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Dominant interest and inflation differentials within the EMS*

Kees G. Koedijk and Clemens J.M. Kool

Rijksuniversiteit Limburg, Maastricht, Netherlands

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This paper investigates nominal interest and inflation behavior in the EMS between March 1979 and September 1989 using a modified version of principal components analysis. Neither over the whole period, nor after March 1983 has the EMS functioned as a Dmark-zone: deviating movements in inflation and interest rates between EMS countries still persist. Most important is the division between Germany, the Netherlands and the United Kingdom on the one hand, and Belgium, France and Italy on the other. Differences in deflationary policies between countries inside and outside the EMS appear to be the most important determinant of this result.

1. Introduction

In recent years it has become well established that the European Monetary System (EMS) has been successful in limiting exchange rate volatility. There is little consensus, though, on how the system has functioned in practice. In this study we assess the timing and speed of monetary convergence between EMS countries over the period from March 1979 to September 1989 by studying nominal interest and inflation behavior. Our approach differs from most of the existing literature in two respects. First, we focus on bilateral interest and inflation rate differentials between each pair of countries, as opposed to most other work in which Germany functions as the sole benchmark country.[1] Second, instead of the generally used VAR-regressions we apply a modified verison of the principal components analysis.

Correspondence to: J.M. Kool, Department of Economics, Rijksuniversiteit Limburg, P.O. Box 616, 6200 MD Maastricht, The Netherlands.

*While writing this paper, both authors were assistant professors of monetary economics at Erasmus University Rotterdam. Since then, Kees Koedijk has become an associate professor of international finance, while Clemens Kool has become an associate professor of monetary and international economics, both at the Rijksuniversiteit Limburg, Maastricht. We are grateful to Eduard Bomhoff, Paul De Grauwe, Casper de Vries and Peter Schotman for stimulating discussions and helpful comments on previous versions of this paper and to two anonymous referees and the associate editor of this journal for valuable suggestions. All remaining errors are of course our own.

[1]De Grauwe (1989), Artis and Taylor (1988), Fratianni and von Hagen (1990a, b), von Hagen and Fratianni (1990) and Cohen and Wyplosz (1989) are examples of studies in which symmetric interest differentials are used too.

The first important issue we address is whether the EMS is a de facto Dmark-zone, that is, whether Germany unilaterally decides on its monetary policy with the other EMS countries passively following Germany's lead. If so, inflation rates should converge, and so would interest rates under the assumption of integrated financial markets. Alternatively, countries unable or unwilling to follow such accommodating policies may infrequently change their exchange rate and impose capital controls to gain limited independence, resulting in considerable movements in interest rate differentials and exchange rates.

The existing empirical evidence is ambiguous on this point. Giavazzi and Giovannini (1988), for example, argue that the EMS is a Dmark-zone, whereas De Grauwe (1989), Fratianni and von Hagen (1990a) and von Hagen and Fratianni (1990) conclude that there may be some room left for independent monetary policies within the EMS.

In this respect, there may be a considerable difference in the functioning of the EMS before and after 1983. While five realignments were necessary in the two-year period from March 1981 to March 1983, only four realignments occurred in the subsequent six years. A policy turn-around giving more priority to the requirements of EMS membership took place in individual countries at different times in the early eighties.[2] We, therefore, compare the full sample evidence with the results over the period from March 1983 to September 1989 to provide an assessment of the increased degree of convergence within the EMS.

Second, we analyze the existence and importance of implicit restrictions imposed by EMS membership with respect to the deflationary paths followed in various countries in the early eighties. For this purpose we explicitly compare inflation and interest rate behavior in high inflation countries within the EMS, such as Italy and France, with inflation and interest rate movements in the United Kingdom, which supposedly should have had more freedom in determining its own monetary policy.

In our empirical work we investigate whether dominant movements in nominal interest and inflation differentials may be attributed to specific countries or groups of countries using a principal components technique.[3] We focus on interest and inflation differentials as opposed to levels because it is differentials that are of central importance in assessing the degree and speed of convergence of monetary policies within the EMS.

The major advantage of the chosen principal components technique is that it allows a simultaneous analysis of all bilateral interest and inflation differentials within the EMS as a system. The technique effectively extracts linear combinations from a multivariate time series in order of persistence

[2]See Sachs and Wyplosz (1986) for the case of France, Dornbusch (1989) for Ireland, and Giavazzi and Spaventa (1989) for Italy. See also Giavazzi and Giovannini (1988).

[3]See Koedijk and Schotman (1989) for an application of this technique to exchange rates.

and so enables us to find the dominant movements in inflation and interest differentials within the EMS. Moreover, given our preference for the use of bilateral differentials, principal components has the advantage that it requires no a priori specification of a benchmark country, as would be necessary in a VAR-analysis. The use of differentials does require a modification of the principal components technique,[4] however, to make the set of extracted principal components unique and invariant to the arbitrary choice of benchmark country.

