BANCO DE ESPAÑA

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1. INTRODUCTION

One of the main issues that arises in the discussion of the European Monetary Union is that of the transmission mechanism of external shocks within member states. The loss of the nominal exchange rate as a policy instrument for accommodating these effects is minimised when the integrated economies suffer common shocks with symmetric impact. When shocks are asymmetric, either in their origin (country specific) or in their transmission mechanism (a common external origin, but different domestic impact), the lack of the nominal exchange rate could be important. The document "One Market, One Money" (CEC (1990)) argues that the economic and monetary union will reduce the number of asymmetric shocks and their effects for each of its members. An initial task in this debate is, therefore, to attempt to quantify the relative importance of external shocks to the different European economies and to explain their transmission mechanism. The effectiveness of nominal exchange rates as a policy instrument also depends on the persistence of the shocks. In the presence of persistent shocks, the only effect of nominal exchange rate arrangements is to delay the adjustment of real variables. Consequently, the question of the time impact of the external shocks is also of interest.

In this paper we address these issues taking four European economies: Germany, France, the United Kingdom and Spain. We take as "common" external shocks those relating to the international oil price, the US output and the US interest rate; and as country specific, those relating to output, inflation and interest rate for each of the European countries. The model used to characterise the interdependence mechanism is a VAR for the complete set of variables.

Obviously, we do not intend a detailed modelling of these economies; we seek rather to represent their respective developments by focusing on the three chosen macroeconomic indicators. By doing this we explicitly forgo the possibility of identifying, for instance, disturbances stemming from the fiscal and labour market sides; in fact, shocks to variables in the model are to be interpreted as linear combinations of all the disturbances that hit the economy.

With this model we assess the relative importance of external and internal sources of European fluctuations. We also compare the different transmission mechanisms of external shocks so as to characterise symmetries in terms of the sign of the disturbance, its magnitude and its persistence. We try to establish, for each variable, whether there is a leader country within Europe. Finally, we investigate how dependent those results might be on different co-operation mechanisms, in particular to alternative exchange rate regimes.

The paper is structured as follows. Section 2 briefly describes the methodology and the specifics of the estimated model. Section 3 uses the variance decomposition and impulse-response results to characterise the degree of openness of European economies and the transmission mechanism of shocks for the whole sample period 1964-1991. Section 4 reports on the robustness of results to specific changes of the restrictions used to identify the model. Section 5 analyses the differences detected between the periods before and after 1979. Section 6 offers conclusions.

2. THE VAR APPROACH

2.1. METHODOLOGY

Our analysis assumes that the n-dimensional observable vector Y is determined at each t according to the model

$$Y(t) = X(t)\,\beta(t) + \epsilon(t) \tag{1}$$

where

$$X(t) = \begin{bmatrix} x_1(t)' & & & \\ & \cdot\cdot & & \\ & & \cdot\cdot & \\ & & & \cdot\cdot \\ & & & & x_n(t)' \end{bmatrix}$$

$$x_i(t)' = (Y(t-1)' \ldots Y(t-m)' \; D(t)')$$

$$i = 1,\ldots,n$$

$$\beta(t)' = (\beta_1(t)' \ldots \beta_n(t)')$$

$$\beta(t) = S\beta(t-1)+u(t)$$

$$\epsilon(t) \mid F_t \sim N(0,\Sigma_\epsilon)$$

$$u(t) \mid F_t \sim N(0,\Sigma_u)$$

$$\epsilon,\ u \quad \text{independent}$$

D(t) is a d-dimensional vector of deterministic variables, so $x_i(t)$ and $\beta_i(t)$ are k-dimensional vectors, k=mn+d. F_t is the information set at the beginning of period t.

VAR's are weakly restricted models and, in this sense, highly useful for analysing sample evidence without conditioning on prior controversial assumptions about the working of the economy. A key goal of the VAR methodology is precisely to make a sharp distinction between the specification (intended to be uncontroversial) and the identification (where disagreement is more likely to arise) processes, stating clearly the restrictions used to identify the model. This goal explains the usual two-step procedure followed to estimate the dynamics that underlie the evolution of the vector of endogenous variables Y.

In a first step, the reduced form coefficient vector ß is estimated. This usually poses a degree of freedom problem[1], which is technically solved estimating by the bayesian method. Specifically, a prior distribution for ß is specified as a function of a parameter vector, τ say, that controls aspects of the prior about which we are ignorant (mean, degree of tightness, etc). The reason for introducing the functional dependence on τ is that, with finite samples, we do not expect the prior to be neutral (in the sense of not affecting the posterior), and therefore it is necessary to have a choice criterion. A reasonable criterion is to select the prior associated with the setting τ^* that maximises the likelihood function of the model[2]. Once the prior is set, it is modified according to the Bayes rule using the sample information; the result is a posterior distribution, whose mean and variance provide the estimates of the coefficients in ß and their corresponding covariance matrix.

It should be emphasised that the only restriction imposed with certainty in the first step of the estimation procedure is the maximum number of lags allowed for, m. In particular, stationarity is not imposed, so unit roots and cointegration relations may arise if the data suggest that they characterise the stochastic process under analysis.

In a second step, a set of contemporaneous interactions among the components of Y is proposed and estimated. These interactions are intended to account for the contemporaneous correlations of the error term ϵ (as reflected in the previously estimated covariance matrix Σ_ϵ) and to generate a new error vector of orthogonal components, $\mathbf{v}$; this is actually why the process is sometimes referred to as the "orthogonalisation process". But, in fact, the orthogonalisation process amounts to identifying the model using variance-covariance matrix restrictions.

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(1) In a model like (1) the number of coefficients to be estimated increases exponentially with the number of variables included in the system.

(2) Under regularity conditions, this provides a good approximation to a full bayesian implementation. See Doan, Litterman and Sims (1984).

Since the set of contemporaneous interactions is not unique, alternative sets of identification restrictions are feasible, each generating a particular structural model and possibly implying different dynamic properties. Formally, the identification (orthogonalisation) process requires matrices A and Σ_v be estimated such that

$$A\epsilon = v$$

and

$$\Sigma_\epsilon = A^{-1}\Sigma_v A^{-1'}$$

where Σ_v, diagonal, is the covariance matrix of the disturbance vector v. Changing the identification scheme structure amounts to changing the non-zero entries of the matrix A.

Identifying the model by simply imposing restrictions on the set of contemporaneous interactions is not the only possibility. Some authors also use restrictions on the sums of structural coefficients. For instance, Blanchard and Quah (1989) impose the absence of long-run effects of nominal shocks on real variables, a restriction which involves imposing some zero entries in the long-run matrix of structural coefficients.

For a more detailed description of the bayesian VAR methodology see Doan, Litterman and Sims (1984) and Sims (1986).

2.2. THE ESTIMATED MODEL

The model analysed contains three variables for each of the following countries:

Germany
France
United Kingdom
Spain

plus three variables from the "rest of the world", so that n=15. For the European countries, the model includes: real output growth, inflation rate and nominal interest rates. The "rest of the world" block includes the rate of change of the oil price and the output growth and nominal interest rate for the US economy[3].

The model is estimated with annual data for the period 1964-1991 (see Appendix 1). The number of lags included is two (m=2) and the deterministic component (D) contains just a constant term, since no deterministic trend was detected. The number of coefficients in each equation is, therefore, 15x2+1=31. Given the small sample size there is no choice but to use a bayesian approach to estimation, which avoids the degree of freedom problem. The τ vector is described in Appendix 2. Since the prior information defined by this vector breaks the efficiency of univariate estimation, we have estimated the system using the multivariate version of the Kalman filter. Both the dimensionality of the τ vector and the number of lags included in the model are considered appropiate, since the stochastic structure of the estimated reduced form residuals does not appear to deviate from the white noise hypothesis.

The identification of the model is achieved by imposing restrictions on the set of contemporaneous interactions. The estimated scheme is presented in Appendix 3. A basic assumption of the proposed set is a hierarchical structure among the countries as a function of their relative size. More specifically, the identification scheme incorporates the following restrictions (see Figure 1):

- European shocks do not have a contemporaneous effect on the world block.

- Among world variables, the energy price is a primitive source of variability affecting both US and European real activity and

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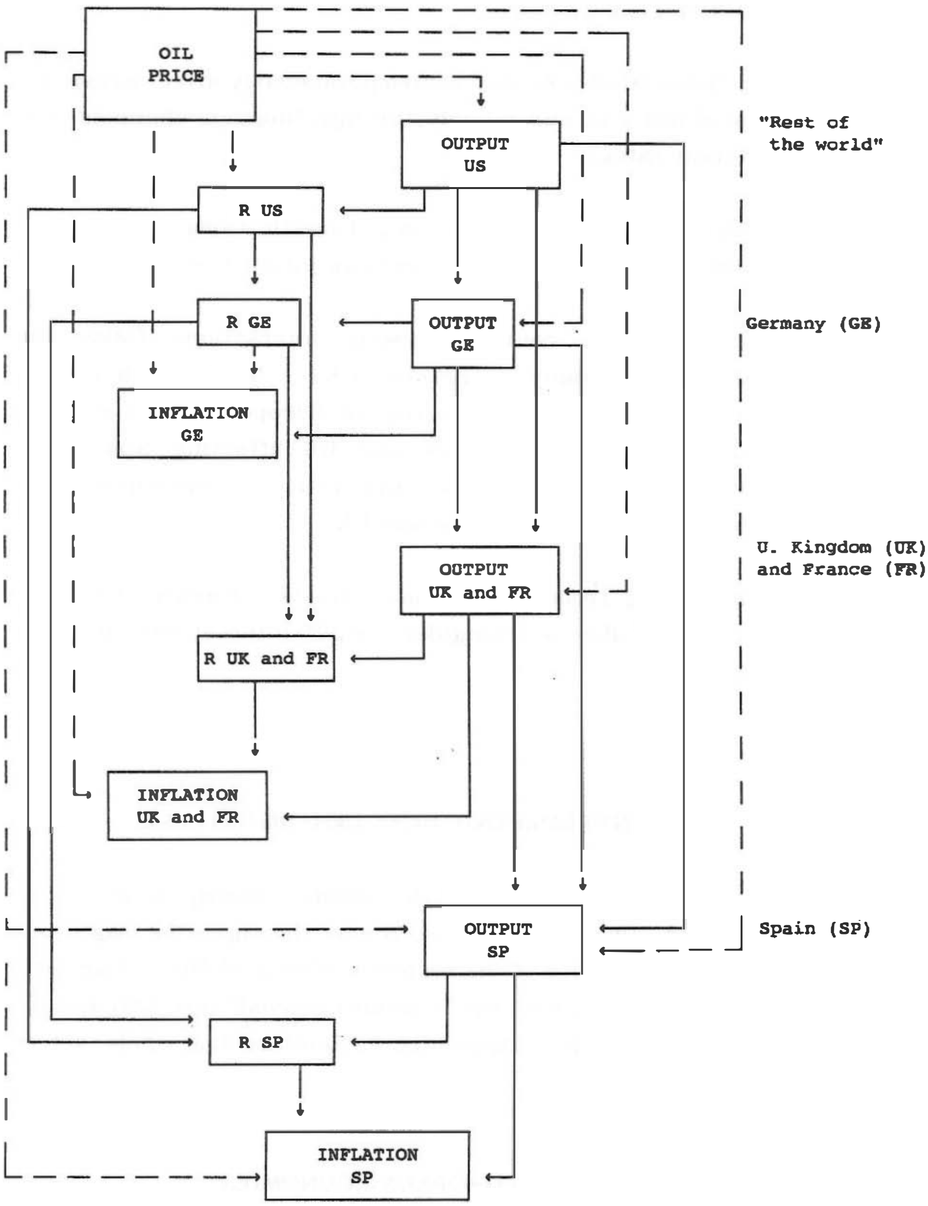
[3] By focusing on growth rates, we analyse variability abstracting from stochastic trend components. The null hypothesis of absence of common stochastic trends is accepted according to a Johansen (1991) multivariate test.

Figure 1. IDENTIFICATION SCHEME



interest rates, which may also respond to current real activity.

- US financial shocks may contemporaneously affect prices and real activity in Europe only through financial channels (i.e. interest rates).

- Other than energy prices, only domestic variables may have a direct current effect on European inflation rates.

- Within Europe contemporaneous interactions follow the hierarchy Germany → [France, UK] → Spain, with German disturbances affecting the rest of Europe through real and financial channels, France and UK affecting Spain only through output channels, and with no contemporaneous interaction between France and UK.

- Abstracting from international effects, domestic European variables follow a triangular output-interest rate-inflation scheme.

3. INTERDEPENDENCE: 1964-1991

In this section we interpret the variance decomposition for the whole sample period, 1964-1991. We also report the sign, the magnitude and the degree of persistence of the response of each of the 12 European variables to all innovations, both the "common external" (oil, US) and the European "country-specific". Appendix 4 contains the whole set of impulse-responses.

3.1 DEGREE OF OPENNESS OF EUROPEAN ECONOMIES

Tables [1] to [3] contain the average variance decomposition of the one and six periods ahead forecast error of the European variables and its corresponding standard error[4]. In the left panel of each table we present the percentage variance of each series explained by the "common" or "world" shocks: innovations in the international oil price, in the US real output and in the US nominal interest rate. The right panel contains the variance decomposition in an aggregate fashion: for each of the European variables we sum the percentages explained by the variables of each other country, the base country excluded. For example, in Table [1], on average, 3.6% of the variance of the German output was explained by European shocks: 1.5% by France's variables (French output, inflation and interest rates), 2.1% by UK variables and none by Spanish variables[5]. We will discuss the degree of interdependence from a double perspective: a country-by-country analysis and a variable-by-variable one.

