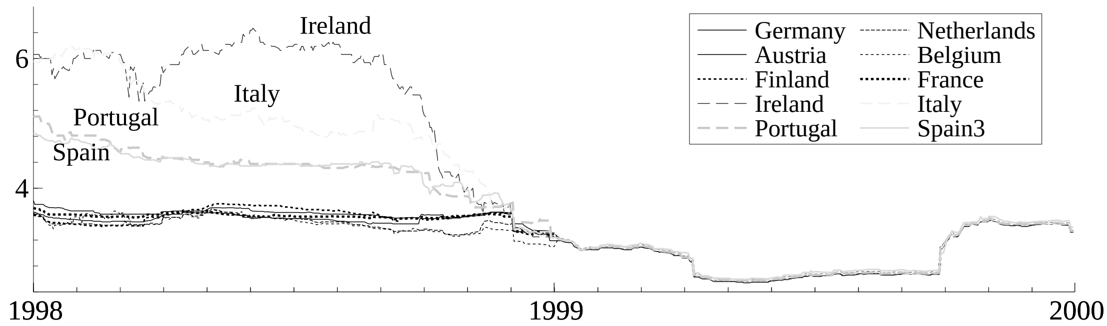

Figure 1: Interest rates between 1998 and the end of 2000 in the EMU members considered in this paper.

implies that one interest rate must go to infinity; however, with the fixed time horizon in our sample, a time trend is appropriate. Furthermore, we can establish what the rate of convergence was between particular types of countries, which may be of use empirically given the current attempts by other European nations to achieve convergence and join the Eurozone.[8] With a time trend, our cointegrating vector, written generally, would be:

$$r_t = \beta_0 + \beta_2 r_t^* + \beta_t t + \varepsilon_t. \quad (10)$$

Thus we have a number of testable hypotheses on monetary policy independence in Europe:

1. $\mathbf{H}_0 : \alpha_2 = 0$: Germany is dominant: it drives the relationship.
2. $\mathbf{H}_0 : \alpha_1 \neq 0$: Domestic country adjusts to relationship and exhibits little or no independence.
3. $\mathbf{H}_0 : \beta_0 = 0$: Absence of risk premium over Germany.
4. $\mathbf{H}_0 : \beta_2 = -1$: One-for-one relationship between Germany and domestic country.

In Section 4 we will test these hypotheses individually and jointly. The last hypothesis is tested in reverse, by considering how significant the α_a coefficient is in each model.

Interest rates cannot be unit root processes theoretically; their variance is not exploding over time, and they will always be bounded below and above.[9] Figure 2 plots in nine separate panels the three-month interbank interest rate of EMU countries against the corresponding German interest rate.[10] The data are daily in frequency and obtained from the Global Financial Database.[11] The central, original members of the EU (or European Community, as it was previously called) alongside Germany (Austria, Belgium and the Netherlands) display almost identical interest rate behaviour over their sample periods, whereas those displaying less similar behaviour show clear signs of convergence over the period plotted. Table 1 displays summary statistics for each country's data series. All the series stop on December 31, 1998, after which the euro was created. Thus only the start date for each sample is provided, along with the number of observations.

It is important for testing monetary policy independence empirically that we select appropriate variables for our regression models; Juselius (2007) discusses this issue at length, asserting its centrality in the credibility of testing economic theory using econometric methods. Daily data do not solely represent policy

[8]We relegate this latter exercise to future research.

[9]Above is more an approximation than below, but extreme situations such as hyperinflations are rare, and non-existent in the sample considered here.

[10]Of the 1999 entrant countries, only Luxembourg, which has operated a monetary union with Belgium since 1922, is not included.

[11]The UK data series, discussed later, is taken from Datastream, and again is the daily 3-month interbank interest rate.

stances of monetary authorities in each country, which are typically adjusted in monthly meetings of their respective monetary policy committees. But to a large extent daily rates do reflect policy stance, as market participants generally anticipate policy movements and price these into the market before the decision has even been made. Furthermore, daily rates also indicate the extent to which two economies are interlinked in their behaviour on a day-to-day basis. If two economies are intricately linked, as dictated by close movements of their three-month interbank interest rates, it it unlikely that domestic monetary policy exerts much independence. As such, we are satisfied with the closeness of our chosen interest rates to the theoretical variable of interest for our empirical strategy.

Considering the important question of the order of integration of the series, Juselius (2007) has argued the merits of treating ambiguous time series as non-stationary, in order to exploit potential co-movements between them and other possibly non-stationary time series. This is helpful since single-equation testing such as Dickey-Fuller testing suffers from a lack of power, particularly in near unit-root cases. Nonetheless, it is important to characterise the series at least from a conceptual starting point, and to avoid the possibility of modelling I(2) series.[12] From the plots, regardless of the sample length, there is marked non-stationarity in the behaviour of the interest rates; the mean for interest rates in the early 1990s is higher than it was in the late 1990s, while the series that go back to the 1970s display prolonged periods of high and low interest rates. At the very least, high persistence is displayed by these series.

