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ABSTRACT

This paper provides empirical evidence on the effectiveness of movements in nominal exchange rates in smoothing cyclical imbalances between countries, as explained by the literature on optimal currency areas. We use restrictions from the Mundell-Flemming model (on which the theory of optimal currency areas is based) to identify VAR systems that explain the exchange rate movements and the relative output movements of potential members of a European Monetary Union (EMU). We find that the shocks that cause most of the variation in relative output do not seem to result in movements in nominal exchange rates. Moreover, the shocks that explain movements in nominal exchange rates are monetary in nature, rather than real. Such results make it hard to argue that the loss of exchange rate flexibility accompanying EMU would come at a significant cost to macroeconomic stability.

I. INTRODUCTION

The Maastricht Treaty calls for a European Monetary Union (EMU) by the end of the decade. Given the political and economic significance of the changes envisaged in the treaty, it is not surprising that there has been -- and still is -- a heated debate in both academic and political circles about the economic desirability of EMU.

Much of the debate is focused on the potential cost of losing of the nominal exchange rate as a tool for macroeconomic stabilization. In particular, it has been argued that the nominal exchange rate can be an effective instrument for addressing international macroeconomic imbalances. The logic -- which goes back to Mundell's (1961) theory of optimal currency areas -- runs as follows: Suppose demand shifts away from the product of country A, and over to the product of country B. If labor is not mobile between countries, and if wages and prices are slow to adjust, then unemployment will develop in country A and inflationary expectations will build up in country B. If however exchange rates are free to adjust -- even within a limited range -- then there are two forces that may be expected to address the imbalance. First, market pressures will automatically move the nominal exchange rate in a way that helps the relative product price adjust, absorbing some of the effect of this "asymmetric" shock. And second, a counter cyclical monetary policy can be implemented in each country. Critics of EMU argue that both of these forces would be lost if the two countries were to form a monetary union.

Most of the existing empirical work on the potential costs of EMU tries to assess the importance of asymmetric shocks within the European Union.[1] ("Symmetric" shocks -- shocks that have a similar impact across countries -- do not require a relative price adjustment; they are not relevant for the issue at hand). A standard approach has been to compare the variability of real exchange rates within Europe with the variability of relative prices across regions within a given country, such as the United States; the European real exchange rates are generally found to be more variable.[2] Eichengreen (1991) has noted however that this approach does not distinguish between the size of a shock and the ability of a given economy to cope with it.[3] Furthermore, according to the theory, the response of the real exchange rate to a given shock depends on the exchange regime that is in place. These considerations led Bayoumi and Eichengreen (1993) (and others) to look for a more direct way to measure the size and symmetry of regional shocks.[4]

Bayoumi and Eichengreen used VAR techniques developed by Blanchard and Quah (1989) to identify shocks for countries in Europe and for regions within the US. They found that "only if the EC core is compared with the entire US ... is the magnitude and coherence of aggregate supply and demand disturbances comparable". They thus conclude that "Germany and its immediate EC neighbors (the EC core) come much closer than the Community as a whole to representing a workable monetary union along American lines". The implication seems to be that a narrow EMU would function satisfactorily, but that a wider EMU would experience large asymmetric shocks, leading to serious international imbalances, and perhaps to pressures on the newly created European System of Central Banks to adopt an excessively accommodating monetary stance, thereby endangering price stability.

This is probably a fair summary of the consensus view, a view that can be gleaned from a large number of empirical studies that have tried to assess the potential costs of EMU. However, we think that the literature has left two important gaps in the argument, and that the consensus it has reached may therefore be premature. In particular, the literature has not distinguished between real and monetary shocks,[5] and it has not asked whether nominal exchange rates actually move in response to the shocks that cause international macroeconomic imbalances.

The theory of optimal currency areas suggests that it is important to distinguish between real and monetary shocks. Flexible exchange rates are preferable (on grounds of macroeconomic stability) for aggregate supply and non-monetary demand shocks (henceforth 'demand' shocks), while a common currency (or a system of fixed rates) is preferable for money and financial market shocks.[6] Relative velocity shifts, misguided national monetary policy innovations, time varying risk premia and speculative currency attacks are examples of asymmetric shocks that could (in theory) cause macroeconomic imbalances under flexible rates, but would simply go away after a monetary union was formed. A group of countries that were experiencing asymmetric shocks of this type would be good candidates for a monetary union. An empirical assessment of the costs and benefits of EMU should try to differentiate between shocks to aggregate supply or demand on the one hand, and shocks to money and financial markets on the other.