Discussion of real output transmissions are frequent (the "locomotive" argument). They are, however, rarely quantified. In Table [1] we present a quantification. There are substantial differences across European economies regarding the sources of output variability. Germany and the UK are most open to world shocks: more than a third of their output variability is explained by the "common" shocks (oil shocks and US variable innovations). On the other hand, Spain and France are most dependent on European variables. Such similarities for the last two countries regarding real output fluctuations have also been found in other studies [6]. Proceeding on a variable basis we detect, again, interesting asymmetries: the US output innovations are the main external source of German GDP fluctuations (30% of its variance), but the oil price is the crucial external shock for the UK output (it explains more than 20% of its variance). This runs against the often claimed "locomotive" linkages between the US and the UK real GDPs. The "locomotive" linkages seem to

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(4) The numbers in the Tables are the result of a Montecarlo experiment involving 200 draws from the posterior distribution of the reduced form coefficient vector.

(5) The average effect of German variables on German output can be obtained from the difference between 100 and the sum of the total effects from the World and the Rest of Europe, that is : 100 - 34.9 - 3.6 = 61.5%

(6) See Dolado, Sebastián and Vallés (1993)

Table 1

VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN OUTPUT VARIANCE EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS

	WORLD				REST OF EUROPE[1]				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	34.8 (4.1)	3.6 (2.2)	30.1 (3.8)	1.1 (1.2)	3.6 (2.1)	*	1.5 (1.0)	2.1 (1.7)	0.0 (0.0)
FRANCE	16.8 (5.0)	4.3 (2.7)	11.2 (3.9)	1.3 (1.9)	35.8 (3.7)	33.1 (3.6)	*	2.7 (1.9)	0.0 (0.0)
UK	37.4 (4.2)	20.2 (3.3)	16.4 (4.2)	0.8 (1.0)	8.0 (1.9)	6.5 (1.3)	1.5 (1.1)	*	0.0 (0.0)
SPAIN	21.5 (5.8)	3.6 (3.3)	16.7 (5.4)	1.2 (1.6)	35.0 (4.4)	21.8 (3.5)	9.6 (2.3)	3.6 (3.0)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error.

(1) i^{th} country output variance explained by country $j \neq i$ output plus prices plus interest rate shocks.

Table 2

VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN INFLATION VARIANCE EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS

	WORLD				REST OF EUROPE[(1)]				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	24.2 (4.8)	5.0 (2.2)	3.6 (4.2)	15.6 (4.4)	5.1 (2.5)	*	2.6 (1.9)	2.5 (1.9)	0.0 (0.0)
FRANCE	29.8 (5.4)	16.9 (4.9)	3.4 (4.0)	9.5 (3.4)	9.1 (3.3)	6.2 (2.8)	*	2.9 (2.3)	0.0 (0.0)
UK	15.1 (4.6)	6.4 (4.0)	6.5 (3.3)	2.2 (1.4)	8.3 (3.1)	5.9 (2.4)	2.4 (1.8)	*	0.0 (0.0)
SPAIN	17.9 (5.7)	10.8 (5.1)	4.2 (3.2)	2.9 (1.9)	14.7 (4.0)	6.9 (3.6)	3.7 (2.1)	4.1 (2.9)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error.

(1) i^{th} country inflation variance explained by country $j \neq i$ output plus prices plus interest rate shocks.

Table 3

VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN INTEREST RATE VARIANCE EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS

	WORLD				REST OF EUROPE(1)				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	52.7 (3.3)	5.5 (1.7)	4.6 (3.5)	42.6 (3.6)	3.5 (1.7)	*	1.4 (.9)	2.1 (1.5)	0.0 (0.0)
FRANCE	59.4 (3.1)	10.3 (3.8)	3.1 (1.6)	46.0 (3.3)	10.5 (2.4)	8.6 (1.9)	*	1.9 (1.3)	0.0 (0.0)
UK	39.1 (4.8)	4.1 (2.5)	8.7 (6.0)	26.3 (4.1)	8.7 (2.5)	6.8 (2.0)	1.9 (1.4)	*	0.0 (0.0)
SPAIN	39.4 (4.2)	4.5 (3.2)	4.3 (3.8)	30.6 (4.7)	11.8 (3.5)	5.4 (2.1)	3.4 (1.9)	3.0 (2.0)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error.

(1) i^{th} country interest rates variance explained by country $j \neq i$ output plus prices plus interest rate shocks.

run from the US to German output first, then from Germany to other European economies. The relatively low weight of the oil price shock in the output fluctuations of the European countries excluding the UK is also surprising, a possible indication of those shocks being accommodated.

Regarding intra-European output interactions, the UK and Germany are the most closed economies, their output being very weakly dependent on the rest of the EC countries. France and Spain's output variance are, however, 35% attributable to European variable innovations. These economies are the least explained, in relative terms, by their own shocks (roughly 45%, while the proportion is 55% for the UK and more than 60% for Germany). The transmission mechanism runs, basically, from Germany to France and Spain, the rest of the interactions being of a lower magnitude. As an exception we should mention the importance of France's variables in Spanish output (on average, 10% of the total variance), which is not far from being as important as the US output and twice the oil price. This is consistent with the close ties linking Spain historically and geographically to France, its most significant trade partner. Some interaction between the UK and Germany is also detected in the paucity of intra-European interrelations. The role of Spanish variables in explaining the rest of Europe's fluctuations is, as expected, negligible. Finally, and although not reported in the aforementioned Tables, European variables have a negligible weight (less than 2%) in explaining US output variability, whereas oil price shocks explain 10% of it.

To summarise, we find that idiosyncratic shocks explain a large part of the European output variability[7], while the oil price is, in general, not found to be a source of important output fluctuations. Among the four European economies considered, Germany is the most open to US output shocks, while it is the least open to its EC partners. The UK real activity is exceptionally sensitive to oil price shocks, while less receptive to disturbances in the European economies. French output is

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[7] Serletis and Krichel (1992) explore the degree of shared output trends among EC countries for 1962-1990, which is found to be low. However, they attribute this result to domestic policies, an interpretation favouring current coordination plans towards monetary union.

quite independent of US real activity, but very sensitive to German variables. Spain and France being the closest economies to "world" disturbances, are the most sensitive to European shocks, in particular to those stemming from Germany. For Spain, French variables are an additional source of variability.

On the inflation side the picture is somewhat different. In Table [2] we present the variance decomposition of the European rates of inflation. To start with, the inflation spillovers are much smaller than those relating to output: around 40% for France, 30% for Germany and Spain and 25% for the UK. This is consistent with inflation disturbances being related to domestic labour markets and, possibly to a lesser extent, to domestic monetary policies. In this sense, it is interesting that the UK emerges as the most closed economy in terms of inflation. Also interesting is the relatively small role of the oil price shocks in explaining the European inflation rates, in particular for the German and the UK cases. For France and Spain, the role of the oil price disturbances is larger, yet below 20% of their variance. This is remarkable, given that the oil "crises" have usually been placed as the main source of the European inflation processess of the seventies and early eighties. However, it may not run counter to the findings of the countercyclical pattern of western inflation during these decades (see Kydland and Prescott (1990), for the US, Blackburn and Ravn (1991) for some OECD countries, and Dolado et al. (1993) for the Spanish economy). This pattern has been attibuted to the importance of the "supply side" shocks: more inflation, lower output growth. The controversy would lie on the interpretation of the source of the supply shock: the domestic labour markets may have been the main source of inflation disturbances in these decades, rather than the oil price jumps.

While the US output plays an insignificant role in European inflation rates, for the case of German inflation (and, to a lesser extent, French inflation), the role of the US interest rate is important. Around 15% of its variance is explained by it. However, such a linkage disappears for the UK and Spanish economies. At a first glance, one could interpret this dependence in terms of some coordination of monetary policies among those countries, and the relatively larger dependence of the British and

Spanish inflation on their domestic labour shocks. We later argue that a more likely interpretation is that the exchange rate impact of US fiscal policies on Germany and France has been larger, and this explains the US ability to "export" domestic inflation pressures to those countries. However, as mentioned earlier, the reduced set of variables for each country makes it very difficult to characterise the disturbances in terms of either fiscal or monetary policies or technology shocks.

When we consider the interaction among inflation rates within EC countries (see the right-hand panel of Table [2]) we find that it is surprisingly low and that there is no clear leader country as in the output case. The Spanish inflation is the most sensitive to European variables, but not to those of any country in particular.

The decomposition of the European nominal interest rate volatility is presented in Table [3]. As expected, the degree of interaction is highest at the financial level, specially for France and Germany. The US nominal interest rate is the main source of variability both for French rates (46%, well above its own disturbances) and German rates (roughly 43%, as large as its own variables). For Spain and the UK the linkage is much weaker (roughly 30%). This is consistent with the exchange rate effects mentioned in the inflation decomposition above. In fact, French interest rates are the least dependent on their own variables (just 30%) while the UK and Spain are the most domestically determined (around a 50%). Regarding European interdependence, the lack of interaction among European rates as compared with US rate dependence is again surprising. Morover, although there is no clear leader country as in the output case, German variables explain a higher percentage than the rest of the countries.

3.2 TRANSMISSION MECHANISMS

Here we provide the overtime average response of each European variable to an impulse of a one standard error in an innovation in the system. Contrary to the variance decomposition analysis, now the actual sample variance of the shock does not matter. In this sense, the exercise could be interpreted as the response of every European variable to a hypothetical shock in each other variable, given the information contained in our sample period. The responses, up to six periods, have been normalised by the standard error of the corresponding innovation (see Appendix 4).

We divide our analysis in to two parts: first, we consider the European variables' responses to "common" shocks; and second, we focus on European interdependence, analysing the responses of the European variables in the system to their own shocks.

3.2.1 Europe facing "common" shocks.

Table [4] summarises the responses of European variables to a one standard deviation innovation in oil price, US output and US interest rates. When the responses are monotonic we calculate the average response of the first and the sixth period. If they lie on the interval [0, 0.02] we consider them "null"; if in [0.02, 0.05] "almost null"; in [0.05, 0.30] "low"; in [0.30, 0.50] "high"; and above 0.50 "very high". If they are not monotonic we take averages of the positive and negative values separately. We define a response to be "persistent" when the impact is still significantly different from zero after five periods.

Regarding output interaction (first row of each country), we find a symmetric response to US output innovations (second column): for an identical US positive shock, all the European countries' GDP will react positively, in a large amount (between 15 to 50 percent of a standard deviation) and in a persistent way. Similarly, there is a quite symmetric response of European output to US interest rates, with almost null effects for all countries. We therefore conclude that, from an European output perspective, these shocks are "symmetric" in the sense of fulfilling the two conditions: (i) having a common origin; and (ii) having symmetric transmission patterns both in size and persistence. However, the oil price shocks, in spite of having the same origin, are far from symmetric. In fact, although there is a general negative output impact of an oil price jump, the magnitude of the contemporaneous effect and specially the dynamic pattern differs across countries: for Germany and France, the response is low and transitory; for the UK, high and persistent, the

Table 4

AVERAGE RESPONSE OF EUROPEAN VARIABLES TO "COMMON SHOCKS"			
	OP	YUS	RUS
GERMANY			
OUTPUT	(-) LOW, T	(+) HIGH, P	(-) A. NULL
INFLATION	(+) LOW, T	(+) LOW, P	(+) HIGH, P
INTEREST RATE	(+) LOW, T	(+) LOW, P	(+) VERY HIGH, P
FRANCE			
OUTPUT	(-) LOW, T	(+) HIGH, P	(-) A. NULL
INFLATION	(+) VERY HIGH, P	(+) LOW, P	(+) HIGH, P
INTEREST RATE	(+) VERY HIGH, P	(+) LOW, T	(+) VERY HIGH, P
UK			
OUTPUT	(-) HIGH, P	(+) HIGH, P	(+) A. NULL
INFLATION	(+) HIGH, P	(-) LOW, T	(+) LOW, T
INTEREST RATE	(+) LOW, T	(+) HIGH, P	(+) VERY HIGH, P
SPAIN			
OUTPUT	(+) LOW INITIALLY THEN (-) LOW, P	(+) HIGH, P	NULL
INFLATION	(+) HIGH, P	(-) LOW, T	NULL
INTEREST RATE	(+) LOW, P	(+) LOW, P	(+) VERY HIGH, P

Note: T stands for transitory, P for Persistent and A for Almost.

biggest impact being contemporaneous; for Spain it is negative, low and persistent, also, but the magnitude of the impact peaks with a 3 period delay. This could be due to the political decision of delaying initially the adjustment to the oil shocks.

The responses of European inflation to the common shocks are found to be more asymmetrical than in the output case. As one would expect, the impact of the oil price disturbances on European inflation is positive. However, its magnitude differs across countries: it is lowest on German inflation, besides being transitory. For France the effect is highest and persistent. For Spain and the UK it is also high and persistent. As for the rest of the "common" shocks, the US output effects on European inflation are positive, low and persistent for Germany and France, yet negative and transitory for Spain and the UK. A negative sign is consistent with a real business cycle explanation: output fluctuations are associated with productivity shocks, i.e. with supply shifts that lead to generalised countercyclical prices. The positive sign could reflect an additional transmission to European aggregate demand. In any case, the magnitude of the impact on Europe's inflation is small (around .10 of a standard deviation). There is also a wide range of responses of European inflation to US interest rate shocks. As detected in the variance decomposition, there is a strong, positive and persistent impact on German and French inflation. For the UK the response is also positive, yet low and transitory. For Spain, there is no effect. Coordinated monetary policies, in the sense of joint reductions in the inflation rates, should be reflected in a negative sign. The positive sign may be better interpreted as the transmission channel of US fiscal and monetary policies on German, French and UK inflation via nominal exchange rate appreciation.

Table [4] also contains the responses of European interest rates to these common shocks. There is a symmetric response to US interest rate innovations: positive, very high and persistent. This is consistent with a US dominance of the world financial markets. For the UK interest rate there is also a strong effect coming from US output changes, with a positive sign. In addition to the output linkages between the US and the UK, there seems to be a high sensitivity of UK savings to US output shocks, a possible sign of British direct investment overseas: a positive US output shock (say, an increase in productivity) may shift UK savings overseas and increase interest rates at home. For the rest of the countries this effect is much lower and, in some cases (France), transitory. Finally, the impact of oil price shocks on European interest rates is positive, but of diverse magnitude and persistence: low and transitory for Germany and the UK, low and persistent for Spain and very high and persistent for France.