We restrict our analysis to the EMS countries Belgium (BE), France (FR), Germany (WG), Ireland (IR), Italy (IT), the Netherlands (NL), and the United Kingdom (UK) between March 1979 and September 1989. Denmark is left out of the analysis as no representative interest rate series was available to us. Spain only entered the EMS on June 19, 1989. Both its short membership and the lack of data prevented its inclusion. Although the United Kingdom only joined the exchange rate mechanism (ERM) of the EMS in October 1990, we nevertheless include this country in the analysis to be able to investigate whether its choice not to participate in the ERM before October 1990 has allowed a more independent monetary policy as reflected in diverging inflation and interest rates. In the past, significant interest rate links have been documented between the United States and Europe.[5] Here, however, our objective is to characterize and analyze intra-EMS inflation and interest rate behavior, not to study the linkages between the EMS and the rest of the world. We, therefore, exclude the United States from the analysis. Consequently, our results are conditional on developments outside of the EMS.[6]

The paper is structured as follows. In section 2 we briefly discuss the applied methodology, while we deal with the data-construction in section 3. In section 4 we apply the analysis to interest differentials and inflation differentials between the EMS countries. We discuss the results and evaluate their implications. The sensitivity of the results for choice of sample period is investigated by comparing the results for the full sample period with the

[4]In the co-integration literature Stock and Watson (1988) demonstrate how principal component analysis is connected to tests for the number of unit roots in a multivariate time series and the estimation of co-integrating vectors. Thee links enable a further interpretation of the principal components analysis and of tests of long-run parity conditions. Unfortunately, unit root tests have notorious low power in small samples. Since the theoretical discussion on testing for long-run equilibrium relations has not been settled yet, we consider the application of multivariate unit root tests to be outside the scope of the present paper.

[5]See, for example, Cumby and Mishkin (1986).

[6]In theory, unwarranted omission of important variables like U.S. inflation and interest rates may lead to a spurious correlations between the remaining EMS countries. In a related working paper [Koedijk and Kool (1990)], however, similar evidence is provided for real short-term and long-term interest differentials including the United States. The major conclusion is that within the EMS the same relations are found as reported in this paper, even though U.S. interest behavior on its own accounts for the largest principal component.

results for the sample period March 1983 to September 1989. Section 5 contains our conclusions.

2. The methodology

In the analysis of inflation and interest rate differentials using standard principal components analysis the arbitrary choice of benchmark currency affects the component structure. The correlation matrix of interest differentials vis-à-vis Germany produces a different set of principal components than a similar correlation matrix calculated vis-à-vis France or Italy, although the information content is identical.

To overcome this problem we require the set of principal components to be invariant with respect to the choice of benchmark country. As we will show, the cross-country restrictions on bilateral interest rate differentials (and inflation differentials for that matter) provide useful prior information to obtain such invariance property in a natural and intuitive way.

Consider an $(n \times 1)$ multivariate time series $\{x_t\}_{t=1}^{T}$ of interest (or inflation) differentials vis-à-vis a common benchmark country. Observations on $\{x_t\}$ are stored in the $(T \times n)$ data matrix X. The $(T \times n)$ matrix Z of principal components is a transformation of the data matrix X, such that

(i) $Z = XQB$, with Q positive definite symmetric and B non-singular,
(ii) $Z'Z = \Lambda$, with Λ a diagonal matrix with elements $\lambda_1 \geqq \lambda_2 \geqq \cdots \geqq \lambda_n \geqq 0$,
(iii) $B'QB = I$, a normalization.

Condition (i) expresses the linearity of the transformation $X \rightarrow Z$. Q is a $(n \times n)$ scaling matrix and B is a $(n \times n)$ matrix containing the so-called factor loadings. The second condition requires the components to be orthogonal. Λ is a $(n \times n)$ diagonal matrix. The elements of Λ are the variances of the principal components in descending order of magnitude. The first principal components (the first column of Z) has the largest variance. Condition (iii) is a normalization to set the scale of Z. The transformation from X to Z is unique once Q has been specified, i.e. there exists only one matrix B satisfying conditions (i), (ii) and (iii),[7] see Leamer (1978, Appendix A, Theorem 35). B, Z and Λ may be computed by solving the eigenvalue problem

$$(Q^{1/2}X'XQ^{1/2})(Q^{1/2}B) = (Q^{1/2}B)\Lambda, \tag{1}$$

where $Q^{1/2}Q^{1/2} = Q$. Equation (1) shows how the components depend on the choice of the scaling matrix $Q^{1/2}$. Q is not determined in the principal components analysis, but must be specified a priori by the user.

In many principal components application, scale dependence problems

[7] B is unique apart from sign, if all elements of Λ are different, which we henceforth assume.

exist. If one of the variables has a much larger variance than the others, it will generally dominate the first principal component. For this reason, principal components are most often constructed from normalized variables, dividing all observations by their sample standard deviation. This implies that the diagonal elements of Q are chosen equal to $q_{ii}=1/s_{ii}$, where s_{ii} is the sample variance of $\{x_{it}\}$.

The issue of scale dependence plays no role in our analysis, however as all variables have the same dimension. Instead, Q is chosen such as to make the components Z invariant to a change in the benchmark country.