Unit root testing using the Dickey-Fuller test (Dickey and Fuller, 1979) is carried out and reported in the Unit Root Test Statistic column of Table 1; the test specified includes a constant, or drift component. In all cases bar France, the test statistic is less than the 5% critical value, and with the French test, the decision is more borderline that the Table would suggest. Because we have a large sample, 7043 observations, it is appropriate to reconsider appropriate significance levels for testing, as Campos et al. (2003) suggest, for model selection. Based on consistent model selection algorithms, Campos et al. propose using a formula of $T^{-0.8}$ to determine what the significance level ought to be for a given sample size T. For France then, our critical value ought to be $7043^{-0.8} = 0.0008$, or a 0.08% significance level, which equates to taking a t-value of 3.3 for significance, not the standard 2. For the Augmented Dickey-Fuller test, this also equates to critical values considerably higher than the standard 5% value of -2.86 and 1% value of -3.43, hence showing the borderline nature of this French decision. Furthermore, from its plot, the French interest rate does not look particularly stationary, particularly in the early 1980s, and as such, we feel justified in assuming all these series contain a unit root, or at the very least are near unit root. Nonetheless, even if some of our series are stationary, the Johansen cointegration methodology remains valid; we would simply find, with 7000 observations, no correlation between a unit root series and a stationary series, meaning that no cointegration would be found between, say, France and Germany, if indeed one of these series was stationary and the other non-stationary.[13]

The cointegrated vector-autoregressive model framework allows the modelling of partial systems: provided all the assumptions placed upon the residuals ε_t are satisfied, then the rank test outcome is valid, and any cointegrating vectors found in that system should be found in any enlarged system (Ericsson et al., 1994; Juselius, 2007) (the sectoral-specific-to-general property). It is proposed here that a system involving X_t in (4), solely interest rates, should be sufficient for modelling interest rate movements. Of the studies cited above, only Fratzscher augments this basic system with additional variables, choosing to add exchange rate differentials. An information set containing simply interest rates is a restrictive information set, and moreover an untested restriction. Nonetheless, if a well specified model can be found for a restricted information set, then one can be confident that one has successfully conditioned on these other factors; the sectoral-specific-to-general property of cointegrated vector-autoregressive models discussed above is appealed to - if the other important variables were added, the cointegrating vectors found in the simple system would

[12] Contrary to the assertions of Obstfeld et al. (2004) and Shambaugh (2004), the order of integration is not important for cointegration analysis using the Johansen (1995) approach, provided that the order is less than two. An I(2) series is characterised as being very smooth (Juselius, 2007, Chapter 2) — none of the interest rate series plotted in Figure 2 can be described as smooth, hence we can be confident the highest order of integration exhibited in our data is one.

[13] In fact, assuming the French rate was stationary, we would find a cointegrating vector consisting just of the French interest rate in this situation, since the French interest rate is a stationary linear combination with itself, and this would provide a balanced VAR equation.

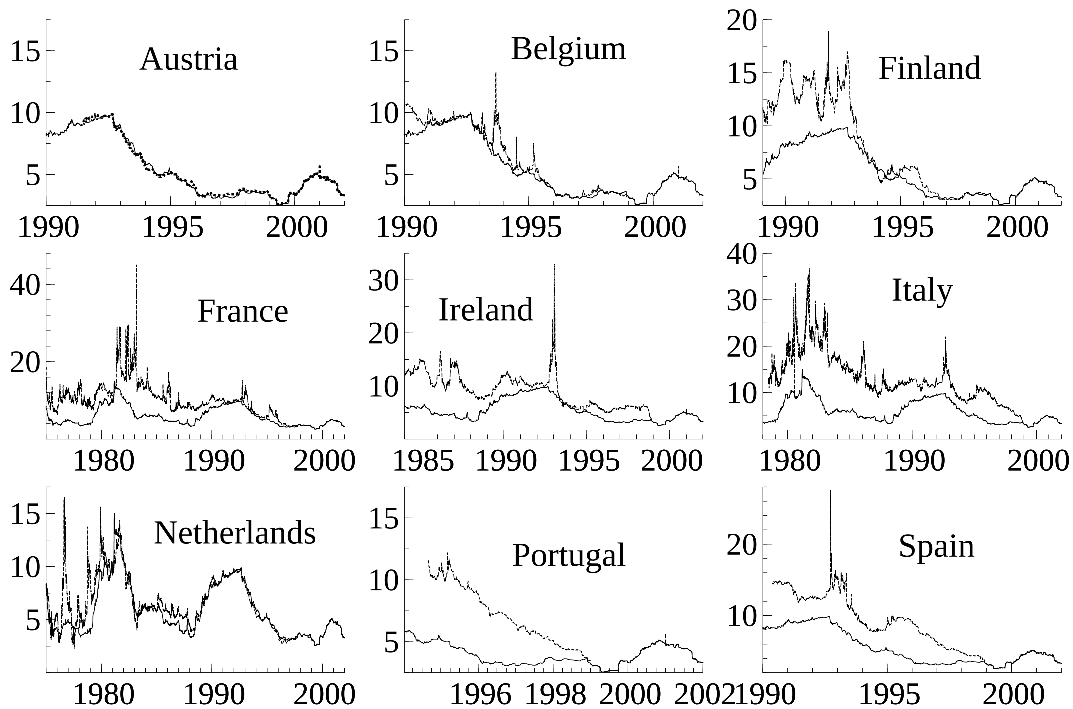

Figure 2: Time series plots of three-month interbank interest rates for nine EMU accession countries, varying sample lengths, ending at the end of 2001.

be found again in the extended model.[14] As the main objective is to analyse interest movements, simple interest rate formulations will be used. It is worth emphasising that the sectoral general-to-specific property ensures that previous research is not invalidated if additional variables are found to be significant, but instead built upon to help identify steady-state relationships in larger more complicated models.