Besides these asymmetries, there is no cross-country relation (direct or inverse) between output, inflation and interest rate effects of oil shocks: there are countries in which the oil impact on inflation and output is large (the UK), yet the interest rate impact is weak. For other countries (Germany) the oil impact is low in all its variables. For others (France) it is very high in nominal variables, inflation and interest rates, but not in output. In others (Spain) it is high in output and inflation, not in interest rates. This may indicate the ability of the German economy to accommodate oil shocks, while for the rest of the European economies the impact is high and persistent for at least two of the three variables considered.

To summarise, the "common" shocks, which are a priori susceptible of being accommodated in a coordinated way from a European perspective, are far from being "symmetric". In this category we include those which are transmitted in a similar way to all variables in all countries. Strictly speaking, the only symmetries are detected from US output to European outputs and from US interest rates to European interest rates. There are fairly symmetric responses of European output to US interest rates. The oil shock is, however, its common origin, transmitted in a quite different way both to European real activity and interest rates. The transmission of oil shocks to European inflation is more symmetrical, except for the German case. It is interesting to notice the similar reaction of both German and French's inflation rates to the US output and interest rates shocks, a transmission that differs from that of Spain and the UK, which can also be considered in a block. Finally, the transmission of US output to European interest rates is highly asymmetrical.

Symmetries:

- US output on European output
- US interest rates on European rates
- US interest rates on European output

Weak asymmetries:

- Oil price on European inflation (except Germany)
- US output on European inflation (two blocks: Uk and Spain, France and Germany).

Strong asymmetries:

- Oil price on European output and interest rates
- US output on European interest rates
- US interest rates on European inflation

It could be argued that some of these asymmetries could come from a lack of coordination in the past, in particular those regarding the impact of US variables on Europe. But for the external oil shock transmission, wich are actually the most asymmetrical, this interpretation can hardly be sustained.

On a country by country basis, comparing pairs, we detect the following set of coincidences of the nine common responses considered:

Germany-France:	6
Germany-UK:	3
Germany-Spain:	3
France-UK:	2
France-Spain:	2
UK-Spain:	4

If we compare trios of countries, we can report the following set of coincidences:

Germany-France-UK:	2
Germany-France-Spain:	3
Germany-UK-Spain:	2
France-UK-Spain:	2

As mentioned above there are only two cases in which the response is strictly coincident for the four countries: that of European interest rates to US interest rate and European output to US output.

We can conclude from these sets of coincidences that the responses to external common shocks are more likely to be symmetrical for a group of two (Germany and France) while UK and Spain seem more "idiosyncratic".

3.2.2 Europe facing "own" shocks

We now report on the impulse-responses of European variables to idiosyncratic shocks: innovations in output, inflation and interest rates in each of the European countries. We will group together the 9 possible interactions considered in 4 categories:

- Output transmission
- Inflation transmission
- Interest rates transmission
- Cross-effects

All the results are summarised in Table [5], in which own effects are ignored, given that our purpose is to highlight the interdependence mechanisms. We also exclude the effects running from Spain to the other European countries, since they are null.

Table 5

AVERAGE RESPONSE OF EUROPEAN VARIABLES TO "IDIOSYNCRATIC" (EUROPEAN) SHOCKS	GERMANY			FRANCE			UK		
	Y	INF	R	Y	INF	R	Y	INF	R
GERMANY									
OUTPUT		*		NULL	NULL	NULL	NULL	NULL	NULL
INFLATION				(+) LOW,P	NULL	(+) LOW,T	(+) A.NULL	(-) A.NULL	NULL
INTEREST RATE				NULL	(-) A.NULL	NULL	(+) A.NULL	NULL	NULL
FRANCE									
OUTPUT	(+) V.HIGH, P	NULL	(-) A.NULL		*		(+) A.NULL	NULL	NULL
INFLATION	(+) A.NULL	(+) LOW, P	(+) LOW,P				(-) A.NULL	(+) LOW,P	NULL
INTEREST RATE	NULL	NULL	(+) LOW,P				NULL	NULL	(+) LOW, P
UK									
OUTPUT	(+) LOW,T	NULL	NULL	NULL	(+) A.NULL	NULL		*	
INFLATION	(-) A.NULL	(+) A.NULL	(+) A.NULL	(+) LOW,T	NULL	NULL			
INTEREST RATE	(+) A.NULL	NULL	(+) LOW,P	NULL	(+) A.NULL	(+) A.NULL			
SPAIN									
OUTPUT	(+) HIGH, P	(+) A.NULL	NULL	(+) LOW, P	(-) A.NULL	(-) A.NULL	(+) LOW, P	NULL	NULL
INFLATION	(-) LOW,T	(+) LOW, P	(+) LOW,P	NULL	(+) LOW,P	NULL	NULL	(+) LOW, P	NULL
INTEREST RATE	(-) LOW INITIALLY THEN (+) LOW,P	(+) A.NULL	(-) LOW INITIALLY THEN (+) LOW,T	(-) LOW INITIALLY THEN (+) LOW,P	(+) LOW,T	(+) LOW,P	(+) LOW,T	(+) A.NULL	(+) LOW,P

Note: T stands for transitory, P for Persistent and A for Almost.

The impact of output shocks, as expected, is positive or null. It is very high and persistent from Germany to France, high from Germany to Spain, low and persistent from the UK and France to Spain, low and transitory from Germany to the UK. The fact that Table [5] is basically null above the diagonal means that the hierarchical ordering prevails in the output transmission. The "locomotive" argument is, therefore, valid for Germany-France-Spain, but it does not apply so clearly to the United Kingdom, except for its interaction with Spain.

As Table [5] shows, the evidence suggests a low inflation transmission within European countries. Such a claim has to be taken cautiously, given that our sample period includes high flexibility in nominal exchange rates. Such flexibility may allow important inflation differentials for long periods. When an inflation transmission is detected it is, as expected, of a positive sign, except from the UK to German inflation rates. In any case, the effects are of a low magnitude, albeit persistent. It is interesting to remark that, as compared with the output transmission, there is not such a clear hierarchical ordering in the inflation spillovers. We detect those mentioned from Germany to France and then to Spain, but also spillovers running from the UK to France and Spain.

When we considered the transmission from US to European interest rates, we concluded that the positive response was symmetric: positive, very high and persistent. Interestingly enough, when analysing the transmission of this variable within European countries, the results are quite different, as shown in Table [5]. Germany seems to be playing in Europe the leadership role of the US at a worldwide level: there is a positive, low and persistent response of French, UK and (lagged one period) Spanish rates to German interest rates. The remaining interest rate interactions are, although persistent, of a low magnitude.

Of the six possible interactions for each country left to analyse, we consider those which are significantly different from zero. (See Table [5]). There are some interesting output-inflation transmissions detected, such as those mentioned at the worldwide level. Here, these are positive and low (with a diverse degree of persistence) running from French output to German and UK inflation. The response of Spanish inflation to German output is negative, as it was in the US-Spanish case. There are also some positive (low and persistent) responses of French and Spanish inflation to German interest rates shocks. Finally, we also detect some effects on Spanish interest rates from European output shocks, negative in the short run, becoming positive later. A positive sign could be consistent both with real business cycles and with demand-pull fluctuations.

To summarise, there are strong output transmissions in a "locomotive" sense: from Germany to France and then to Spain. There are also persistent interest rate transmissions with Germany playing a leading role. However these are not as strong within Europe as from the US to Germany and France. Regarding inflation, there is a substantial degree of isolation, possibly as a result of the nominal exchange rate flexibility. The United Kingdom is the most isolated country within Europe in terms of the GDP locomotive but integrated with Germany in terms of interest rates. Germany seems to play a leading role specially on output (France and Spain) and on interest rates (regarding UK and France, and Spain with a lag). Spain is, in terms of output, highly dependent on other European countries, in particular on Germany, and to a lesser extent, France.

The following list summarises the interactions among the European variables. The numbers indicate, from a total of 9, the interactions for which a significant (positive or negative, high or low) value is detected. Persistent effects are indicated in brackets.

Significant spillovers (of which, persistent):

From Germany to France:	4(4)
France to Germany:	2(1)
Germany to UK :	2(1)
UK to Germany :	0
France to UK :	1(0)
UK to France :	2(2)
Germany to Spain :	6(5)

France to Spain	:	5(4)
UK to Spain	:	4(3)

From the list, we may conclude that Spain to Germany, Spain to France, Spain to the UK and France to Germany are the pairs of countries with a strongest link.

4. ALTERNATIVE IDENTIFICATION SCHEMES

Although conditional on the identification scheme described in Figure 1, the results in the previous section are only partially dependent on it. We should remark at this point that our identification method does not restrict the dynamic interactions among variables.

Several characteristics of the chosen identification scheme may be specially controversial. The first is the triangularisation of the world and domestic European blocks, in which output leads interest rates, a "classical" direction of causality. This implies that interest rates may affect output only with a delay whereas they may have an endogenous response to current economic activity. The assumption (plausible in principle) may be questioned because of the annual frequency of our data set: a year is probably too much of a delay. To assess the dependence of the results on this assumption, the model was estimated inverting the order of output and interest rate within each block (both world and domestic European) so output could respond contemporarenously to interest rate but not vice versa, a "demand determined" setup. Interestingly enough, except for a slight increase in the responses of European output growth rates to US interest rate shocks[8], the interdependence results were not affected.

A second questionable characteristic of the scheme presented in Figure 1 is the imposed output hierarchy between Germany, on the one

[8] In terms of variance decomposition, the only significant increase (around 10%) was in the US interest rate variance share in French output growth rate.

hand, and France and UK, on the other. We let German economic growth have a direct contemporaneous effect on that of France and UK but not vice versa. When the model is estimated allowing for current output feedback from France and UK to Germany, we only detect changes in terms of European output interactions, being of a large magnitude (see Table [6]). Specifically, on average, the shares of European shocks (except own) in German, French, UK and Spanish output growth rates are estimated to be 46, 55, 24 and 34%, respectively. Such an increase is exclusively due to higher output interactions, with the UK playing a surprising leading role. Comparing these with the corresponding numbers in Table 1 (3, 35, 8 and 35%) we conclude that the data appear to be compatible with a wide range of output interactions within Europe, both in terms of levels and of distribution of the explanatory power[9].

Our identification scheme does not allow for contemporaneous effects of domestic inflation on domestic interest rates. This amounts to ruling out potential current monetary policy reactions and indirect effects through expected inflation. Again, the annual frequency of our data set makes this a questionable assumption. When we estimate the model relaxing this restriction, the only significant changes are a shift in the explanatory power of Spanish and French interest rates (about 10%) from the US interest rate to the oil price disturbances, and a higher share of oil shocks in French inflation rate variability (an additional 10%).

When the model is estimated relaxing simultaneously the above restrictions, the results are linear combinations of those obtained when each is incorporated one at a time.

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[9] We should mention that, according to the Schwarz criterion for model selection, the model with output "hierarchy" (Figure 1) dominates the model with current output feedback from France and UK to Germany. This was also the case when we estimated models using even less restrictive identification schemes. We do not think, however, that likelihood differences are so clear as to conclude that the data allow for full discrimination among alternative identification restrictions.

Table 6

ALTERNATIVE IDENTIFICATION SCHEME: INTERDEPENDENCE AMONG EUROPEAN OUTPUTS
VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN OUTPUT VARIANCE
EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS

	WORLD				REST OF EUROPE[1]				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	34.4 (3.3)	3.3 (1.8)	30.0 (3.5)	1.1 (1.2)	46.5 (5.9)	*	5.9 (1.8)	40.6 (3.5)	0.0 (0.0)
FRANCE	16.7 (4.7)	4.2 (2.9)	11.4 (4.1)	1.1 (1.3)	55.3 (4.1)	16.5 (3.1)	*	38.8 (4.0)	0.0 (0.0)
UK	38.0 (4.4)	20.1 (3.4)	17.0 (4.6)	.9 (1.0)	23.9 (3.3)	18.6 (2.8)	5.3 (1.4)	*	0.0 (0.0)
SPAIN	21.9 (5.9)	3.5 (3.3)	17.0 (5.2)	1.4 (1.8)	34.2 (4.3)	9.4 (2.2)	4.2 (1.4)	20.6 (4.2)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error.

(1) i^{th} country output variance explained by country $j \neq i$ output plus prices plus interest rate hocks.

5. SUBSAMPLE ANALYSIS: 1964-1978 AND 1979-1991

In order to detect possible changes associated with developments in the European exchange rate regime and the economic integration process, we divide our sample into two subperiods:

- 1964-1978: a period that includes the end of the Bretton-Woods system and the first oil shock, and which is characterised by high real growth rates followed by a deep recession, a generalised inflationary process followed by disinflation and an upward trend in nominal interest rates.

- 1979-1991: a period that includes the second oil price increase in 1979-80 and the oil price collapse in 1986, the birth of the European Monetary System, advances in European economic integration and substantial trade and financial liberalisation worldwide. It is characterised by a deep recession followed by sizable expansion, mainly in the US, a significant US nominal and real exchange rate appreciation, disinflationary processes in all countries and a reduction in nominal interest rates.

In general, during 1979-91 one could expect greater interdependence in real output and interest rates, due to the integration processes mentioned above. We should also expect a higher interaction within European inflation rates as a result of the Exchange Rate Mechanism. However, the frequency in exchange rate realignments up to 1987 may distort the interpretation of this subsample as a period of tighter coordination among EMS countries. Finally, one could expect the nominal exchange rate fluctuations in the US to be reflected in a higher degree of isolation of the European economies vis-a-vis the United States.

We report the main differences found between both samples when analysing both the variance decomposition on a variable by variable basis (Tables [7] to [9]) and the impulse responses of European variables to all shocks (Table [10]).