To find a suitable matrix Q we first look at the effect of a change in the benchmark country. Let x_{kj} be the nominal interest differential of country j against the benchmark country k. Letting country i be the benchmark instead of country k amounts to the linear transformation:

$$x_{ij}=x_{kj}-x_{ki}, \text{ for } j\neq k, \qquad x_{ik}=-x_{ki}. \tag{2}$$

The transformation can be written in matrix notation as

$$x^1=Px^0, \tag{3}$$

where P is the $(n\times n)$ matrix:

$$P=\begin{pmatrix}-1 & 0' \\ -\iota_{n-i} & I_{n-1}\end{pmatrix}, \tag{4}$$

in which ι is a unity vector[8] (here of length $n-1$), I is the identity matrix, x^0 is a $(n\times 1)$ vector of interest differentials relative to the original benchmark country, and x^1 is the vector of interest differentials relative to the new benchmark country (in this case country 1). For notational convenience we have rearranged the order of interest rate differentials such that currency 1 became the new benchmark. Transformation to another benchmark country, say country k, entails a permutation of the rows and columns of P. An important property of P is that it is unipotent, meaning that $P^2=I$. Applying the same transformation twice yields the original interest differentials.

Let X_i and X_k be the $(T\times n)$ matrices of observations on interest rate differentials with respect to countries i and k. respectively. A change of the benchmark implies that the data matrix X_i is postmultiplied by P' (after the

[8]For notational convenience the subscripts on ι and I will be suppressed when there can be no confusion about their appropriate dimensions.

necessary permutation of columns and rows in P', or of the columns in X_i and X_k). The principal components (Z) are invariant to this change of benchmark if

$$X_i Q B_i = Z = X_k Q B_k. \tag{5}$$

Using the data transformation matrix P in (4) and the fact that P is unipotent, we can write:

$$X_i Q B_i = X_k (P'QP) P B_i. \tag{6}$$

Comparison of (5) and (6) shows that the principal components are invariant to the change in the benchmark if we can construct Q such that $Q = P'QP$, and if the factor loadings are related by $B_k = PB_i$. Moreover, these conditions must hold for all possible benchmark countries, i.e. all permutations of the transformation matrix P. Partitioning Q^{-1} and expanding the condition $Q = P'QP$ yields:

$$Q^{-1} = \begin{pmatrix} q^{11} & q^{12} \\ q^{21} & Q^{22} \end{pmatrix} = \begin{pmatrix} -1 & 0' \\ -\iota & I \end{pmatrix} \begin{pmatrix} q^{11} & q^{12} \\ q^{21} & Q^{22} \end{pmatrix} \begin{pmatrix} -1 & -\iota' \\ 0 & I \end{pmatrix}$$

$$= \begin{pmatrix} q^{11} & q^{11}\iota' - q^{12} \\ q^{11}\iota - q^{21} & q^{11}\iota\iota' - q^{21}\iota' - \iota q^{12} + Q^{22} \end{pmatrix}, \tag{7}$$

where q^{11} is a scalar, q^{12} and q^{21} are $(n-1)$ vectors and Q^{22} is a $((n-1) \times (n-1))$ matrix. From eq. (7) we obtain the restrictions

$$q^{21} = \frac{q^{11}}{2} \iota \tag{8a}$$

and

$$q^{12} = \frac{q^{11}}{2} \iota'. \tag{8b}$$

All non-diagonal elements in the first row and column of Q^{-1} must be the same and equal to half the first diagonal element. Since this must also hold if columns and rows 1 and j ($j = 2, \ldots, n$) are interchanged, the restrictions in (8) must hold for all columns and rows. Hence the matrix Q^{-1} has the structure

$$Q^{-1} = \theta(I_n + \iota_n \iota_n'), \tag{9}$$

where θ is an arbitrary scalar.[9] Using the matrix inversion lemma leads to the following result

$$Q=\frac{1}{\theta}\left(I-\frac{1}{n+1}\iota\iota'\right)=[\theta^{-1/2}(I-\alpha\iota\iota')]^2=(Q^{1/2})^2. \tag{10}$$

with[10] $\alpha=(1-(n-1)^{-1/2})/n$. It remains to be verified that $B_k=PB_i$ relates the new factor loadings to the old factor loadings. To prove this we need condition (ii) in the definition of the principal components. The factor loadings are uniquely determined by the requirement that the principal components are orthogonal with decreasing variances that appear on the diagonal of the Λ:

$$\begin{aligned}\Lambda_i&=B_i'QX_i'X_iQB_i=(B_i'P')(P'QP)(PX_i'X_iP')(P'QP)(PB_i),\\&=(B_i'P'Q^{1/2})(Q^{1/2}X_k'X_kQ^{1/2})(Q^{1/2}PB_i)\end{aligned} \tag{11}$$

But B_k and Λ_k are also uniquely determined in

$$\Lambda_k=B_k'QX_k'X_kQB_k=(B_k'Q^{1/2})(Q^{1/2}X_k'X_kQ^{1/2})(Q^{1/2}B_k). \tag{12}$$

Conditions (11) and (12) define the same eigenvalue problem, since $(Q^{1/2}PB_i)$ and $Q^{1/2}B_k$ are both required to be orthogonal matrices in condition (iii) of the definition of the principal components. Therefore $B_k=PB_i$, and $\Lambda_k=\Lambda_i$. This completes the proof that the proposed choice of Q results in a unique set of principal components, unconditional on the benchmark chosen.

If all n components are extracted from the original series the transformation is non-singular and no information in the data is lost. The amount of variation in the data explained by the first K principal components is expressed by the goodness-of-fit statistic [see Anderson (1984)]:

$$\begin{aligned}R_2(K)&=\frac{\text{total variance of first } K \text{ components}}{\text{total variance of transformed data}}\\&=\frac{\operatorname{tr}(Z(K)'Z(K))}{\operatorname{tr}(Q^{1/2}X'XQ^{1/2})}=\frac{\sum_{i=1}^{K}\lambda_i}{\sum_{i=1}^{n}\lambda_i},\end{aligned} \tag{13}$$

[9]In a maximum likelihood derivation of the principal components, θ has the interpretation of a variance. The choice of θ does not affect the factor loadings; it only serves as a scalar scaling parameter for all time series of principal components.