In this paper, panel cointegration methods, such as those outlined in Binder et al. (2005) will not be used, as the authors are of the opinion that finding a good model for a given pair of European countries requires many nuances such as different lag length and deterministic terms capturing times of structural uncertainty. Additionally, in our case, it is difficult to see the gain from a panel approach as we are pursuing a vector autoregressive approach, and the complexity of carrying out panel estimation on such a system, especially as theoretical econometric work in the area is still in its infancy, leads us to remain with the non-panel vector cointegration approach, as the properties of these systems are now well known.

The likelihood-based Johansen estimation framework will be employed, and so the Normality assumption placed on the residuals in (5) must hold. Thus regressors, lag length, and the inclusion of dummy variables for outliers and possible structural breaks, should be altered in order that an econometric model passing all misspecification tests relating to the Normality of the residuals is found. If these tests are passed, then the rank test has the designed statistical size and power properties, and its outcome can be relied upon. Minor failures of these tests may allow still for accurate rank test outcomes; for example, Nielsen and Rahbek (2000) have shown that failures of heteroskedasticity and ARCH tests are less important than autocorrelation and Normality.[15] With daily data, the Normality assumption usually fails because the sheer

[14] For successful applications of this property, see Juselius and MacDonald (2000, 2004), as well as Tuxen (2007) for Eurozone inflation, and Reade and Stehn (2007) for the interactions of monetary and fiscal policies in the US.

[15] Even within this, because it is a symmetric distribution of errors that is required, failures of the Normality test due to excess kurtosis can be tolerated, but not those due to skewness. Also, with negatively correlated errors, intuitively the rank test suggests more cointegration than actually exists, as the residuals move around the mean more due to negative correlation

Country	Sample Start	Observations	Min.	Max.	Mean	St. Dev.	Lag Length	Unit Root Test Statistic
Austria	1991-07-04	2741	2.57	9.9	5.1	2.1	5	-2.082
Belgium	1989-10-19	3186	2.57	13.3	5.9	2.7	6	-1.339
Finland	1987-01-07	3912	2.57	18.9	7.5	4.1	15	-1.164
France	1975-01-07	7043	2.57	45	9.2	4.7	6	-4.668**
Ireland	1984-01-25	4682	2.57	33	8.3	3.5	4	-2.092
Italy	1978-06-14	6147	2.57	36.75	11.9	5.8	6	-1.538
Netherlands	1975-01-07	7043	2.25	16.5	6.2	2.6	17	-2.541
Portugal	1994-09-05	1914	2.57	12.2	5.8	2.4	2	-2.630
Spain	1990-05-22	3033	2.59	27.5	7.9	3.9	4	-1.492
Germany	1970-04-01	8280	2.54	15.75	6.2	2.7	9	-1.882
UK	1975-01-02	6289	3.34	8.8	18.8	3.6	6	-1.573

Table 1: Details about the data series employed for each country.

number of observations around zero, allied with considerable numbers of potential "outliers", produces a distinctly fat-tailed distribution. All of our daily-data models in this paper fail the Normality assumption, but all of the residual distributions are symmetric, and hence we proceed with our analysis (see Juselius, 2007).

Another important factor in empirical modelling is that of uncovering structural breaks and different regimes; failure to do so will provide a misleading picture, as different regimes are averaged out. With interest rate data between different nations, the possibility of changes in currency regimes, and revaluations/devalualtions offer plenty of potential for structural breaks. The possibility of structural breaks can be incorporated into the cointegrated vector-autoregressive model by means of a Markov-switching model (Krolzig, 1997), which estimates $m > 1$ regimes, and calculates transition probabilities. Kim and Lee (2008) employ such a model for measuring monetary policy independence in East Asia. Alternative strategies are to insert dummy variables into the model at the point of structural breaks, or to split the sample. Hendry and Clements (2001) have shown that only shifts in equilibrium means of models affect forecasting and modelling in a significant way, and so inserting a shift dummy in the cointegrating vector can often be an effective way of incorporating structural change; the disadvantage is that the presence of such terms affect the asymptotic properties of the rank test. Splitting the sample before and after a structural break has the advantage of allowing more than just the equilibrium mean coefficient to change at a break, and retain the asymptotic properties for testing that the cointegrated vector-autoregressive model strongly benefits from. However, the structural break goes unmodelled in terms of its impact on parameters, and each regime has a reduced number of observations over which to estimate.[16] In this paper, we model from the earliest date daily data is available for each country, up until the end of 1998, when exchange rates were fixed irrevocably, ushering in a new structural regime in Europe. If we uncover evidence of structural breaks while modelling (recursive graphics, serial correlation unaffected by lag length, etc.), we suitably refine our model.[17]