Table 7

VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN OUTPUT VARIANCE EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS									
	WORLD				REST OF EUROPE(1)				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	51.0 (2.8) 24.5 (5.4)	3.8 (1.8) 2.4 (2.0)	46.3 (2.8) 20.0 (5.5)	0.9 (1.1) 2.1 (2.3)	3.2 (2.2) 4.4 (2.3)	*	1.3 (.9) 1.5 (1.1)	1.9 (1.4) 2.9 (2.2)	0.0 (0.0) 0.0 (0.0)
FRANCE	38.9 (4.0) 31.2 (5.4)	2.6 (2.4) 22.0 (4.3)	35.4 (3.9) 6.7 (4.7)	0.9 (1.2) 2.5 (2.9)	24.0 (2.7) 19.6 (4.4)	22.3 (2.5) 16.2 (4.0)	*	1.7 (1.5) 3.4 (2.4)	0.0 (0.0) 0.0 (0.0)
UK	48.3 (3.9) 29.6 (6.7)	22.5 (3.9) 14.8 (3.3)	25.1 (3.9) 13.0 (7.4)	0.7 (1.0) 1.8 (2.1)	5.1 (2.2) 5.8 (2.0)	3.7 (1.8) 4.4 (1.8)	1.4 (1.0) 1.4 (1.0)	*	0.0 (0.0) 0.0 (0.0)
SPAIN	40.3 (4.2) 14.2 (7.0)	2.8 (2.7) 5.4 (3.5)	36.4 (4.5) 6.1 (6.6)	1.1 (1.3) 2.7 (2.8)	39.5 (3.4) 46.7 (5.3)	29.2 (2.8) 14.0 (3.0)	5.3 (1.6) 8.2 (2.3)	5.0 (1.9) 24.5 (4.5)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error. In the upper corner the first subsample period (1964-78), in the lower corner the second subsample period (1979-91).

(1) i^{th} country output variance explained by country $j \neq i$ output plus prices plus interest rate shocks.

Table 8

VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN INFLATION VARIANCE EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS

	WORLD				REST OF EUROPE[1]				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	34.4 (3.6) 18.0 (6.0)	9.7 (2.8) 2.0 (2.3)	5.4 (4.6) 6.0 (4.8)	19.3 (3.3) 10.0 (6.0)	4.4 (2.3) 5.7 (2.9)	*	2.4 (1.5) 2.4 (1.6)	2.0 (1.8) 3.3 (2.5)	0.0 (0.0) 0.0 (0.0)
FRANCE	39.8 (4.7) 25.1 (6.2)	27.6 (6.0) 6.3 (3.6)	3.2 (2.7) 3.6 (3.8)	9.0 (3.3) 15.2 (4.7)	8.3 (3.2) 8.2 (3.1)	5.7 (2.8) 5.6 (2.2)	*	2.6 (2.1) 2.6 (1.7)	0.0 (0.0) 0.0 (0.0)
UK	21.1 (4.5) 44.4 (5.9)	4.9 (4.6) 36.0 (4.7)	14.5 (2.7) 5.1 (5.1)	1.7 (1.4) 3.3 (2.7)	6.4 (2.7) 7.1 (3.5)	4.2 (2.2) 4.8 (2.9)	2.2 (1.7) 2.3 (2.0)	*	0.0 (0.0) 0.0 (0.0)
SPAIN	38.6 (5.8) 26.1 (4.6)	25.6 (6.0) 18.0 (2.0)	6.9 (4.0) 4.1 (4.2)	6.1 (1.7) 4.0 (2.8)	16.4 (4.2) 11.7 (4.2)	9.1 (3.5) 4.9 (3.3)	3.7 (2.2) 2.8 (2.2)	3.6 (2.3) 4.0 (2.4)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error. In the upper corner the first subsample period (1964-78), in the lower corner the second subsample period (1979-91).

(1) i^{th} country inflation variance explained by country $j \neq i$ output plus prices plus interest rate shocks.

Table 9

VARIANCE DECOMPOSITION: PERCENTAGE OF EUROPEAN INTEREST RATE VARIANCE EXPLAINED BY WORLD AND EUROPEAN (EXCEPT OWN) SHOCKS									
	WORLD				REST OF EUROPE[1]				
	TOTAL	OP	YUS	RUS	TOTAL	GERMANY	FRANCE	UK	SPAIN
GERMANY	52.8 (2.5) 66.5 (4.0)	7.8 (1.9) 9.5 (1.9)	4.2 (3.7) 5.8 (3.9)	40.8 (3.5) 51.2 (4.2)	3.5 (1.8) 3.4 (4.2)	*	1.5 (1.1) 1.1 (0.8)	2.0 (1.5) 2.3 (1.7)	0.0 (0.0) 0.0 (0.0)
FRANCE	64.8 (2.1) 70.3 (4.0)	14.5 (7.4) 11.3 (3.1)	1.6 (1.7) 4.2 (2.2)	48.7 (3.4) 54.8 (3.9)	4.5 (1.5) 15.8 (3.6)	3.1 (1.2) 13.6 (2.4)	*	1.4 (1.0) 2.2 (1.7)	0.0 (0.0) 0.0 (0.0)
UK	54.5 (4.2) 31.1 (4.9)	5.4 (3.9) 3.6 (1.4)	11.8 (6.6) 7.4 (5.4)	37.3 (5.7) 20.1 (3.4)	6.2 (2.5) 19.4 (2.2)	3.7 (1.9) 18.5 (1.9)	2.5 (1.6) .9 (.8)	*	0.0 (0.0) 0.0 (0.0)
SPAIN	59.4 (3.7) 44.8 (4.5)	9.1 (5.7) 7.1 (2.2)	10.8 (5.1) 4.1 (2.1)	39.5 (3.4) 33.6 (3.5)	20.6 (3.4) 9.8 (3.3)	12.0 (2.1) 3.1 (1.7)	4.6 (2.0) 2.4 (1.2)	4.0 (2.4) 4.3 (2.0)	*

Note: The number in each cell is the average of the variance decomposition and its corresponding standard error in the first and sixth forecast error. In the upper corner the first subsample period (1964-78), in the lower corner the second subsample period (1979-91).

(1) i^{th} country interest rates variance explained by country $j \neq i$ output plus prices plus interest rate shocks.

Table 10

AVERAGE RESPONSE OF EUROPEAN VARIABLES TO "COMMON SHOCKS"	OP		YUS		RUS	
	1964-78	1979-91	1964-78	1979-91	1964-78	1979-91
GERMANY						
OUTPUT	(-) LOW,T	(-) A.NULL	(+) VERY HIGH ,P	(+) LOW,P	NULL	(-) A. NULL
INFLATION	(+) LOW,P	(-) A.NULL	(+) LOW,P	(-) LOW,T	(+) HIGH,P	(+) A.NULL
INTEREST RATE	(+) LOW,T	(+) LOW,T	(+) LOW,P	(+) LOW,P	(+) VERY HIGH,P	(+) VERY HIGH,P
FRANCE						
OUTPUT	(-) LOW,P	(-) HIGH,P	(+) VERY HIGH, P	(-) LOW THEN (+) LOW,P	(-) A.NULL	(-) A.NULL
INFLATION	(+) VERY HIGH, P	(+) LOW,P	(-) LOW THEN (+) LOW,P	(+) A. NULL	(-) HIGH,P	(+) HIGH,P
INTEREST RATE	(+) VERY HIGH, P	(+) VH, P	(+) LOW,T	(+) LOW, T	(+) VERY HIGH,P	(+) VERY HIGH,P
UK						
OUTPUT	(-) HIGH,P	(-) LOW,P	(+) HIGH,P	(+) HIGH,P	NULL	NULL
INFLATION	(+) LOW,P	(+) VERY HIGH, P	(-) VERY HIGH,T	(-) LOW,T	(+) A.NULL	(+) A.NULL
INTEREST RATE	(+) LOW,P	(+) LOW,P	(+) VERY HIGH,P	(+) LOW,P	(+) VERY HIGH,P	(-) HIGH,P
SPAIN						
OUTPUT	(+) LOW THEN (-) HIGH,P	(+) LOW THEN (-) LOW,P	(+) VERY HIGH,P	(+) LOW,P	NULL	(-) A.NULL
INFLATION	(+) VERY HIGH, P	(-) HIGH THEN (+) LOW,T	(-) LOW, T	(+) LOW,T	(-) HIGH THEN (+) LOW,P	(+) A.NULL
INTEREST RATE	(+) VERY HIGH, P	(+) LOW,P	(-) VERY HIGH THEN (+) VERY HIGH,P	(+) LOW,T	(+) VERY HIGH,P	(+) VERY HIGH,P

Note: T stands for transitory, P for persistent and A for almost.

5.1 European output

In Table [7] we present the variance decomposition for European output in both samples (upper-left corner for 1964-1978, lower-right corner for 1979-1991). The left-hand panel of the Table contains the percentage of the European variable variance explained by "world" shocks (oil price, US output and US nominal interest rate).

When comparing the second to the first subsample, a lower weight for the "world" variables in explaining European real activity is detected. This is specially true for the US output fluctuations, a result to be considered when currently using "locomotive" arguments linking the course of the US economy to European real activity. The US output was the key variable behind the variance of German output (almost 50% in the first subsample); it played a similar role in explaining the volatility of French and Spanish output (35%) and a lower, yet important, role for the variance of the UK real GDP (25%). However, in the second subsample this linkage substantially diminishes, specially for Germany (US output explains less than 15% of European output variation). Interestingly, the degree of interaction between the UK economy and the United States, in relative terms, suffers something less of a reduction. The weight of the second oil shock is larger for Spain, and specially for France, and lower in the UK. It is negligible for German output in either subsample, a result that shows the German ability to accommodate the oil shocks, as we mentioned in the preceding section. Consistent with these variance decompositions, Table [10] shows that the responses of European output to impulses in US real activity are also lower in the second sample period.

Regarding the interaction among European variables (see the right panel of Table [7]) we still find a small role in explaining both German and UK real activity, a larger role, although not significantly different, for France; and a more important role for Spanish output. One could assign, in principle, this effect to the fact that most of the European economies had gone through trade integration for decades before this subsample, while for Spain the degree of openness shifts radically from 1976 onwards, and it changes in favour of EC countries in the last part of the sample. However, it is interesting that the UK is the country that seems to gain the leader role for Spanish GDP, rather than Germany or France.

As the small role of European output interdependence detected for the 1980's is quite disappointing, which variable assumes the lost role of the US output in most European GDPs? For all of them without exception, domestic output. For Germany, "own" output shocks that explained 45% of its variability during the 60's and 70's, rose to explain 70% during the 80's and early 90's, an unpleasant result for the European monetary union process. Dimensionality reasons in our VAR precluded the introduction of a larger set of variables that could give us a more precise explanation for this "increasing German idiosyncracy": German technology shocks, labour market particularities, fiscal and monetary policies, disturbances in other economies closely linked to Germany but unrelated to the rest of the European countries considered, etc. For the rest of the countries, a similar picture: for the UK, own output shocks explained 45% of its variance in the first subsample, more than 60% in the second. For France and Spain, the "closed-economy" result is not so clear, given the larger role of the oil price shocks (specially for France) and the larger role of European variables for Spanish GDP. In any case, 20% of Spanish activity in the first subsample was explained by own output shocks, 35% in the second. For France the numbers run from 35% in the first to 45% in the second.

To summarise, we detect generally lower interdependence at the output level. This result is not new in the literature. Schiantarelli and Grilli (1990), using a country by country structural VAR, found internal shocks to be more important than external ones in explaining output variability during the 80's, specially in Germany and the UK. Canova and Dellas (1993) relate business cycle fluctuations with bilateral trade dependence. In that sense, they also find more interdependence before than after 1973, a result applicable to a set of industrialised countries. Although a precise explanation to this smaller interdependence is beyond the scope of this paper, given the limitations mentioned above, our conjecture is that idyosychratic shocks (other than oil) have dominated the second subsample at a worldwide level. We will further elaborate on this point.

5.2 European inflation

Table [8] contains the variance decomposition for European inflation. Remarkable once more is the substantial increase in the divergence of the inflation processes of the European countries considered, interpreted in terms of the percentage variance explained by domestic shocks. The large variability in the US nominal exchange rate may have dominated the increasing linkages among European currencies, so that the inflation convergence process may have been heavily distorted by US dollar fluctuations.

On a variable by variable basis, we detect a much lower weight to the oil price shocks in explaining both French and German inflation variability. For Spain, the effect is not as clear, and for the UK the opposite occurs. This latter effect becomes apparent even from a direct comparison of the inflationary episodes in the UK with the oil price changes during the 80's. These results are also consistent with the impulse-responses of European inflation to oil price innovations, as presented in Table [10].

Contrary to the oil price asymmetry, the roles of the US output and interest rates regarding the European inflation processes have contributed to some convergence: the percentage variance shares have become more homogeneous in the second subsample.

Domestic factors explained 61% of the German inflation in the 60's and 70's, and 76% in the 80's. For France and Spain, own factors also became pivotal, explaining more than 60% of the inflation variance. For the UK, however, the opposite took place. In order to further analyse the internal factors explaining this divergence in the inflation-disinflation processes, a disaggregation of the contribution of domestic output, inflation and interest rates is conducted. In doing this we find interesting differences. German inflation was explained in the first subsample in 44% by its own process, 4% by output fluctuations and 13% by nominal interest rate disturbances. In the second subsample, its own process explained 62%, 9% was due to output and only 3% to nominal interest rates. These facts may indicate a larger role for supply shocks, both technological (output) and from the labour market (own inflationary process) and a lower role for nominal demand shocks, either monetary or fiscal (nominal interest rates). For the UK the results are exactly the opposite: the shares of "domestic shocks" in the inflation process change from (output, inflation, interest rate) (30, 40 and 1%) in the first subsample to (4, 40 and 5%) in the second. This suggests that the labour market has retained its role in determining inflation, with a larger role for nominal demand policies and a much lower one for output fluctuations. The French inflationary experience undergoes a change that partially resembles the German one, although with almost no role for other factors than its own inflationary process: in the first subsample (1, 47 and 3%), in the second (4, 60 and 1%). For the Spanish inflation, a composition closer to the French one and a change along the lines of the British experience: (2, 39 and 3%) in the first subsample and (1, 47 and 6%) in the second.