[10]The alternative solution is $\alpha=(1+(n+1)^{-1/2})/n$. Which of the two solutions for α is chosen is irrelevant, since the principal components depend on Q, not $Q^{1/2}$.

where $\lambda_1 > \lambda_2 > \cdots > \lambda_n$ are the eigenvalues of $(Q^{1/2}X'XQ^{1/2})$, and $Z(K)$ is the $(T \times K)$ matrix of the first K principal components of the transformed data $XQ^{1/2}$.

For the interpretation of the components our interest is in the correlation between component i and a time series of interest rate or inflation differentials x_{ij}. Since the principal components are orthogonal, the total amount of variation in x_{ij} explained by the first K components is the sum of the squared correlations:

$$R_{ij}^2(K) = \sum_{l=1}^{K} r_{ij}^2(l), \tag{14}$$

where $r_{ij}^2(l)$ is the squared correlation between x_{ij} and component l.

The principal components analysis is largely descriptive and only allows for identification of groups of countries with similar interest and inflation rate patterns. Formal testing is as yet infeasible. In our analysis, we will focus on a comparison of individual correlations $r_{ij}^2(l)$ with the overall fit measured by $\lambda_l/\sum_{i=1}^{n}\lambda_i$, therefore. We concentrate on those correlations $r_{ij}^2(l)$ exceeding the average fit $\lambda_l/\sum_{i=1}^{n}\lambda_i$, which are printed bold in the tables. If a number of interest or inflation differentials is highly – that is, above average – correlated with some principal component, we identify this component with that group.

3. Data construction

The principal components analysis is applied to Belgium (BE), France (FR), Germany (WG), Ireland (IR), Italy (IT), the Netherlands (NL) and the United Kingdom (UK). End-of-month domestic nominal interest rates (3- and 4-month representative money market rates) between March 1979 and September 1989 are obtained from several issues of World Financial Markets (Morgan Guaranty). Inflation is measured as the year over year growth of the CPI, which is taken from the IFS databank (line 64) for all countries. For Ireland only quarterly CPI data are available. We, therefore, use the interpolated CPI series for Ireland from various issues of European Economy.

4. The results

Section 4.1 below presents the principal components results for the whole sample from March 1979 to September 1989. In section 4.2 we show the results for the period since March 1983, excluding the volatile years 1979–1982. From that time onward, realignments in the EMS have been scarce, deflationary policies have generally led to lower inflation rates and proposals for world-wide policy coordination have increased. In section 4.3 we discuss whether a shift has taken place in dominant interest and inflation movements and to what extent convergence within the EMS has occurred. The issues raised in the introduction of the EMS being a de facto Dmark-zone, the possible constraints on deflationary policies as imposed by EMS membership and the position of the United Kingdom on the threshold of the EMS are covered in greater detail here.

4.1. March 1979 to September 1989

The results of the principal components analysis for nominal interest rate[11] and inflation differentials respectively are summarized in table 1. The upper part of the table gives some overall statistics for both interest and inflation differentials: the variance of the individual principal components and their respective goodness-of-fit. It only takes two principal components to explain 80% and 90% respectively of the total variance of interest and inflation differentials within the EMS.[12]

The interpretation of the principal components relies on the correlations between the interest or inflation differentials and the corresponding first two principal components. Parts A to G in table 1 report the squared correlations between each of the first two components and the corresponding underlying differentials versus each of the benchmark countries in turn. The upper right triangle of the table contains the results for the interest differentials, while the correlations in the lower left triangle are for the inflation differentials. Individual correlations exceeding the average fit of the principal component under consideration are printed in bold characters and are the main focus of discussion.

The difference in interest rate behavior between the United Kingdom – and to a somewhat lesser extent the Netherlands and Germany – on the one hand and Belgium, France and Italy on the other appears the most important single factor. This is exemplified in the first row of the column headed UK in table 1 and the column headed WG in part F: The correlations between the first principal component and the bilateral interest rate differentials vis-à-vis the United Kingdom are very high for Belgium, France and Italy and low for the other countries. This first principal

[11]We did the same analysis using 3-month Eurorates. After 1983, results closely resemble those of domestic interest rates. For the whole sample, French and Italian interest rate behaviour dominates the principal components analysis due to speculative attacks in times of expected realignments. As this is not the issue we are interested in, we only present the results for the domestic interest rates.

[12]To examine the sensitivity of the results for the observed realignments in the full sample period, principal components have also been computed excluding all months in which a realignment occurred and the months immediately preceding and following the realignments. The results were only marginally different from the ones that are presented in table 1.

Table 1

Principal components of interest differentials (upper right triangle) and inflation differentials (lower left triangle) in the EMS: March 1979–September 1989.