Even if it were determined that goods market shocks are causing most of the international macroeconomic imbalances, it would still be necessary to verify that nominal exchange rates are actually moving to address the imbalances before concluding that EMU would be costly. The alternative hypothesis we have in mind can be stated as follows:

The Asset Price Hypothesis: The exchange rate acts primarily as an asset price in the financial markets. It responds to shocks that are not directly related to the macroeconomic imbalances. It is not the shock absorber for goods market disturbances that has been described by the theory of optimal currency areas.

Indeed, the real exchange rate volatility that has been documented in the literature may be entirely unrelated to the asymmetric shocks that cause international macroeconomic imbalances. If this were the case, then EMU would bring no additional costs. Asymmetric shocks might be causing significant macroeconomic imbalances, but nominal exchange rates would not be moving to address them. This issue seems to have received very little attention in the empirical literature.[7]

In this paper, we seek the answers to two specific questions.

Question 1: Among potential EMU participants, can most of the variation in nominal exchange rates be explained by the same shocks that explain the movements in relative national outputs?

Question 2: Among potential EMU participants, can much of the variation in the relative national outputs be explained by money and financial market shocks (as opposed to aggregate supply and demand shocks)?

The theory of optimal currency areas suggests that we would need a positive answer to the first question, and a negative answer to the second, before we could conclude that EMU would be costly to the macroeconomic stability of its members.

In order to proceed, we need some way of identifying shocks. Like Bayoumi and Eichengreen, we will use the VAR techniques developed by Blanchard and Quah (1989). Question 1 is not -- on the surface anyway -- very demanding in this regard; all it requires is a well defined classification of the shocks that move nominal exchange rates and relative national outputs. This classification does not have to correspond to the definition of shocks in any particular theory or model of exchange rate determination. Question 2 is more demanding. It requires us to identify money and financial market shocks, and to separate their effects on exchange rates and relative outputs from those of aggregate supply and demand shocks. This has to be done within the context of the Mundell-Flemming model, since it provides the theoretical foundation for the theory of optimal currency areas.[8]

The rest of the paper is organized as follows: In Section II, we provide an answer to Question 1 using the simplest VAR possible and what we think is a very natural classification of shocks. The VAR has only two variables: the exchange rate and the ratio of the national outputs of the two countries in question. Shocks are classified as "neutral" if they have no long run effect on relative output, and as "non-neutral" if they do. These VARs provide some useful insights, but it turns out that their simplicity and generality is both a strength and a weakness. The variance decompositions from these VARs can be interpreted in several ways, some of which are favorable to EMU and some of which are not. To differentiate between the competing interpretations, and to get an answer to Question 2, we need a classification of shocks that corresponds more closely to the shocks defined by the Mundell-Flemming model. More specifically, we need to identify what we will call the "money and financial markets" shock, and to set it apart from the "goods market" (aggregate supply and demand) shocks.

In Section III, we begin by reviewing the short run implications of the Mundell-Fleming model; these short run implications can be used as overidentifying restrictions on the impulse response functions to test our interpretation of the shocks in the VARs. It turns out that the impulse response functions of the VARs presented in Section II are rather uninformative; they do not confirm or deny that our initial classification of shocks -- as either neutral or non-neutral -- can be interpreted as a separation of the money and financial markets shock from the goods market shocks. We go on to specify several 3-variable VAR systems that might produce the desired classification of shocks. In Section IV, we present the most successful of these. We look at bilateral relationships between Germany and six European countries. We also look at bilateral relationships between periphery countries and a "core", using several different aggregations to define the core. In Section V, we summarize our results, and relate them to the recent empirical literature. Finally, in Section VI, we draw important policy conclusions from our analysis. We focus in particular on the economic viability of a European monetary union that extends beyond a small group of core countries.