Irrespective of the possible explanations for the internal factors, we conclude that the existing fixed exchange rate regime between France and Germany has not precluded domestic (fiscal or monetary) policies affecting domestic inflation[10].

5.3 European interest rates

Table [9] contains the variance decomposition for European interest rates. We detect a larger degree of interaction in the second subperiod for German and French rates, since a smaller portion of variability is explained by domestic disturbances. This is consistent with the expected large financial integration followed by market liberalisation and the reduction of transaction costs. In fact, there is a higher dependence of both on US rates; besides, French interest rates become more dependent on European variables, mainly German rates. However, it is susprising that, for the 80's, just 13% of the variability of French interest rates is explained by its German counterparts, as compared to

[10] Although this argument may seem more likely for fiscal policies, Stockman (1992) has studied the inflation and monetary processes during the Bretton Woods period in different countries, finding a limited transmission of monetary policies and, hence, of inflation rates. However, increasing international capital mobility could weaken this result.

55% explained by US rates and 11% explained by oil shocks. We have already mentioned the asymmetric responses of output and interest rates to an inflationary shock such as an unexpected change in the oil price. Such an asymmetry holds for France and Germany when considering separate subsamples (see Table [10]). There is no evidence that a more fixed exchange rate regime has provided for a more homogenous interest rate outcome through a coordinated monetary policy. As mentioned above, the frequency in realignments in the period 1980-87 may distort this interpretation.

For the UK interest rates we estimate a higher interaction with German rates (16% in the second subsample, barely 1% in the first) which is not significantly different from that of the US rates (20% in the second). The percentage explained by domestic factors rises from 40% to 50%, another possible indication of idiosynchratic nominal demand disturbances.

For Spanish rates we obtain a substantial increase in the explanatory power of domestic variables from 20% in the first subsample to 45% in the second. In fact, as in the UK case, these are mainly due to own nominal interest rate disturbances: in the first subperiod domestic output explained roughly 6% of the variance of interest rates, while in the second the percentage diminishes to 3%. However, its own process moves from explaining 13% to 42% in the second subsample, again a possible sign of domestic nominal demand management.

6. CONCLUSIONS

Using a Vector Autoregressive (VAR) approach we have attempted to characterise the interdependence mechanisms of four European economies. We identify the model imposing restrictions on the set of contemporaneous interactions. In particular, we assume that common external disturbances are a primitive source of variability for Europe, assuming also a contemporaneous hierarchical structure among European countries and output leading interest rates, as in a "classical" setup.

The main results for the whole sample 1964-91 can be summarised as follows:

(i) European output interdependence is not large: idiosyncratic shocks explain a substantial part of their output variability. Surprisingly, the oil price is, in general, not found to be a source of important output fluctuations. In relative terms, the US output plays a leading role for European output, while Germany plays such a role at a European level.

(ii) the inflation spillovers are even smaller than those of output. The interaction among inflation rates within EC countries is surprisingly low and there is no a clear leader country as in the output case.

(iii) regarding nominal interest rates, the degree of interaction is, as expected, highest. The US nominal interest rate is the main source of variability, specially for France and Germany, but within Europe the degree of interaction among rates is low.

(iv) the main symmetries detected in the transmission mechanisms of "common" or "world" shocks run from US output to European outputs and from US interest rates to European interest rates. However, in spite of its common origin, the oil shock is transmitted in a quite different way both to European real activity and interest rates. On a country-by-country basis, the responses to external common shocks are more likely to be symmetrical for Germany and France, while UK and Spain seem more "idiosyncratic".

(v) analysis of the transmission mechanisms of "European shocks" reveals that there are output transmissions in a "locomotive" sense from Germany to France and then to Spain. The United Kingdom is the most isolated country within Europe in terms of the GDP linkages. There are also persistent interest rate transmissions with Germany playing a leading role, yet not as strong within Europe as is the US worldwide. On the inflation side, there is a substantial degree of isolation.

In searching for robustness on the identification side, we should remark the following:

(vi) when the model is estimated inverting the order of output and interest rate, as in a "demand determined" setup, the interdependence results are not affected except for a slight increase in the responses of European output growth rates to US interest rate shocks.

(vii) when the imposed output hierarchy between Germany, on the one hand, and France and UK on the other, is relaxed, we only detect changes in terms of European output interactions, albeit of a large magnitude, with the UK playing a surprising leading role. We conclude that the data appear to be compatible with a wide range of output interactions within Europe.

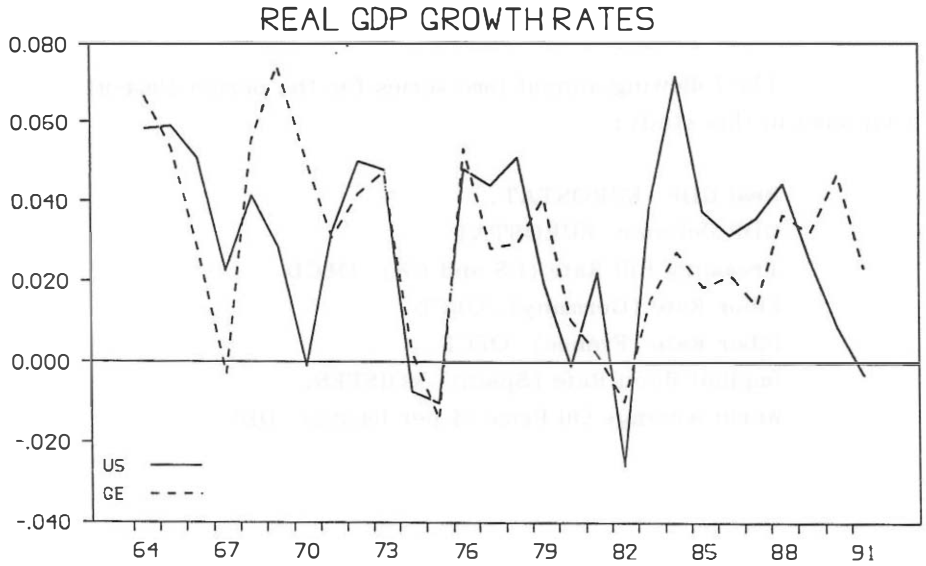
In order to ascertain how stable the previous results are, the model was re-estimated for two subsamples, with the following results:

(viii) surprisingly, we detect a generally lower interdependence at the output level in 1979-91 than in 1964-78. Although a precise explanation to this smaller interdependence is beyond the scope of this paper, given dimensionality limitations, we claim that idiosynchratic shocks have dominated the second subsample at a worldwide level. The substantial increase in the divergence of the inflation processes of the European countries considered is also remarkable. Irrespective of the possible explanations for the internal factors, we conclude that the existing fixed exchange rate regime between France and Germany has not precluded domestic (fiscal or monetary) policies affecting domestic inflation. Regarding interest rates, we detect a larger degree of interaction mainly for France and Germany. This is consistent with the expected large financial integration induced by market liberalization and the reduction of transaction costs. However, it is surprising that, for the 80's, intra-European financial interaction is much lower than with respect to the US rates. Finally, there is no evidence that a more fixed exchange rate regime has provided for a more homogenous interest rate outcome through a coordinated monetary policy, although the high frequency in realignments up to 1987 may distort this intepretation.

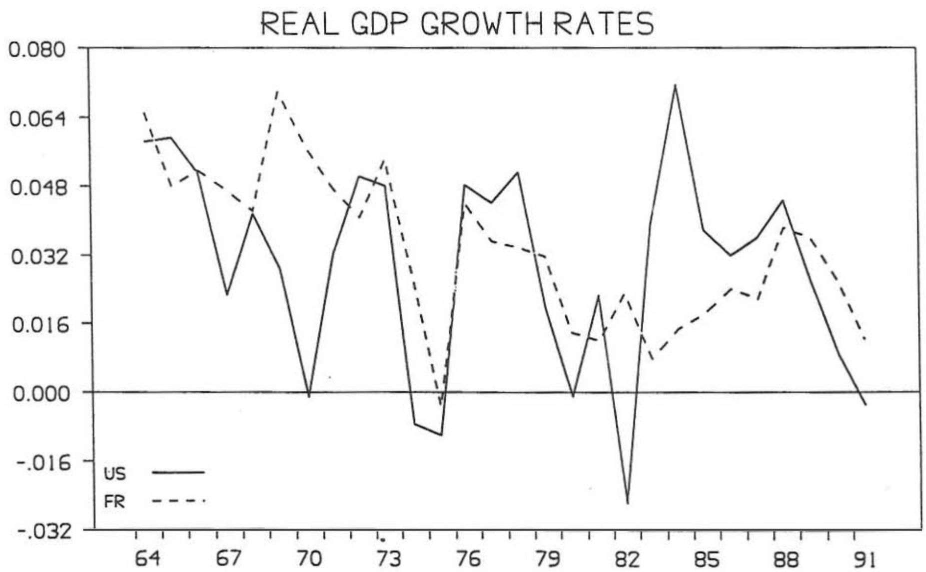
APPENDIX 1. DATA

The following annual time series for the period 1964-91 have been used in this study:

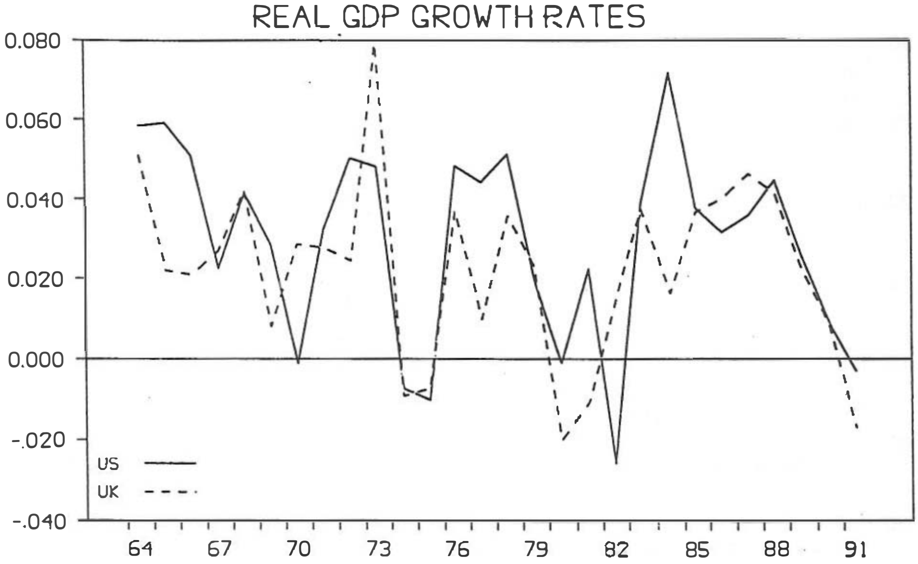
- Real GDP. EUROSTAT.
- GDP Deflator. EUROSTAT.
- Treasury Bill Rate (US and UK). OECD.
- Fibor Rate (Germany). OECD.
- Pibor Rate (France). OECD.
- Implicit Bond Rate (Spain). MOISEES.
- World Average Oil Price ($ per barrel). DRI.