	Interest differentials				Inflation differentials		
Component	1	2	Cumulated		1	2	Cumulated
Variance	8.34	3.99			14.03	8.37	
Fit[a]	0.54	0.26	0.80		0.56	0.34	0.90
(A) Belgium is benchmark country[b]							
	BE	FR	IR	IT	NL	UK	WG
1	–	0.11	0.00	0.50	**0.68**	**0.75**	0.33
2	–	0.11	**0.78**	0.08	0.02	0.00	0.22
1+2	–	0.22	0.78	0.58	0.70	0.75	0.55
(B) France is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	**0.64**	–	0.04	0.32	**0.81**	**0.81**	**0.59**
2	0.24	–	**0.87**	0.00	0.01	0.02	0.03
1+2	0.88	–	0.91	0.32	0.82	0.83	0.62
(C) Ireland is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	**0.89**	**0.76**	–	0.24	0.33	0.52	0.10
2	0.04	0.01	–	**0.68**	**0.62**	**0.37**	**0.86**
1+2	0.93	0.77	–	0.92	0.95	0.89	0.96
(D) Italy is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	**0.81**	0.49	0.19	–	**0.86**	**0.96**	**0.76**
2	0.11	0.00	0.01	–	0.01	0.02	0.01
1+2	0.92	0.49	0.20	–	0.87	0.98	0.77
(E) Netherlands is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.03	**0.76**	**0.95**	**0.82**	–	0.19	0.30
2	**0.55**	0.00	0.00	0.00	–	0.02	0.19
1+2	0.58	0.76	0.95	0.82	–	0.21	0.49
(F) U.K. is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.07	0.06	0.43	0.29	0.08	–	0.40
2	**0.92**	**0.89**	**0.53**	**0.63**	**0.87**	–	0.10
1+2	0.99	0.95	0.96	0.92	0.95	–	0.50
(G) West Germany is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.04	**0.83**	**0.96**	**0.89**	0.31	0.20	–
2	**0.67**	0.01	0.01	0.00	0.03	**0.76**	–
1+2	0.71	0.84	0.97	0.89	0.34	0.96	–

[a]Percentage of total variance and inflation differentials respectively, explained by first two components, partial and cumulated.

[b]Entries in part A to G of this table show the squared correlation of component i with each of the interest differentials (upper right triangle) and inflation differentials (lower left triangle) respectively, and the cumulated fit of the first two components (1+2).

component alone explains almost 54% of the total variation in interest rate differentials. The second principal component which still accounts for 25.80% of all variation, clearly is an Irish phenomenon. This is illustrated by the high correlations of the second principal component with the nominal interest differentials relative to Ireland (see upper right triangle, part C, row 2, and column headed IR, row 2).

We now turn to the partitioning of inflation differentials into a number of orthogonal components. The first component, which accounts for 56.2% of all variation, captures the inflation differentials of France, Ireland and Italy versus Belgium, the Netherlands and Germany.[13] The identification of the second principal component which accounts for 34.5% of all variation as a United Kingdom phenomenon is suggested by the large correlations between the second principal component and all inflation differentials relative to the United Kingdom (lower left triangle, part F, row 2, and part G, column headed UK, row 2).[14]

4.2. March 1983 to September 1989

In table 2 we report the results of the principal components analysis for the sub period from March 1983 to September 1989. The layout is similar to that of table 1.

The first component in table 2 which captures 65.0% of all variation, reflects the interest differentials of the United Kingdom, the Netherlands and Germany with Belgium, France, and Italy. The second component is an Irish phenomenon again, as can be seen from the high correlations of the second principal component with the Irish differentials (see upper right triangle, part C, row 2, and column headed IR, row 2). The only maverick observation in this classification is the British–Irish differential, which is highly correlated with the first instead of the second principal component.

The inflation results in table 2 are most unambiguous: 84.9% of all variation in inflation differentials after March 1983 is taken care of by the first component, reflecting the behavior of inflation in the United Kingdom – and to a lesser extent Germany and the Netherlands – versus the other countries. The second principal component is only marginally significant and represents a mixture of effects that are hard to identify.

4.3. Discussion of the results

The above results for interest rate behavior over the whole sample –

[13]The high correlation of the Irish–French differential with the first component does not fit into this division.

[14]Additionally, this second component takes account of the difference of Germany and the Netherlands versus Belgium.

Table 2

Principal components of interest differentials (upper right triangle) and inflation differentials (lower left triangle) in the EMS: March 1979–September 1989.

	Interest differentials				Inflation differentials		
Component	1	2	Cumulated		1	2	Cumulated
Variance	7.84	2.744			8.43	0.56	
Fit[a]	0.65	0.23		0.88	0.05	0.06	0.91
(A) Belgium is benchmark country[b]							
	BE	FR	IR	IT	NL	UK	WG
1	–	0.02	0.08	0.59	**0.74**	**0.83**	**0.73**
2	–	0.13	**0.81**	0.03	0.02	0.04	0.00
1+2	–	0.15	0.89	0.62	0.76	0.87	0.73
(B) France is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.06	–	0.04	0.51	**0.75**	**0.78**	**0.81**
2	0.04	–	**0.92**	0.00	0.12	0.10	0.03
1+2	0.10	–	0.96	0.51	0.87	0.88	0.84
(C) Ireland is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.43	0.27	–	0.08	0.62	**0.79**	0.49
2	**0.21**	**0.10**	–	**0.83**	**0.35**	0.16	**0.50**
1+2	0.64	0.37	–	0.91	0.97	0.95	0.99
(D) Italy is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.61	0.39	0.05	–	**0.86**	**0.94**	**0.90**
2	**0.11**	**0.19**	**0.65**	–	0.04	0.05	0.00
1+2	0.72	0.58	0.70	–	0.90	0.99	0.90
(E) Netherlands is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	0.62	0.65	0.82	0.80	–	0.38	0.06
2	**0.16**	**0.08**	0.01	**0.19**	–	0.03	**0.32**
1+2	0.78	0.73	0.83	0.99	–	0.41	0.38
(F) U.K. is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	**0.97**	**0.95**	**0.96**	**0.97**	0.73	–	0.46
2	0.00	0.01	0.03	0.01	**0.13**	–	0.15
1+2	0.97	0.96	0.99	0.98	0.86	–	0.61
(G) West Germany is benchmark country							
	BE	FR	IR	IT	NL	UK	WG
1	**0.86**	0.84	**0.90**	**0.95**	0.24	0.74	–
2	0.00	0.01	0.05	0.02	**0.44**	0.00	–
1+2	0.86	0.85	0.95	0.97	0.68	0.74	–