II. A NATURAL AND PARSIMONIOUS APPROACH TO QUESTION 1

To answer either Question 1 or Question 2 we need a procedure that will allow us to classify shocks and assess their impact on the variables of interest. One method of doing this was developed by Blanchard and Quah (1989), and later extended by Bayoumi and Eichengreen (1993) and by Clarida and Gali (1994). The method consists of imposing long run identifying restrictions on a VAR model that captures the relevant economic interactions, here the short run effects of the various shocks on relative national outputs and nominal exchange rates. The identifying restrictions have to come from economic theory. Once the VARs are estimated, variance decompositions will us tell how much of the variation in each variable can be attributed to each of the shocks.

We begin with the most parsimonious VAR possible, given the questions that have to be addressed; it includes only the two variables of interest -- the nominal exchange rate and the ratio of the national outputs of the two countries in question. And we choose what would appear to be the most natural long run identifying restriction, given the two variables in the system: all shocks are classified as being either "neutral" or "non-neutral", depending on whether they have a long run affect on relative output. This classification of shocks is consistent with a wide range of macroeconomic theories, although the interpretation of which category a given shock might fall into may differ from one model to another. For example, monetary shocks are neutral (in the long run) in virtually all modern macroeconomic models, but government spending shocks are neutral (in the long run) in most Keynesian models and non-neutral in some endogenous growth models. (We discuss the classification of shocks in the Mundell-Flemming model at some length in the next section.) This generality is both a strength and a weakness. The variance decompositions that come from these simple VARs can have a more than one interpretation, and this will lead us to some difficulties in the end.

Identifying and Estimating the 2-variable VARs --

The log of the nominal exchange rate (e) and the log of the ratio of national outputs (y) are the two variables in the system. Using first differences (for stationarity), we start by assuming that the vector Δx_t = $[\Delta e_t, \Delta y_t]'$ has a structural interpretation given by:

(1) $\Delta x_t = C(L)\epsilon_t$,

where L is the lag operator and $\epsilon_t = [\epsilon_{nt}, \epsilon_{pt}]'$ is a vector of structural shocks; ϵ_{nt} is the neutral shock and ϵ_{pt} is the non-neutral (or permanent) shock. ϵ_t is serially uncorrelated and has a variance-covariance matrix normalized to the identity matrix.

The vector of structural shocks, ϵ_t, is not observed directly. The trick is to recover ϵ_t from an estimate of the moving average representation:

(2) $\Delta x_t = A(L)u_t$,

where the first matrix in the polynomial A(L) is the identity matrix, and the disturbance vector u_t has an estimated variance-covariance matrix Σ.

Equations (1) and (2) imply a linear relationship between ϵ_t and u_t:

$$(3) \quad u_t = C_0\epsilon_t.$$

We have to pin down the 2x2 matrix C_0 to be able to recover the vector of structural shocks, ϵ_t, from the estimated disturbance vector, u_t. Observing that the symmetric matrix $\Sigma = C_0C_0'$ imposes three of the four restrictions that are required, we need one more identifying restriction.

Let $C(1) = C_0 + C_1 + \ldots$ be the long run effect of ϵ_t on Δx_t coming from the structural form (1). Blanchard and Quah (1989) suggest that we use economic theory to impose the final restriction on C(1). Then, we can work our way back to C_0.

The long run representation of (1) can be written as:

$$(4) \quad \begin{bmatrix} \Delta e_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) \\ C_{21}(1) & C_{22}(1) \end{bmatrix} \begin{bmatrix} \epsilon_{nt} \\ \epsilon_{pt} \end{bmatrix}.$$

The long run identifying restriction is $C_{21}(1) = 0$; that is, the neutral shock has no long run effect on relative output. This restriction makes the matrix C(1) upper triangular, and we can use this fact to recover C_0. Equating (1) and (2) (in their long run form) and using (3), we see that $A(1) = C(1)C_0^{-1}$. A Cholesky decomposition of $A(1)\Sigma A(1)'$ gives the C(1) matrix. And finally, $C_0 = A(1)^{-1}C(1)$. This gives us the matrix we need in (3) to calculate the unobserved structural shocks. The long run restriction on C(1) fully identifies the VAR and its structural shocks. We are ready to estimate the two-variable VARs.