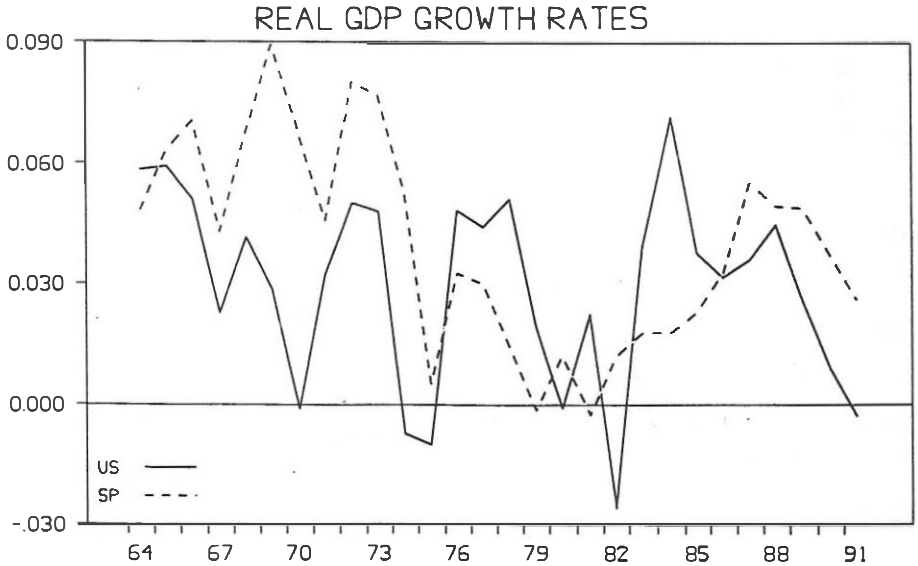


REAL GDP GROWTH RATES
0.080
0.060
0.040
0.020
0.000
-.020
-.040
US
GE
64
67
70
73
76
79
82
85
88
91

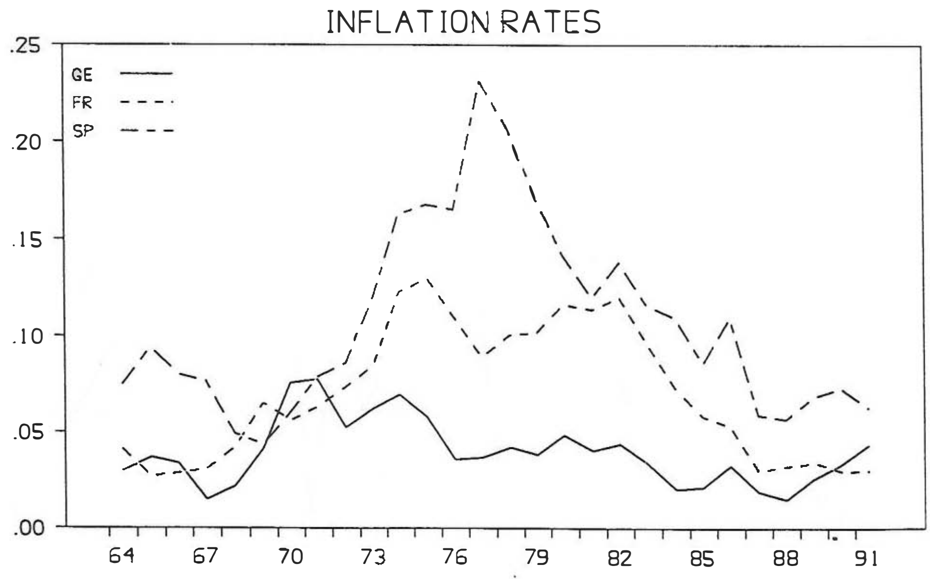


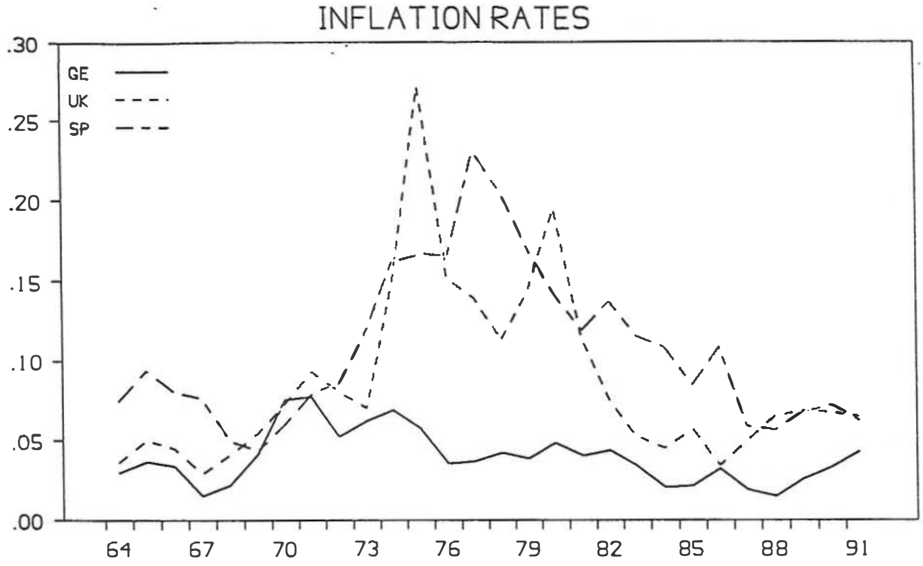
REAL GDP GROWTH RATES
0.080
0.064
0.048
0.032
0.016
0.000
-.016
-.032
US
FR
64
67
70
73
76
79
82
85
88
91

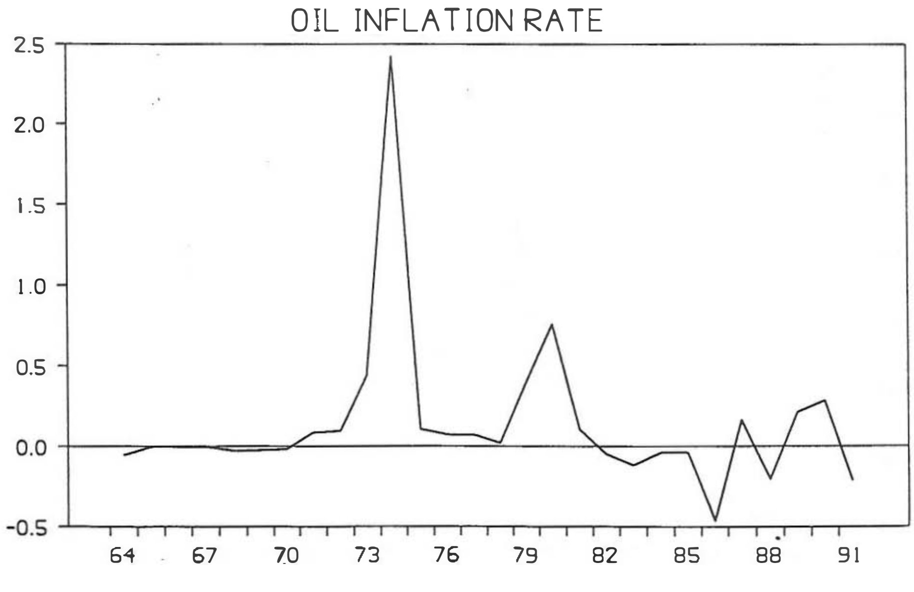

REAL GDP GROWTH RATES
0.080
0.060
0.040
0.020
0.000
-.020
-.040
US
UK
64
67
70
73
76
79
82
85
88
91

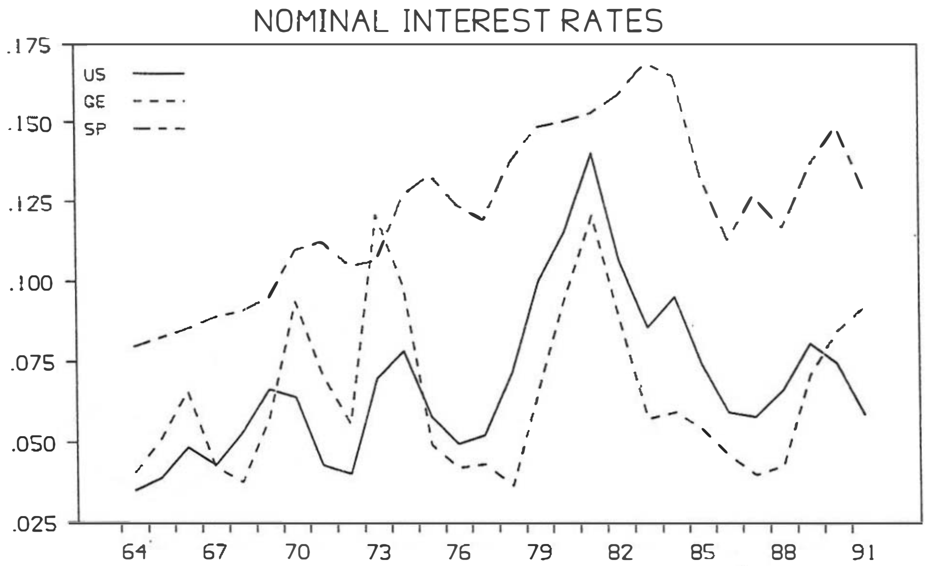

REAL GDP GROWTH RATES
0.090
0.060
0.030
0.000
-.030
US
SP
64
67
70
73
76
79
82
85
88
91


INFLATION RATES
GE
FR
UK
.30
.25
.20
.15
.10
.05
.00
64
67
70
73
76
79
82
85
88
91

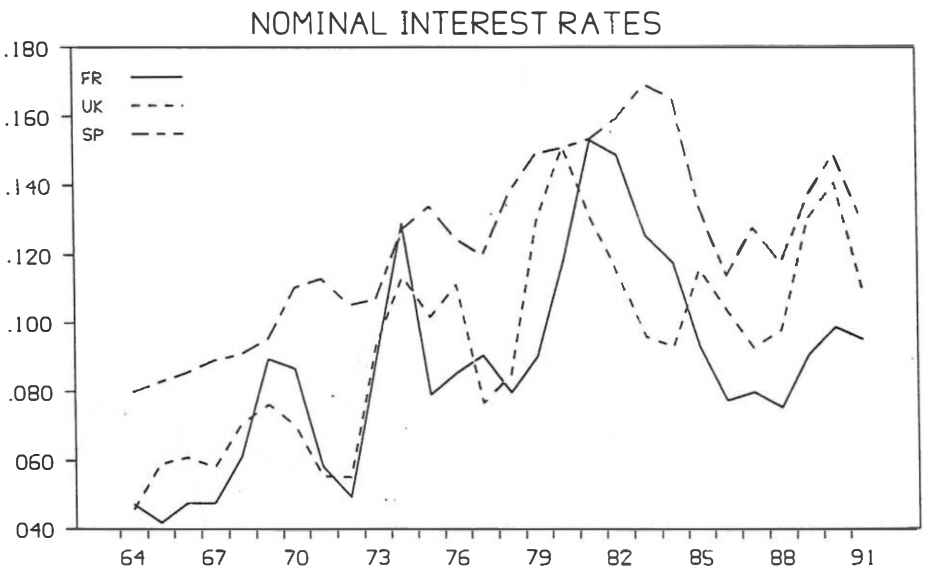

INFLATION RATES
GE
FR
SP
.25
.20
.15
.10
.05
.00
64
67
70
73
76
79
82
85
88
91


INFLATION RATES
GE
UK
SP
.30
.25
.20
.15
.10
.05
.00
64
67
70
73
76
79
82
85
88
91


OIL INFLATION RATE
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
64
67
70
73
76
79
82
85
88
91



NOMINAL INTEREST RATES
US
GE
SP
.175
.150
.125
.100
.075
.050
.025
64
67
70
73
76
79
82
85
88
91



NOMINAL INTEREST RATES
FR
UK
SP
.180
.160
.140
.120
.100
.080
060
040
64
67
70
73
76
79
82
85
88
91

APPENDIX 2. PRIOR INFORMATION

The τ vector has ten components, each controlling the following aspects of the prior (the numbers in brackets indicate the optimal setting in this model, τ^*):

τ_0..........	first own lag prior mean [.7324]
τ_1..........	overall tightness [.0229]
τ_2..........	other variable lags tightness [.3005]
τ_3..........	lag decay tightness [1.0000]
τ_4..........	constant term tightness [4.9999]
τ_5 and τ_6...	time variation in ß; $\tau_5 \neq 0$ and τ_6=1amounts assuming a random walk law of motion for ß, whereas τ_5=0 and τ_6=1 imposes $ß_t(L)=ß_{t-1}(L)$ for all t [.00001 and 1.0000]
τ_7..........	tightness of World variables in European equations [1.4309]
τ_8..........	tightness of European variables in World equations [.10833]
τ_9..........	tightness of Spanish variables in Europe and World equations [.0000]

The prior mean for lags other than first own is set equal to zero. We also experimented with a τ vector containing two different first own lag prior means: one for interest rates and the other for the rest of the system. The stochastic structure of the estimated reduced form residuals did not differ. In particular, in both cases the white noise null hypothesis was accepted at the 5% level according to a Portmanteau test (Hosking(1980)) for the overall significance of the residual autocorrelations up to lag ten.

The specification of the diagonal elements of the prior Covariance matrix for ß is as follows:

$$\sigma_{ij}^{s}(s) = (\tau_1/s**\tau_3)\Sigma_\epsilon(i,i) \qquad i = j$$

$$\sigma_{ij}^{s}(s) = (\tau_1\tau_2/s**\tau_3)\Sigma_\epsilon(i,i)/\Sigma_\epsilon(j,j) \qquad i \neq j$$

$$\sigma_{ij}^{s}(s) = (\tau_1\tau_2\tau_7/s**\tau_3)\Sigma_\epsilon(i,i)/\Sigma_\epsilon(j,j) \qquad i = \text{Europe},\ j = \text{World}$$

$$\sigma_{ij}^{s}(s) = (\tau_1\tau_2\tau_8/s**\tau_3)\Sigma_\epsilon(i,i)/\Sigma_\epsilon(j,j) \qquad i = \text{World},\ j = \text{Europe}$$

$$\sigma_{ij}^{s}(s) = (\tau_1\tau_2\tau_9/s**\tau_3)\Sigma_\epsilon(i,i)/\Sigma_\epsilon(j,j) \qquad i = \text{World and Rest of Europe},\ j = \text{Spain}$$

$$\sigma_{ic}^{s}(s) = (\tau_1\tau_4)\Sigma_\epsilon(i,i)$$

where i=1,...,n represents equation; j=1,...,n endogenous variable; s=1,...,m lag; and c the constant term.

APPENDIX 3. IDENTIFICATION SCHEME

$$OP = \upsilon_{OP}$$

$$YUS = \underset{(-1.5)}{-.013}\ OP + \upsilon_{YUS}$$

$$RUS = \underset{(1.8)}{.011}\ OP + \underset{(1.1)}{.138}\ YUS + \upsilon_{RUS}$$

$$YGE = \underset{(.9)}{.001}\ OP + \underset{(3.5)}{.545}\ YUS + \upsilon_{YGE}$$

$$INFGE = \underset{(.4)}{.002}\ OP - \underset{(-.4)}{.036}\ YGE + \underset{(2.9)}{.249}\ RGE + \upsilon_{INFGE}$$

$$RGE = \underset{(5.3)}{1.043}\ RUS - \underset{(-.3)}{.042}\ YGE + \upsilon_{RGE}$$

$$YFR = \underset{(-.4)}{-.002}\ OP - \underset{(-.6)}{.069}\ YUS + \underset{(3.7)}{.439}\ YGE + \upsilon_{YFR}$$

$$INFFR = \underset{(.9)}{.006}\ OP - \underset{(-.4)}{.078}\ YFR + \underset{(1.2)}{.194}\ RFR + \upsilon_{INFFR}$$

$$RFR = \underset{(2.8)}{.639}\ RUS + \underset{(2.1)}{.351}\ RGE + \underset{(.8)}{.146}\ YFR + \upsilon_{RFR}$$

$$YUK = \underset{(-2.0)}{-.016}\ OP + \underset{(1.0)}{.199}\ YUS + \underset{(1.6)}{.347}\ YGE + \upsilon_{YUK}$$

$$INFUK = \underset{(-1.0)}{-.014}\ OP - \underset{(-3.8)}{.964}\ YUK + \underset{(1.3)}{.438}\ RUK + \upsilon_{INFUK}$$

$$RUK = \underset{(1.3)}{.361}\ RUS + \underset{(1.3)}{.266}\ RGE - \underset{(-.1)}{.016}\ YUK + \upsilon_{RUK}$$

$$YSP = \underset{(1.1)}{.006}\ OP + \underset{(.6)}{.076}\ YUS + \underset{(1.3)}{.228}\ YGE + \underset{(2.0)}{.517}\ YFR - \underset{(-.2)}{.025}\ YUK + \upsilon_{YSP}$$

$$INFSP = \underset{(1.5)}{.013}\ OP - \underset{(-1.9)}{.437}\ YSP - \underset{(-1.2)}{.495}\ RSP + \upsilon_{INFSP}$$

$$RSP = \underset{(2.8)}{.456}\ RUS - \underset{(.9)}{.102}\ RGE - \underset{(-1.1)}{.114}\ YSP + \upsilon_{RSP}$$