The possibility of splitting the sample poses the question of how many years are required before one can 'reasonably' call any cointegrating relation found a 'long run' relationship? If over a period of time, a relationship exists to which countries adjust, while still making other short-run adjustments outside the relationship, then we argue that the sample length is less important; what is important is that a constant relationship over a number of years has been uncovered using the model. In this paper, some of our samples, such as those for Spain, Austria and Portugal, are below ten years in length; however, the use of daily data allows a large number of observations despite the small number of years. Such larger sample sizes increase the precision of estimates enabling more firm conclusions to be made on aspects such as rank order, and the nature of cointegrating vectors. Hendry and Hubrich (2006) investigate the effects of time disaggregation,

with previous observations. By the same logic, positively correlated errors will cause the rank test to suggest less cointegration than actually exists.

[16]Although this is less of a problem with daily data.

[17]It turns out only Ireland appears in need of extra deterministic terms to cope with structural instability around the ERM crisis of 1992; this is discussed in the next Section.

and find little impact in terms of mitigating breaks of higher frequency data, although higher frequency data allows a swifter response to a break than monthly or quarterly data. In our case, possibly more important is that more observations over the same period allows more precision in our estimates. In most cases this leads to little change in results (we carried out the same analysis on monthly data too), but as would be expected with statistical analysis, in one or two cases results are different: at the monthly level, no cointegration appeared apparent in Spain, but at the daily level reported here, we find cointegration. This, we argue, is the result of having smaller standard errors and hence less noise with vastly larger sample sizes.

Having determined rank, the cointegrating space β must be identified; for a given rank of r, $r-1$ restrictions must be imposed upon the system. A variety of identification strategies have been proposed, and a number of these will be used; there is little theory to guide which countries should form particular steady-state relationships, but ideally one relationship will involve the "small" country b, and any additional relationships may be more macro or global interest rate relationships. Once a system has been identified along the lines described, likelihood ratio test statistics can be calculated to check that further restrictions imposed reflect what the data supports. In the systems reported in this paper, restrictions suggested by insignificant coefficients in the α and β matrices will be imposed until either there are no possible restrictions, or one previous restriction is rejected by the likelihood-ratio test.

A vector-autoregressive system is preferable to any single-equation approach for a number of reasons. Not least, Banerjee et al. (1993) showed that the Engle and Granger (1987) single-equation estimation method for cointegrated data induces bias. Also, the adjustment of both countries to the same cointegrating vector is estimated in the same system, and the possibility of endogeneity bias is averted, because each variable in the system is modelled.[18] As such, many of the facets of monetary policy independence can be analysed without adding prior restrictions (other than that of the information set).

4 Econometric Results

Having described our econometric strategy, and our dataset, we now report our results. We present our results in two tables; Table 2 presents the final results, and displays various tests on our models, and some checks for model specification. Then Table A.1 in the Appendix presents the just-identified models, after the rank of one has been imposed; with rank one; we normalise on the domestic interest rate, hence $\beta_1 = 1$ by design. Once our system is identified, as in Table A.1, then we can begin to test the additional restrictions listed in Section 3, using Likelihood Ratio tests. In Table 2 we present just the final restricted models, based on what restrictions are deemed acceptable by the data, and so by reporting the initial identified models in Table A.1 we provide the reader with the opportunity to check whether we have distorted the reality of the models by the restrictions we impose. Table 2 shows on the top panel the final restricted regression results, with the first two columns displaying the adjustment to the cointegrating vector (α coefficients), then the latter four columns displaying the four possible coefficients in the cointegrating vector (β coefficients). The bottom panel then displays a number of tests related to our final model. Misspecification tests are not reported because we select lag-length based on absence of autocorrelation, hence this test is passed for all our models. The Normality test always fails for the reasons described in Section 3, but our residual distributions are always symmetric, which ensures we can rely on our rank test output and subsequent coefficient values.[19] The tests reported on the bottom panel are firstly the rank test, to show that the choice of rank one, while the natural choice, was also supported in the data; in all cases we reject the null hypothesis of rank zero, but cannot reject the null hypothesis of rank one.[20] Then following the rank test output, the tests of the restrictions discussed in Section 3 are reported.

In these regressions, the lag length used for unit-root testing in Table 1 is not necessarily adhered to; we require that together, both the German and domestic series in each model exhibit no autocorrelation, and this may require more or less lags than when we consider the domestic country rate in isolation. Furthermore,

[18] This is particularly important with interest rate interlinkages.

[19] The interested reader can find the misspecification test output by contacting the first author.

[20] Cointegration is weakest for Belgium and Finland, but coherent cointegrating vectors are found for both systems after imposing a rank of one, hence this system is taken.