[a]See table 1 for notation.

looking at the explanatory power of individual principal components – show that most of the total variance can be attributed to the difference between the United Kingdom plus the hard currencies Germany and the Netherlands on the one hand and the soft currencies – Belgium, France and Italy – on the other, and to the independent behavior of the Irish interest rate.

Additional relevant evidence is provided by the last row of each part of table 1 where the cumulative explanatory power of the first two principal components for each bilateral interest or inflation differential is shown. The first two principal components explain 80% of the total variance of the set of bilateral interest differentials. For individual interest differentials the amount of explained variation may be significantly higher or lower, giving information about the (dis)similarity of interest rate behavior across countries.

Only 22% of the French–Belgian interest rate differential in table 1, for example, is explained by the first two principal components. Thus, almost all of the variation between the interest rates in these two countries belongs to the least important 20% of variation in the whole system. This suggests a close similarity between France and Belgium. In the same way, the close links between the United Kingdom, Germany and the Netherlands may be illustrated (cumulative explanatory power for UK/NL 21%, UK/WG 50% and WG/NL 49%).

The inflation results are similar, though not identical to those for interest rate differentials. The partitioning is somewhat different. The first principal component in the interest rate analysis, for example, is very close to the second principal component in the inflation analysis. This similarity is confirmed by a highly significant correlation coefficient of 0.85 between these two principal components. Both reflect the difference between primarily the United Kingdom on the one hand and the European countries, Belgium, France and Italy, on the other.

Movements in the Dutch–German inflation differential are even less important than those in the Dutch–German interest differential: the first two principal components with a cumulative average explanatory power of about 90% only explain 34% of the variation between Dutch and German inflation rates.

The above characterization needs some modification after March 1983. First, there appears to be a shift in the partitioning of the inflation differentials: Belgium moves more to the French/Italian bloc in the second half of the sample, while the United Kingdom moves in the direction of Germany and the Netherlands. No apparent shifts take place in the interest analysis. As a consequence, the first principal components in both the interest rate and inflation analysis become very similar – exemplified by a high correlation coefficient of 0.93 – reflecting the behavior of the Netherlands, Germany and the United Kingdom versus the other countries.

Overall, we conclude that the hypothesis that the EMS should be considered as a Dmark-zone must be rejected both for the total period and for the period after 1983. While the Netherlands and Germany for all practical purposes may be treated as a monetary union, a considerable amount of independent movements in the inflation and interest rates versus Germany has been present in the other countries.[15]

A possible source of the observed independent interest and inflation movements between countries may be the differences in timing and implementation of deflationary policies within the EMS. Moreover, this may help explain the fact that the United Kingdom, which in theory should have been able to have the most independent monetary policy, in practice has experienced inflation and interest movements closer to Germany than EMS countries like France and Italy after 1983.

In this respect, it is important to note that the total variation in inflation differentials is considerably lower for the period after 1983 than for the whole period, while the total variation in nominal interest rate differentials remains about constant. Unreported results for real interest – measured as nominal interest minus inflation – differentials and money growth differentials support our hypothesis.[16] The variation in real interest differentials significantly declines after 1983, corresponding to the decline in the variation in inflation differentials, suggesting it had a primarily monetary origin.

Additional evidence on interest and inflation differentials of France, Italy and the United Kingdom versus Germany to support this hypothesis is provided in figs. 1 and 2. From these figures, it is clear that the United Kingdom was a high inflation – high interest country in the early eighties, looking more like France and Italy, than like Germany (or the Netherlands). The timing of peaks and troughs in inflation and interest rates were quite different, though, in these three high inflation countries. The United Kingdom experiences a sharp peak in 1980 and rapid decline thereafter. The peaks in France and Italy arrive later, in 1981, persist longer and only gradually decline.

In terms of dominant movements in interest and inflation differentials, the figures suggest that the major part of interest and inflation movements of the United Kingdom versus Germany occurred before March 1983. From that time onward, these differentials fluctuated around more or less stationary means of 6% and 4%, respectively, signalling persistent but approximately constant differences in interest and inflation levels between the United Kingdom and Germany.

[15]These findings are also consistent with Germany acting as a Stackelberg-leader, taking into account policy actions of other EMS countries, specifically France, Belgium and the Netherlands. As the principal components analysis lacks a temporal dimension, however, determination of the direction of causality and discrimination between alternative hypotheses is infeasible.