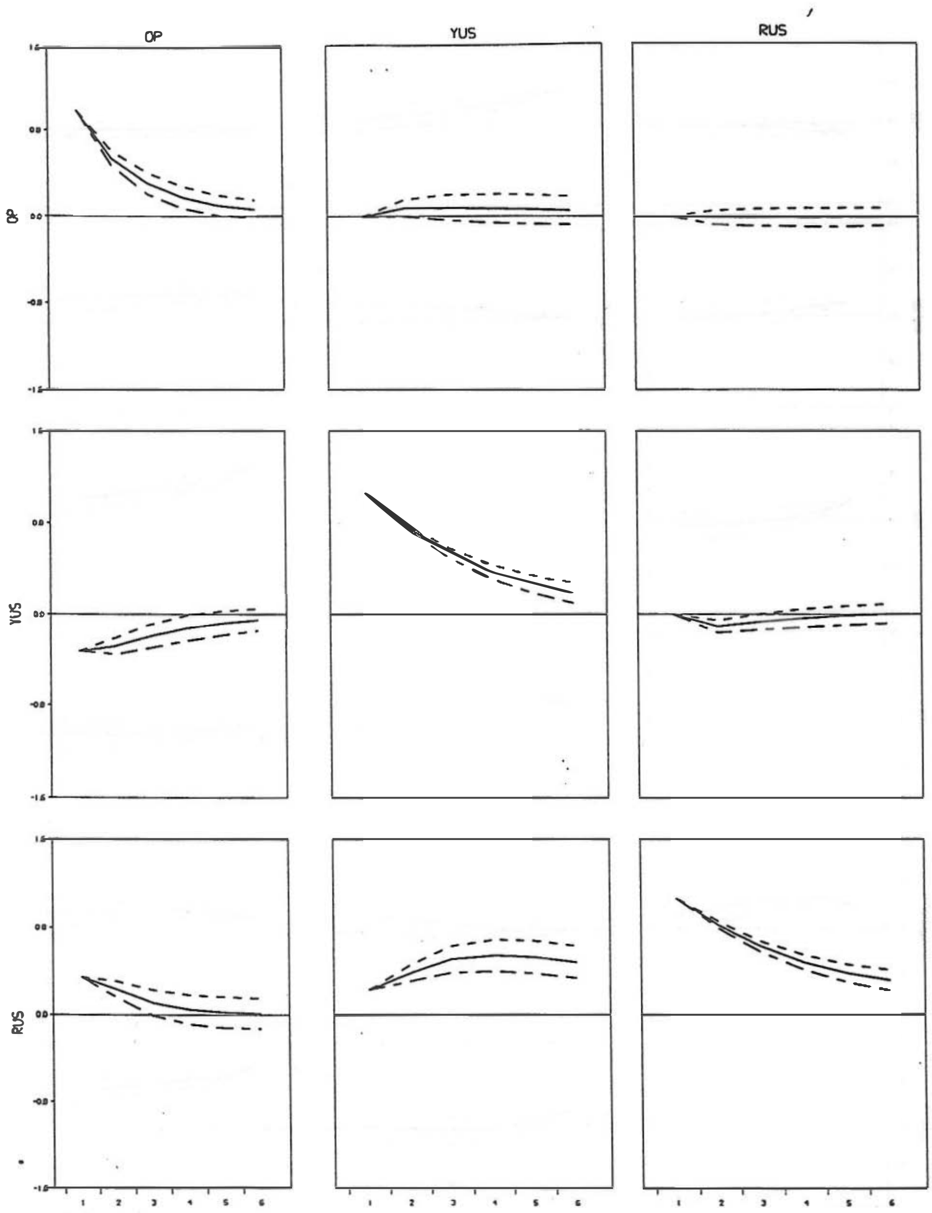
NOTE:
- Variable names stand for reduced form innovations
- t-statistics in parenthesis
- The diagonal elements of Σ_υ are, following the order above,

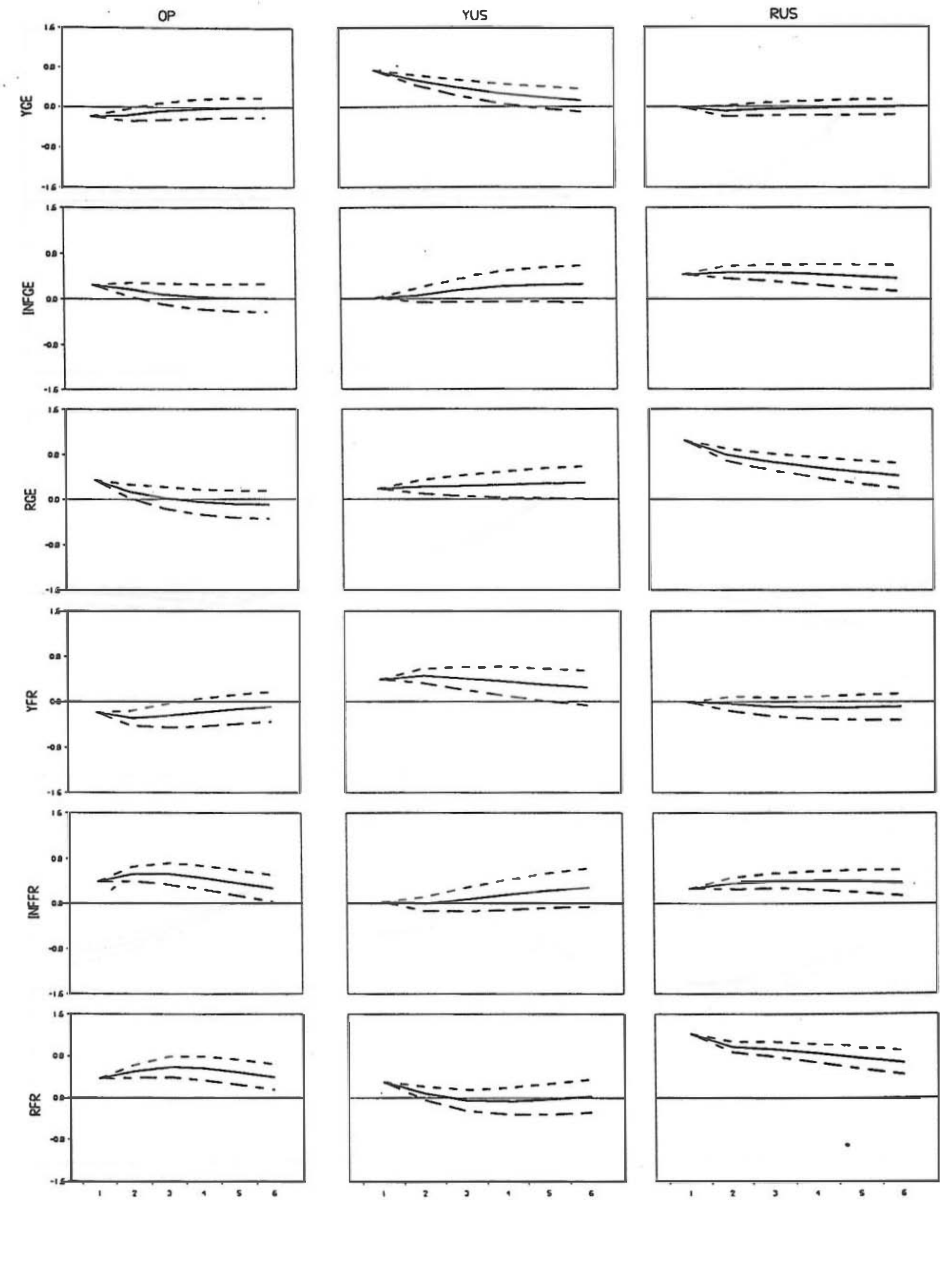
.28295	.00049	.00019	.00030	.00008	.00021
.00010	.00012	.00015	.00035	.00072	.00021
.00016	.00035	.00007			

APPENDIX 4. IMPULSE RESPONSES

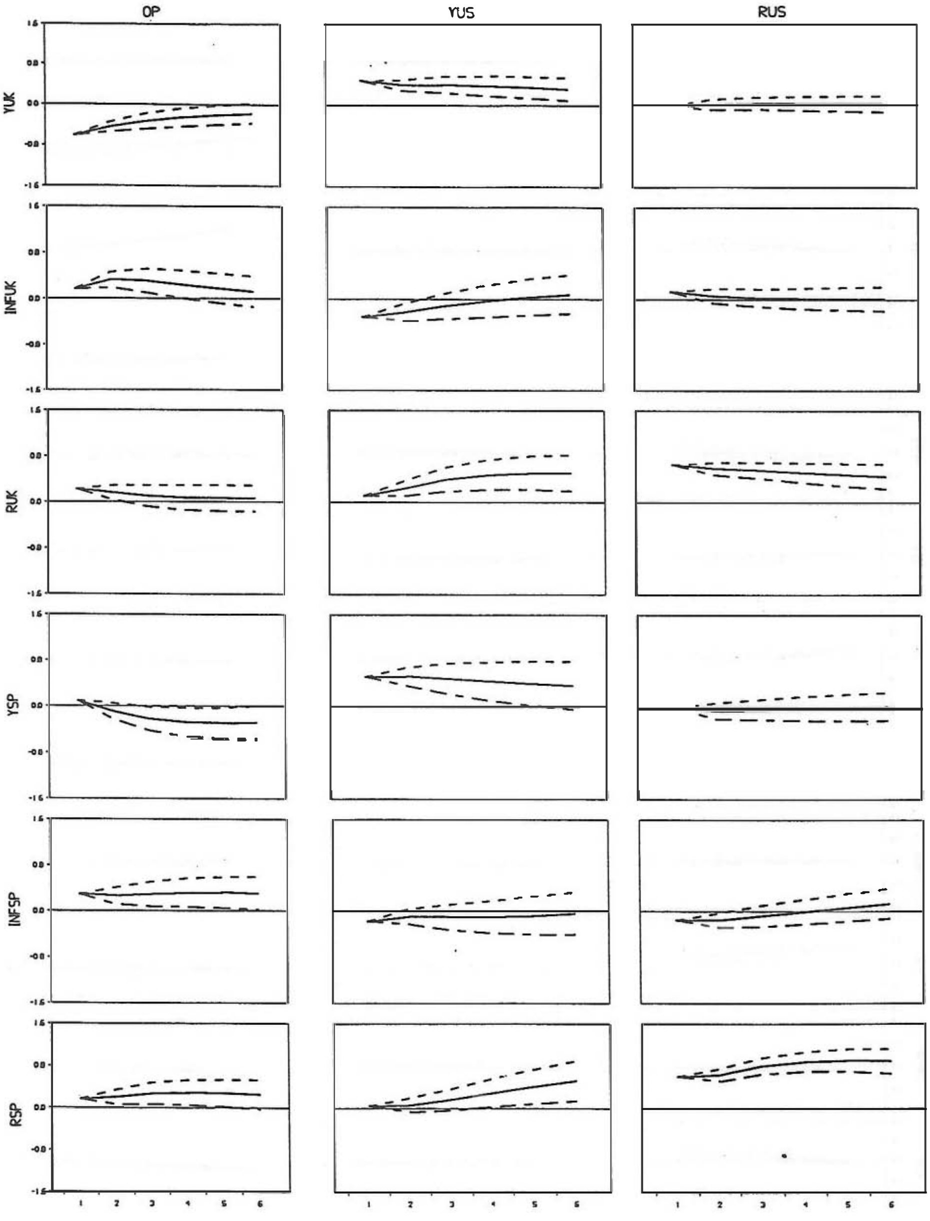
Each graph contains the average response (in standard deviation units) of the variable labeling the vertical axis to an impulse of one standard deviation to the heading variable. The response is plotted for a time span of six periods with a plus/minus standard deviation band.