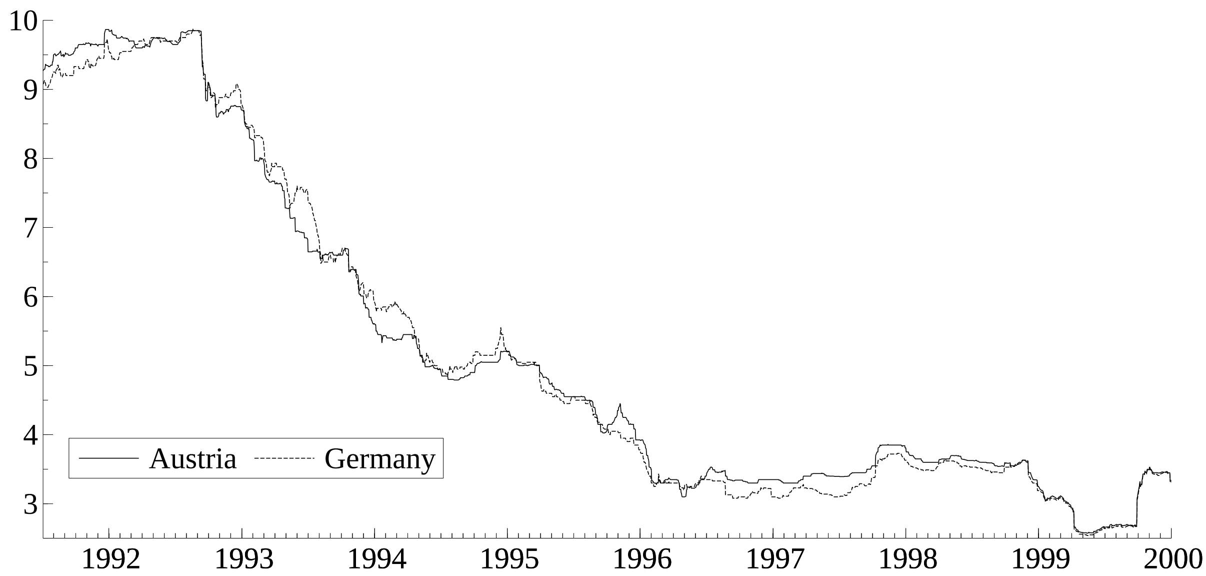

Figure 3: Plot of the German and Austrian interest rates in isolation, from July 1991 to the end of December 1998.

we report in the Table the sample-size adjusted critical value, based on the $T^{-0.8}$ rule of Campos et al. (2003), which we use in discussing the viability of particular restrictions.

A picture of German dominance in Europe emerges from these Tables; in almost all regressions, Germany either does not adjust to the cointegrating vector, or if it adjusts, it does so with a 'wrong' coefficient: i.e. if the disequilibrium is positive, and Germany's rate is too high, it raises its rate. In other words, it doesn't correct, but merely 'adjusts' in a destabilising matter, leaving the partner country to correct the disequilibrium. This is evidence for Germany dominance. There is one notable counter example though, provided by Austria. Figure 3 plots these two country rates in isolation, and shows that these two rates moved very closely together. However, the test of German dominance, that of $\mathbf{H}_0 : \alpha_{DE} = 0$ is emphatically reject, and Germany even *corrects* to this relationship, while Austria's adjustment coefficient, α_b, is significant but of the wrong sign. While it is tempting given such a patently implausible result to disregard all the other results in this paper, it is worth having a closer look at Figure 3. Such a closer look reveals that it is in the *data* that Germany appears to follow, not just in the statistical model. As interest rates fall during the mid-1990s, it is the Austrian rate that is usually below the German one, and then when rates rise slightly in the very early and also late 1990s, the Austrian rate is above the German one. These situations give the appearance that Germany is actually following Austria, although even brief knowledge of the European economic context would tell the onlooker that in fact, the opposite was really the case. As such, we emphasise that the results of the statistical model employed are not in any way invalidated by this strikingly odd result — the statistical model is simply reflecting the data, which in this case give a rather perverse rendering of economic reality.

Thus, having dealt with this anomaly, we proceed to discuss the rest of our countries. Germany adjusts to only three cointegrating vectors (those of Italy, Spain and Portugal), and even then does not correct: Germany destabilises these relationships, showing that as it set interest rates, it did not consider equilibrium in these countries as a policy issue. Furthermore, the domestic country always adjusts and corrects significantly in every equation (except Austria), with the smallest t-value being over 4 for these countries. A word on the bottom panel of the Table is in order here; the second last column gives a sample-size adjusted critical value that might be used in place of the standard 0.05 level, given our huge sample sizes (for a motivation of this, see the discussion of Campos et al. (2003) in Section 3). At this adjusted critical value levels, only in Italy, Portugal and Ireland could the null hypothesis of no German adjustment ($\mathbf{H}_0 : \beta_{DE} = 0$) have been rejected. The next column considers whether the cointegrating relationship was one-to-one, hence gives some idea of countries with more riskiness inherent; here, only Portugal is significantly different from -1. The following column gives the joint test statistic of the two hypotheses in the previous two columns, those of German dominance and a one-to-one relationship; only for the three Southern European countries (and Austria) do these two restrictions do not hold.

Finally, the risk-premium hypothesis, $\mathbf{H}_0 : \beta_0 = 0$ is rejected everywhere except Austria and Belgium, although the premium is of varying size in all those countries where it is significant. In Portugal for example, the coefficient is 107.9, while in the Netherlands just 1.89, reflecting the differences between these countries.