[16]The principal components results for real interest and money growth differentials may be obtained from the authors on request.

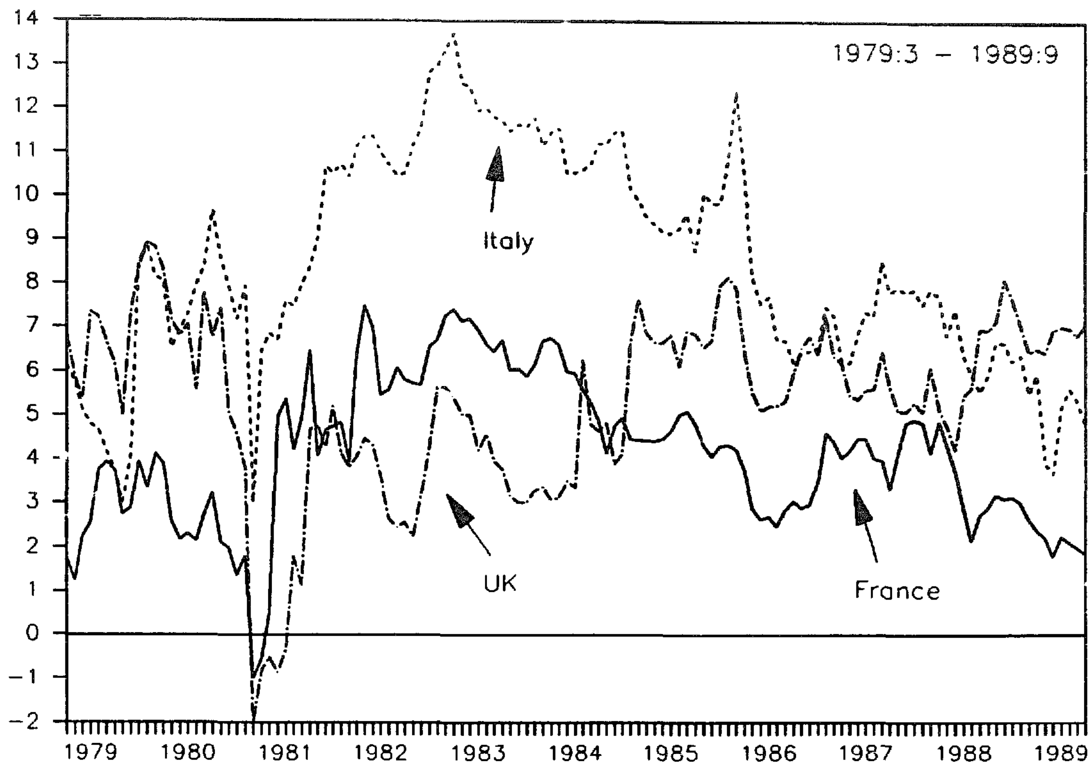

Fig. 1. Interest rate differential relative to Germany.

For Italy and France a different picture emerges. Starting with high interest and inflation relative to Germany in the early eighties, the decline in interest and inflation differentials strongly continues after 1983. For both countries and both variables a pronounced negative trend is visible in figs. 1 and 2, which is picked up by the principal components analysis.

This exemplifies the difference between a floating and a fixed exchange rate regime and supports De Grauwe's (1990) claim that membership of a fixed exchange rate arrangement limits the speeds of deflationary policies: the United Kingdom managed a rapid deflation after 1980 due to its floating exchange rate at the cost of a large economic down-turn, while it took France and Italy until 1986 to bring their inflation down to similar levels. On the other hand, the United Kingdom facing no long-run exchange rate constraint was either unable or unwilling to reduce the remaining inflation and interest differential with Germany after 1983. By 1989, the gradual approach followed by France and Italy – forced by the long-run exchange rate constraint – has resulted in inflation and interest rates closer to German levels than is the case for the United Kingdom.

Stated alternatively, countries within a fixed exchange rate system may borrow anti-inflation credibility from the leading country, as argued in Giavazzi and Spaventa (1989). Thus, the long-run political credibility of the