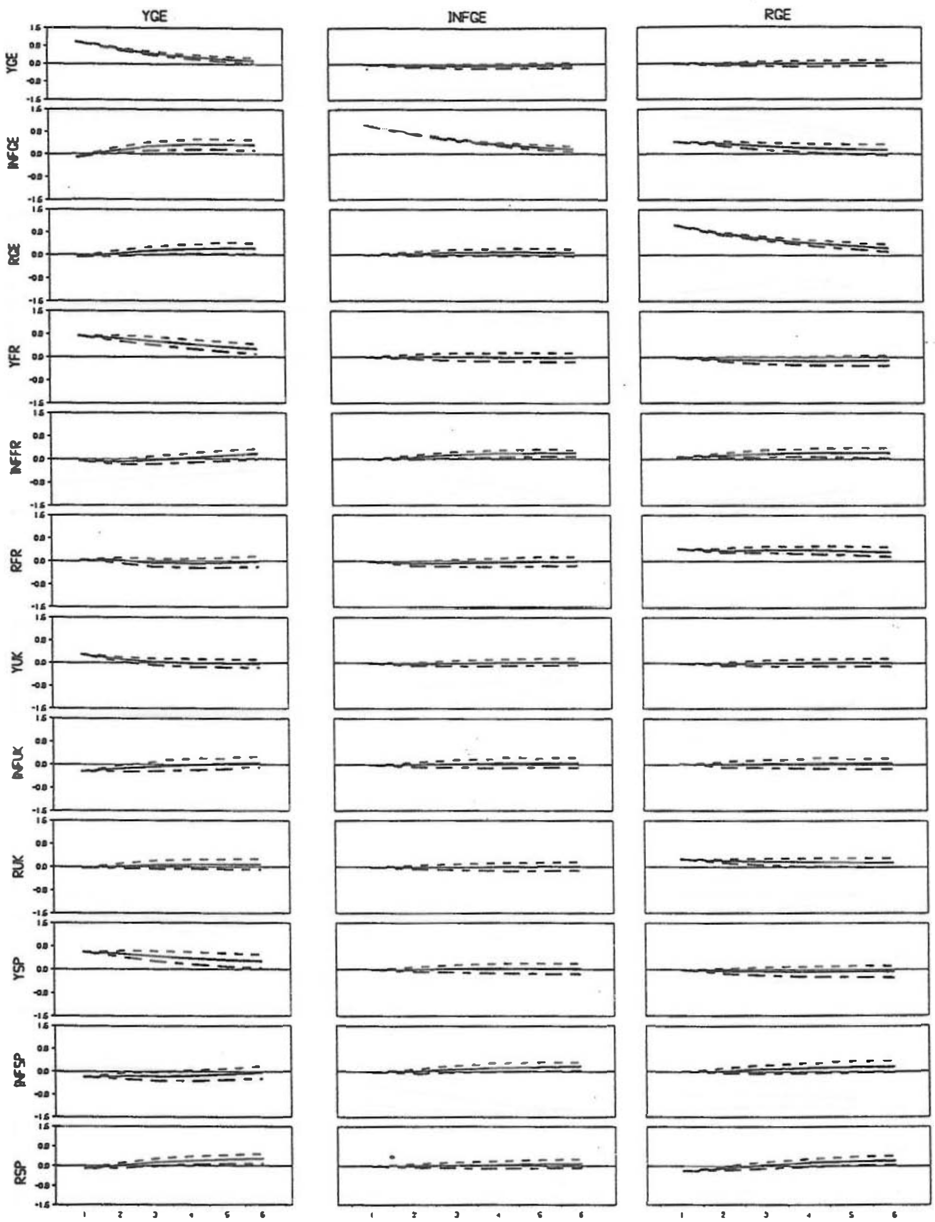
OP: Oil price (in Δ%)
YUS: US output (in Δ%)
RUS: US nominal interest rate
Yi: Output of country i (in Δ%)
INFi: Inflation rate in country i
Ri: Nominal interest rate in country i
i: GE = Germany
FR = France
UK = United Kingdom
SP = Spain


OP
YUS
RUS
OP
YUS
RUS
1
2
3
4
5
6

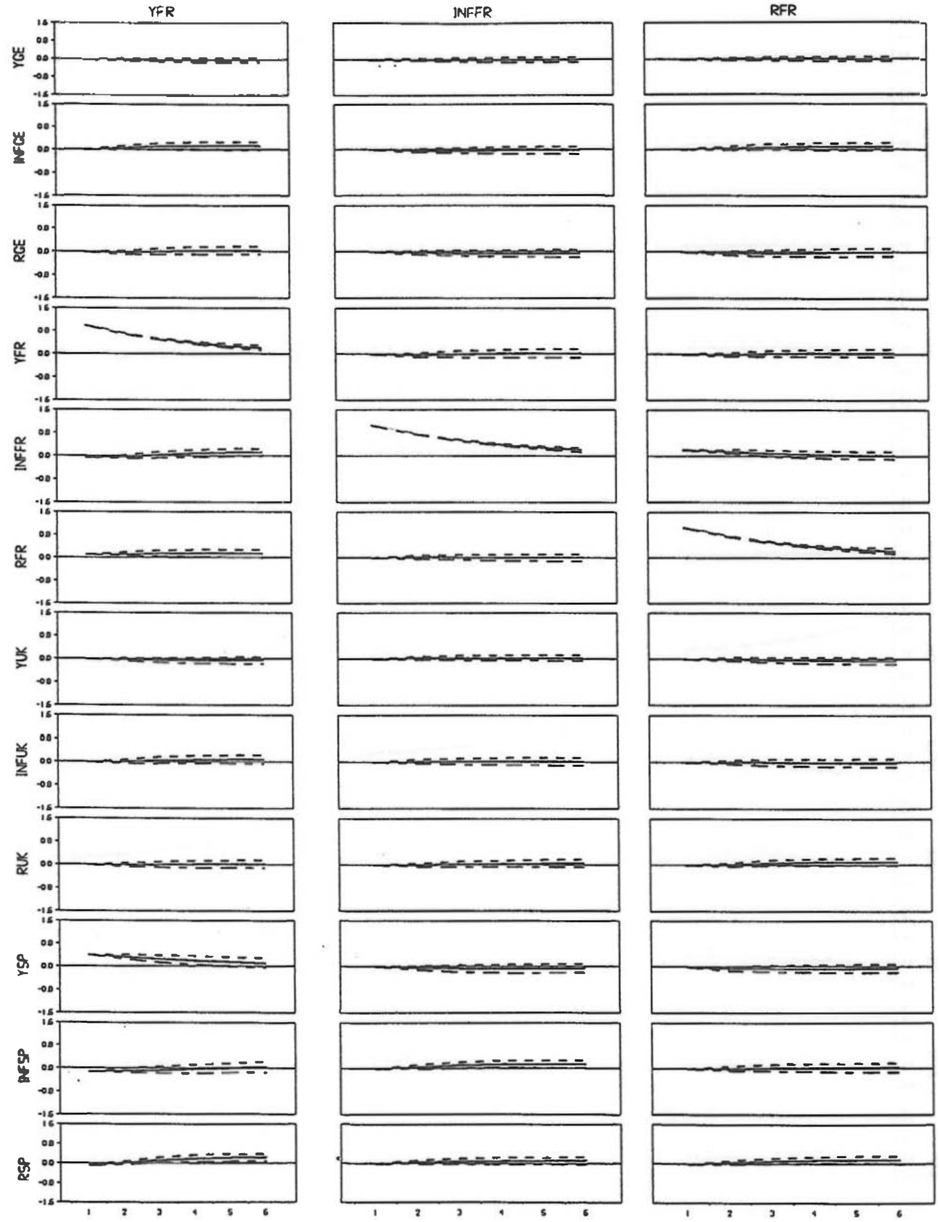


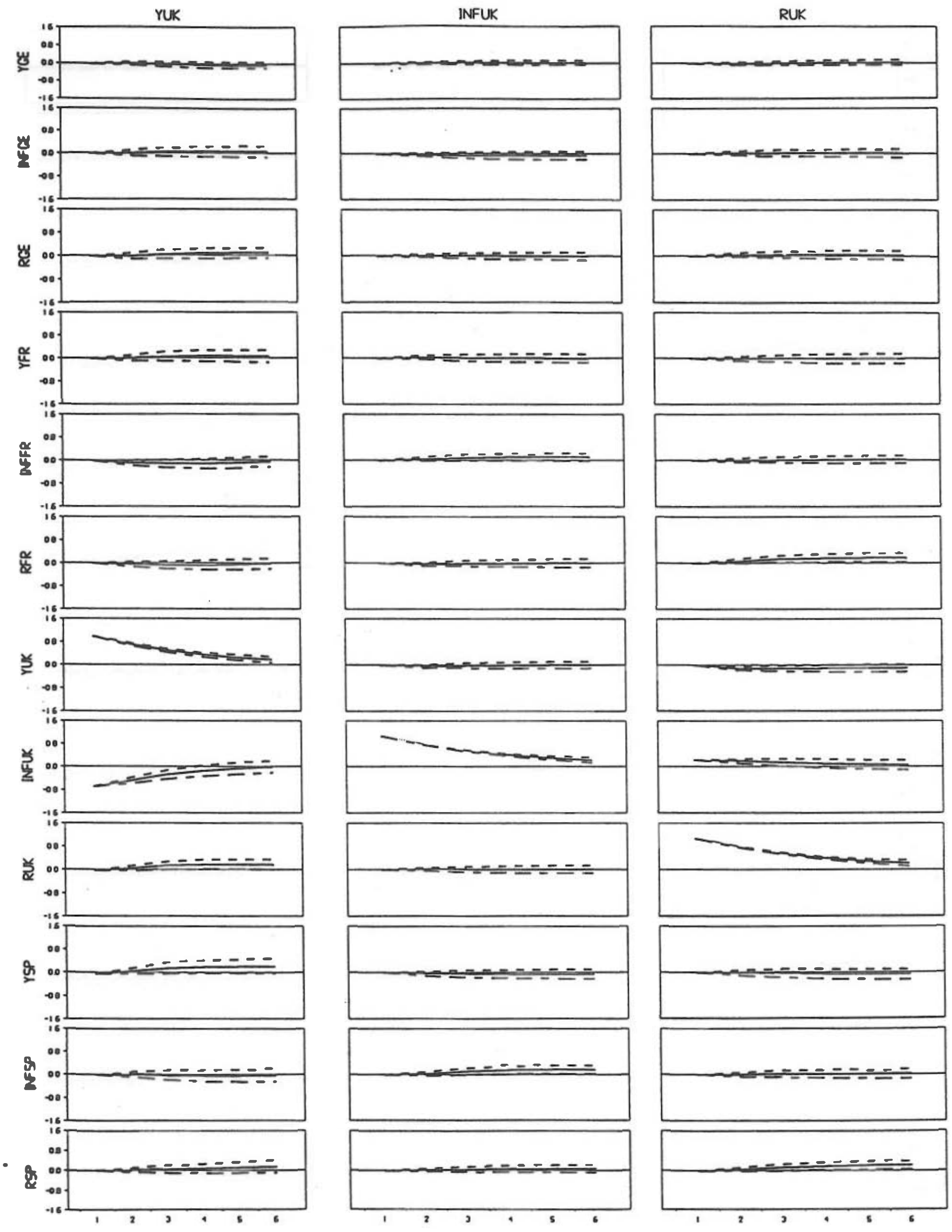
OP
YUS
RUS
YGE
INFGE
RGE
YFR
INFFR
RFR


OP
YUS
RUS
YUK
INFUK
RUK
YSP
INFSP
RSP

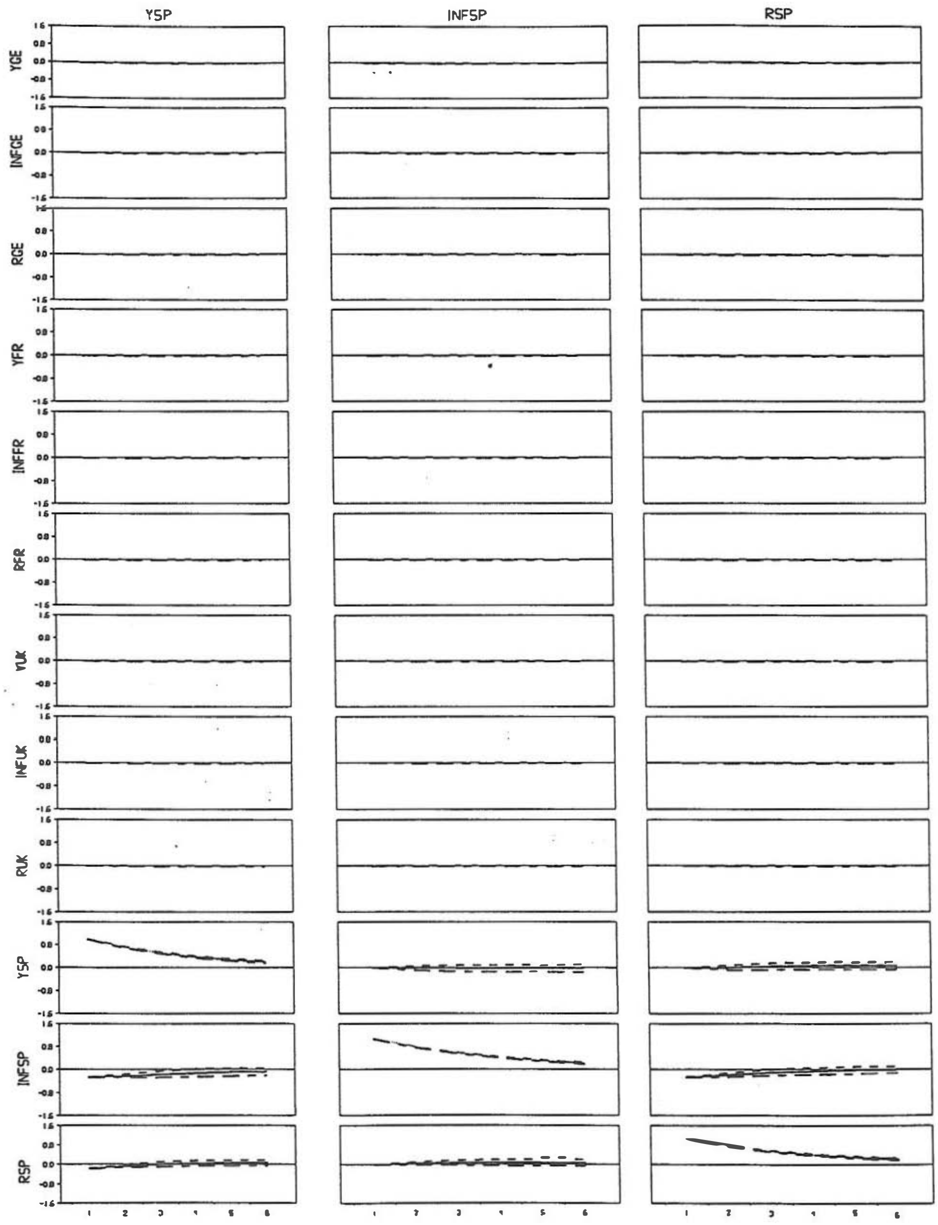


YGE
INFGE
RGE
YGE
INFGE
RGE
YFR
INFFR
RFR
YUK
INFUK
RUK
YSP
INFSP
RSP
1.6
0.8
0.0
-0.8
-1.6
1
2
3
4
5
6


YFR
INFFR
RFR
YGE
INFGE
RGE
YFR
INFFR
RFR
YUK
INFUK
RUK
YSP
INFSP
RSP
1
2
3
4
5
6



YUK
INFUK
RUK
YGE
INFGE
RGE
YFR
INFFR
RFR
YUK
INFUK
RUK
YSP
INFSP
RSP


YSP
INFSP
RSP
YGE
INFGE
RGE
YFR
INFFR
RFR
YUK
INFUK
RUK
YSP
INFSP
RSP

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