Over the sample period up to 1999, perhaps the most notable event was the ERM crisis in 1992, affecting many European countries, forcing Italy temporarily out of the ERM, the UK permanently, and leading to the adoption of looser exchange bands for many member states. Furthermore, currency devaluations and revaluations were commonplace over the sample period, particular in the 1980s; one hence might question whether our results average over a large number of structural breaks. However, there seems to be little sign of such breaks; in almost all cases, a very short lag length is required to eliminate autocorrelation (often a sign of undiscovered structural breaks), which is all the more reassuring when one considers that a 'rule of thumb' for lag length is 'periodicity plus one', hence suggesting a lag order of over 300. Furthermore, for the Netherlands, which requires the most lags at 17, its recursive plots settle down to roughly their final values after about 1981, and before that merely displayed some evidence of insignificance, potentially due to lack of observations prior to then.[21] Ireland required a structural break in order to ensure model stability, and this is reported in the full regression table, Table A.1, but when restricted alongside the other terms in the cointegrating vector, we find that it can be restricted to zero, suggesting that in actual fact the structural break is not that important for the interest rate relationship between Ireland and Germany. Thus we suggest that what the data is supporting is the existence of long-run relationships between the European nations pre-EMU over the *entire* sample period, relationships that included a convergence element as dictated by the time trend component, and relationships that are driven by the dominant European player of the period, Germany.

Another measure of the independence enjoyed by an economy is how long it is able to deviate from any long-run equilibrium relationships they partake in. A measure of this is the half-life of any disturbance from equilibrium; the formula for calculating the half-life of a decaying process is $\ln(2)/\lambda$, where λ is the per period percentage decrease in the disequilibrium. If we consider a unit shock from equilibrium, with all other factors held constant, then we can use the α_b coefficient values in Table 2 to calculate the half-life for each European nation; the final column of Table 2 contain these half lives. As can be seen, the longest departure from the steady state relationship is found in Finland, whose deviation half life is 77 days. Following this, the Netherlands has a half life of 69 days, while France displays the shortest deviation time, with a half life of just 36.5 days. This provides a different metric to gauge some idea of the persistence of deviations from equilibrium in the ERM. Our half life values are considerably smaller than those reported in Edison and MacDonald; this we believe is a consequence of the time trend in our steady state relationships capturing convergence, which is bound to affect any cointegrating relationships uncovered in the data.[22] Finally, in no case (apart from Austria) is it sensible to calculate a half life for Germany, because it does not act to decrease any disequilibrium.

Unmentioned so far is another check on our model's plausibility: the UK. The UK belatedly joined the ERM, the precursor to EMU which all the modelled nations took part in, in October 1990. In September 1992 it was forced out of the ERM as its currency peg became undefendable given the economic circumstances, yet the UK has always viewed itself as something of an outsider of European economic initiatives. Figure 4 gives an indication of this; the two series, while displaying at a very broad level some similarities, contain many

[21] It might be suggested that the parameter instability prior to 1981 argues against the structural stability of the model; however, it is not entirely unreasonable that on six years of (noisy 1970s) data or less, the long-run relationship between the Netherlands and Germany is unrecoverable; simply, more observations are required.

[22] We also suspect the presence of the US in cointegrating vectors in Edison and MacDonald contributes to the documented differences.

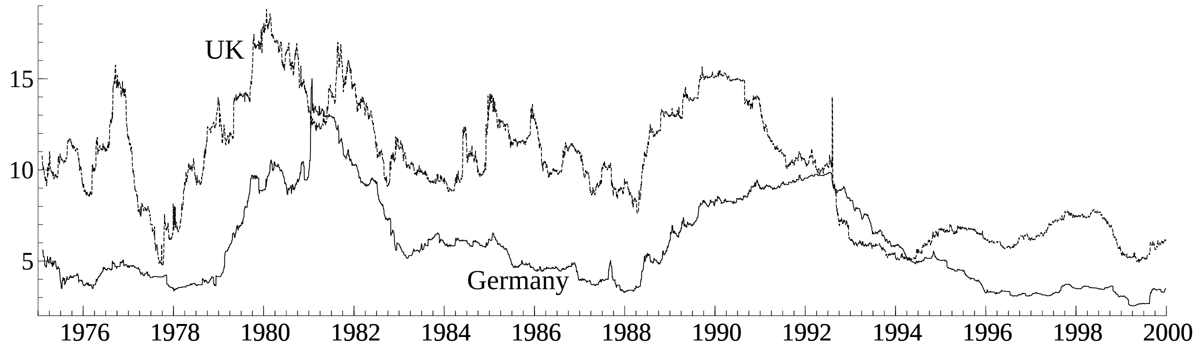

Figure 4: Plot of the German and UK interest rates in isolation, from 1975 to the end of 1998.