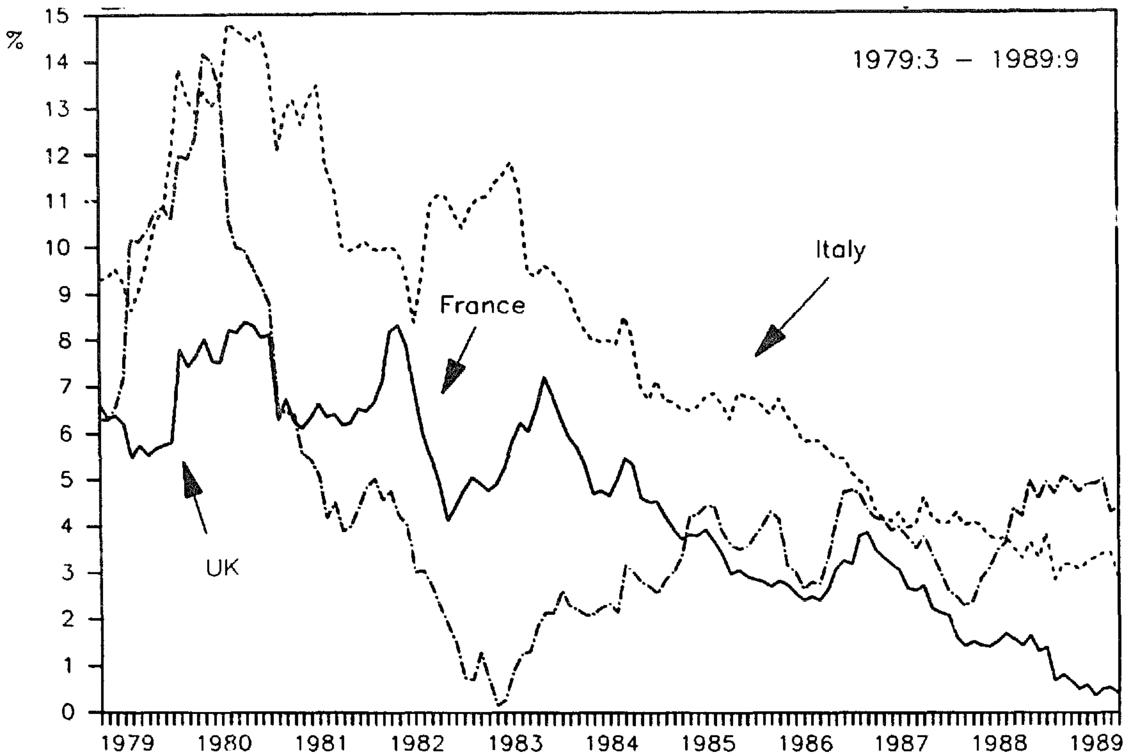

Fig. 2. Inflation differential relative to Germany.

fixed exchange rate regime of the EMS may have facilitated the slow convergence observed in France and Italy. This way, these countries have been able to avoid (part of) the costs of a large recession. Since October 1990, the United Kingdom also has effectively opted for using the exchange rate constraint to borrow credibility and to gradually reduce inflation and interest rates to German levels and has entered the exchange rate mechanism (ERM) of the EMS.

Recently, the issue has risen how the final transition to EMU should take place. While the Delors-report argues in favor of gradual total convergence to a situation of permenently fixed exchange rates, Giovannini (1991) and Dornbusch (1991) favor a discontinuous jump in the near future, particularly for those currencies which do not exhibit trend depreciation versus the German mark any more.

Several arguments are presented for this latter position: first, the smaller the inflation differential with Germany, the harder to reduce it further. In countries like Italy, for example, inflation has converged considerably more than interest rates, leading to exceptionally high real interest rates. Second, with narrowing inflation differentials and a growing unwillingness to initiate new realignments on the way to EMU, chances are that convergence will be – partly – achieved by raising German inflation instead of lowering inflation in other countries. Third, a criterion to decide at what point sufficient convergence has been achieved for the move to permanently fixed exchange rates is still lacking and suffers from the problem to distinguish real and monetary shocks.

Our results suggest that even the long-run exchange rate constraint generated by the EMS allows much latitude in the movements of inflation and interest differentials, both through differences in institutions and in the timing and implementation of monetary – deflationary – policies across countries. Given the very different positions of the various EMS countries, ranging from the Netherlands which already almost forms an implicit monetary union with Germany, to Spain and the United Kingdom with high inflation and interest rates – not to mention countries like Greece and Portugal which do not even participate in the ERM as yet – our results provide additional evidence in favor of a discrete jump to permanently fixed exchange rates in the not too distant future.

5. Conclusions

In this paper we have applied a modified version of the principal components analysis to investigate nominal interest and inflation differentials within the EMS, including the United Kingdom. All countries have been treated symmetrically, removing the need to a priori choose a benchmark country. Monthly data for the period March 1979–September 1989 have been used. The sub-period March 1983–September 1989 has also been considered separately.

We conclude that the most important differences within the EMS are between Germany, the Netherlands and the United Kingdom on the one hand, and Belgium, France and Italy on the other. In the interest rate analysis, Ireland takes a separate position accounting for the second most important component.

Neither for the whole period, nor for the period after March 1983 the EMS has functioned as a Dmark-zone. Although the Netherlands and Germany almost form one currency-area, large differences in independent interest and inflation differentials wth other countries have persisted. This supports earlier work by De Grauwe (1989), Fratianni and von Hagen (1990a, b) and von Hagen and Fratianni (1990).

Deflationary policies have been implemented sooner and faster in the United Kingdom than in, for example, France and Italy. These latter two countries have only gradually deflated leading to stabilized and lower inflation after 1986 only. De Grauwe (1990) argues that membership of a fixed exchange rate arrangement limits the speed of deflationary policies. On the other hand, France and Italy may have been able to avoid part of the negative consequences of their deflationary policies due to the borrowed credibility of their exchange rate commitment.

The experience in the United Kingdom of a 'short sharp shock' deflation in the early eighties shows that a country with a flexible exchange rate regime is theoretically able to independently gain anti-inflationary credibility based on its own policy actions and at large internal costs. The stabilization of interest and inflation rate high above German levels after 1983 and the occurrences in the last few years have shown, however, that it may be difficult to maintain such credibility.

With respect to the issue of how to proceed to EMU, our results show that inflation and interest differentials may exhibit considerable independent movements, despite the exchange rate constraint. We interpret this as evidence in favor of a discrete jump to permanently fixed exchange rates in the near future for at least part of the current EMS countries.

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