important differences. The UK's interest rate appears much more volatile, and displays many spikes during the 1970s and 1980s, while the German rate is much more acquiescent. In particular, the late 1980s and early 1990s display remarkably different characteristics; the UK's attempts to contain its late 1980s 'Lawson' boom at clear as interest rates reach 15%, while the subsequent fall into recession around 1990 is shown as interest rates fall to 10%; this happened however at exactly the same time that German interest rates rose because of the Bundesbank's quest to counter the inflationary pressure that resulted from huge public spending associated with reunification. The spike in the UK rate to 15% in 1992 marks its response to its exchange rate crisis, an attempt to defend the currency's value. However the UK was still in recession, and the cost of such high interest rates was deemed untenable, and the UK departed from the ERM on September 16, 1992. A reason the UK was unable to stay within the ERM was its inability to commit to a steady state relationship involving Germany which, as our results show, all the other countries in the European system were able to. Thus we investigate the possibility of a cointegrating vector involving Germany and the UK, and this is done in the final row of Table 2; the rank test reveals that there was indeed no cointegration, no steady state relationship, between Germany and the UK over the period 1975 to 1999; we cannot reject the null hypothesis of rank zero. Even considering only the period in which the UK was more (officially) committed to European monetary integration, up until 1992, there is no cointegration, confirming that the UK entered into no steady state, long run, relationship with Germany during the pre-EMU period, and this helps explain its departure from the ERM in 1992. This also acts as another confirmation of our modelling strategy; our model has the power to discriminate between those countries for which relationships did exist with Germany, and those for which such relationships did not exist.

Country	α_b	α_{DE}	β_0	β_b	β_{DE}	β_t	Half life
Austria	-0.005 (0.002)	-0.012 (0.002)		-1	1	0.00003 (0.000007)	n/a
Belgium	0.016 (0.004)			-1	1	-0.0004 (0.0002)	43.3
Finland	0.009 (0.002)		17.3 (1.96)	-1	1	-0.002 (0.0003)	77.0
France	0.019 (0.002)		9.25 (0.88)	-1	1	-0.0012 (0.0002)	36.5
Ireland	0.013 (0.003)		13.05 (2.46)	-1	1	-0.002 (0.0004)	53.3
Italy	0.017 (0.0025)	0.001 (0.0003)	17.66 (1.18)	-1	1	-0.002 (0.0002)	40.8
Netherlands	0.010 (0.002)		1.89 (0.59)	-1	1	-0.0003 (0.0001)	69.3
Portugal	0.013 (0026)	0.003 (0.0007)	107.9 (19.5)	-2.28 (0.35)	1	-0.014 (0.002)	53.3
Spain	0.016 (0.004)	0.001 (0.0003)	14.0 (3.02)	-1	1	-0.002 (0.0005)	43.3

	Rank		Tests of Hypotheses							
Country	$r = 0$	$r = 1$	All res.	$\mathsf{LR}\,(\alpha_{DE} = 0)$	$\mathsf{LR}\,(\beta_b = -1)$	Joint test	$\mathsf{LR}\,(\beta_0 = 0)$	T	$T^{-0.8}$	Sig. t
Austria	36.3 ([0.001]**)	8.4 ([0.23])	0.54 ([0.76])	19.5 ([0.00]**)	0.31 ([0.58])	19.6 ([0.0001]**)	0.12 ([0.73])	2741	0.0018	3.13
Belgium	28.82 ([0.02]*)	8.6574 ([0.208])	5.39 ([0.07])	1.78 ([0.18])	5.24 ([0.02]*)	5.39 ([0.07])	7.39 ([0.07]*)	3186	0.0016	3.16
Finland	30.6 ([0.01]*)	5.43 ([0.54])	6.90 ([0.03])	6.85 ([0.01]*)	1.45 ([0.23])	6.90 ([0.03])	8.73 ([0.003]**)	3912	0.0013	3.21
France	79.9 ([0.00]**)	2.85 ([0.88])	8.28 ([0.02]*)	8.26 ([0.004]**)	0.17 ([0.68])	8.28 ([0.02]*)	33.1 ([0.00]**)	7043	0.0008	3.35
Ireland	36.5 ([0.001]**)	10.6 ([0.10])	8.17 ([0.04]*)	5.22 ([0.02]*)	5.73 ([0.02]*)	6.63 ([0.04]*)	9.38 ([0.002]**)	4682	0.0012	3.25
Italy	61.5 ([0.00]**)	6.31 ([0.43])	2.03 ([0.15])	18.4 ([0.00]**)	2.03 ([0.15])	18.4 ([0.0001]**)	40.3 ([0.00]**)	6147	0.0009	3.32
Netherlands	40.9 ([0.00]**)	2.38 ([0.93])	9.06 ([0.01]*)	4.60 ([0.03]*)	2.92 ([0.09])	9.06 ([0.01]*)	10.7 ([0.001]**)	7043	0.0008	3.35
Portugal	43.51 ([0.00]**)	2.52 ([0.91])	n/a	23.4 ([0.00]**)	11.7 ([0.0006]**)	25.4 ([0.00]**)	25.7 ([0.00]**)	1914	0.0024	3.04
Spain	39.7 ([0.00]**)	3.63 ([0.79])	7.03 ([0.01]*)	19.0 ([0.00]**)	7.03 ([0.01]*)	20.1 ([0.0002]**)	12.9 ([0.003]**)	3033	0.0016	3.15
UK	19.0 ([0.29])	4.17 ([0.72])						6289	0.0009	3.32

Table 2: Econometric results for all 1999 accession European countries plus the UK. Final restricted regression reported on top panel, rank test and tests of restrictions listed in Section 3 on page 7, and sample-size related information given in bottom panel. See Table A.1 for originally estimated systems before restrictions imposed.

We should deal with some possible counter arguments. As mentioned in Section 1, these economies may be responding to common shocks, possibly even induced by a third party. However, our modelling methodology enables us to detect the direction of dependence, and we are able to detect the direction of interest rate movements in Europe, and hence identify whether or not Germany was leading these relationships. A lack of independence within Europe is sufficient to argue our point relating to Germany's dominance in policymaking, and the subsequent gains and losses from monetary union, regardless of the nature of those shocks.

It is very likely that each country in our sample was affected by idiosyncratic shocks during the sample period, but if cointegration exists between each country interest rate and the German rate, then these shocks must have been of secondary importance to the country, and whatever form their dependence on Germany took, it dictated that they must adjust to what was happening in Germany.

A corollary of our approach is that if we find countries that do not adjust, such as the UK, then at least three conclusions are possible: the country is impacted by idiosyncratic shocks that distinguish it from Germany; these shocks are of a magnitude that dictates that interest rates react to them; and it also has the independence to react to these shocks in the appropriate manner. It seems clear however that aside from the UK, the countries considered do not fall into this latter bracket.

We conclude this Section again by emphasising the dominance of Germany uncovered in these regressions; in no case (bar the anomalous and discussed Austrian case) did Germany correct to the cointegrating vector found linking it to the domestic country in question. In all cases, Germany called the shots, and was, indeed, the leader of the pack. These results, we argue, have important policy implications for monetary unions. The loss of monetary policy independence is often claimed to be the main cost of monetary unification, yet our findings suggest that a reappraisal of the costs and benefits of monetary integration is appropriate. Countries can only lose policy tools they can effectively make use of, and in Europe the countries that joined EMU – with the exception of Germany – apparently did not have much to lose, at least not in terms of monetary independence. Instead of following the Bundesbank's monetary diktat, they actually gained monetary policy influence by getting a seat at the ECB's decision-making tables.

5 Conclusions

In this paper we have sought to investigate the hypothesis that Germany was the dominant monetary policymaker in Europe, pre-EMU, and hence had the most independence to lose by adopting the euro in 1999. By using cointegration methods on daily data pre-1999, we find that indeed, Germany was the dominant European country, and that the other EMS central banks were, except for the Bank of England, adjusting to the Bundesbank's policy moves. In other words, we find that EMS countries other than Germany had in fact already abandoned monetary autonomy long before entering EMU, and that Germany has been the only country that actually lost sovereignty through EMU.

Our results have important policy implications. Given that the loss of monetary policy independence is generally viewed as the main cost of monetary unification, our findings suggest a reconsideration of the costs and benefits of monetary integration. A country can only lose what it has, and in Europe the countries that joined EMU – spare Germany – apparently did not have much to lose, at least not in terms of monetary independence. Instead, they actually gained monetary policy influence by getting a seat in the ECB's governing council which is responsible for setting interest policy in the euro area. This is not to say that they lost nothing. They lost monetary sovereignty as well as their national coins and notes which might have had a high symbolical value. They also forewent the opportunity to use the exchange rate for adjustments in case of adverse, country-specific shocks. But these losses appear to us much smaller than the gains that the common currency has brought in terms of monetary stability and usage of an international key currency.

Country	α_b	α_{DE}	β_0	β_b	β_{DE}	β_t	$\beta_{IE,1992}$
Austria	−0.006	−0.012	−0.60	−0.97	1	0.0001	
	(0.002)	(0.002)	(1.62)	(0.05)		(0.0002)	
Belgium	0.012	0.0010	20.7	−1.57	1	−0.003	
	(0.003)	(0.0006)	(7.18)	(0.23)		(0.0009)	
Finland	0.010	−0.0017	11.83	−0.87	1	−0.002	
	(0.0025)	(0.0006)	(2.93)	(0.09)		(0.0004)	
France	0.0007	0.018	10.21	−1.06	1	−0.001	
	(0.0002)	(0.002)	(1.76)	(0.09)		(0.0002)	
Ireland	0.003	0.0002	61.2	−4.30	1	−0.0042	−15.4
	(0.0008)	(0.00007)	(17.3)	(0.85)		(0.0026)	(6.79)
Italy	0.013	0.0010	25.6	−1.29	1	−0.003	
	(0.002)	(0.0002)	(3.83)	(0.14)		(0.0005)	
Netherlands	0.009	−0.001	3.29	−1.16	1	−0.0004	
	(0.002)	(0.0005)	(0.98)	(0.09)		(0.0001)	
Portugal	0.013	0.003	107.9	−2.28	1	−0.014	
	(0026)	(0.0007)	(19.5)	(0.35)		(0.002)	
Spain	0.004	0.0004	154.52	−4.32	1	−0.019	
	(0.001)	(0.0001)	(35.4)	(0.81)		(0.004)	

Table A.1: Regressions for all 1999 accession European countries. Full unrestricted regression reported here. See Table 2 for final estimated models.

A Appendix

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