Here, we look at bilateral relationships between Germany and six of its potential EMU partners: we consider Germany vis-a-vis Austria, The Netherlands, France, Italy, Spain and the United Kingdom. While our sample does not include all 15 of the current EU Member States, it is nevertheless quite representative for our purposes. It contains what are generally thought of as core countries and periphery countries; it contains large and small countries; and it contains countries with different degrees of openness and (possibly) different economic structures.

We use quarterly data from the OECD's Main Economic Indicators: cross country differences in the log of real GDP for relative output and the log of quarterly averages for the exchange rate. The data runs from 1970:1 to 1985:4. This is the period between the end of the Bretton Woods System and the hardening of the Exchange Rate Mechanism of the EMS; we take it to be a period of flexible exchange rates (though we will see that this assumption is questionable in the cases of Austria and the Netherlands). For each bilateral relationship, we estimated a VAR in Δe and Δy; standard stationarity tests (Dickey-Fuller and Phillips-Perron) supported the use of first differencing.[9] The VARs include a constant and four lags.

Variance Decompositions for the 2-variable VARs --

Tables 1 and 2 show average variance decompositions at different forecast horizons. They also report (in parentheses) the standard deviations at each forecast step. These were obtained from a Monte Carlo exercise of 100 draws from the posterior distribution of the estimated VAR.

Table 1 shows the variance decompositions for relative output. Several interesting results emerge from it. First, in all of the bilateral relationships, and at all of the time horizons, the most important shock by far is the non-neutral shock, ϵ_p. For our purposes here, we are most interested in horizons of one or at most two years; this is the horizon over which monetary policy and exchange rate flexibility are presumed to be most potent. Reading across the table, the non-neutral shock explains over 90% of the variation in relative output after one year (or four quarters), and over 95% of the variation after two years; for Spain, the numbers are slightly lower. Put alternatively, the neutral shock, ϵ_n, has very little to do with the short run fluctuations in relative national outputs; it can only explain 5% to 10% of the variation at horizons of one to two years.

The results of Table 1 allow us to state Question 1 more precisely: can much of the variation in exchange rates be explained by the non-neutral shock, ϵ_p, which explains virtually all of the variation in relative national outputs? Table 2 suggests that the countries fall into two or three groups: For Austria, the Netherlands and France, the non-neutral shock explains 10-15% of the variation in exchange rates at horizons of one to two years; for Spain and the UK, it explains 15-20% of the variation; and for Italy, it explains about 40% of the variation.

So, what then is the answer to Question 1? The methodology we employ does not allow an explicit statistical inference; conclusions are necessarily impressionistic. This is the way we read the results: For Austria, the Netherlands, France, Spain and the UK as well, the shock that explains about 90-95% of variation of relative national outputs explains less (and in some cases much less) than 20% of the variation in nominal exchange rates. The nominal exchange rate is not moving much in response to the shocks that are causing virtually all of the international macroeconomic imbalances. It would probably not be costly in terms of macro-economic stability for any of these countries to join a monetary union with Germany, though the case is stronger for Austria, the Netherlands and France than it is for Spain and the UK. For Italy, the shock that explains most of the variation in relative output (more than 90%) also explains a significant proportion (40%) of the variation in exchange rate; for Italy, the costs of EMU may well be significant.

Further Interpretation and Some Caveats --

Figures 1 through 4 show the impulse response functions from the 2-variable VARs, along with two standard deviation confidence intervals. We will discuss these graphs in some detail in the next section. However, it is worth noting here that neither of the shocks has a very large effect on the nominal exchange rate in the cases of Austria and the Netherlands. Even in the period we are considering -- 1970 to 1985 -- these countries were maintaining a fairly tight peg to the DM; in effect, they already had something approaching a monetary union. The data and the variance decompositions for these countries may therefore be rather uninformative for our purposes.

We quickly run into difficulty if we try to push the interpretation of these variance decompositions much further. In particular, it matters critically whether we think that the neutral shock, ϵ_n, is composed primarily of money and financial market shocks, or of shocks to aggregate supply and demand.

If we think the neutral shock reflects money and financial market shocks then we have support for the Asset Price Hypothesis put forward in the introduction. The real exchange rate volatility that has been documented across countries in Europe was caused by money and financial market disturbances; it is not an indication that flexible rates are needed to smooth international macroeconomic imbalances. In addition, we have an answer to Question 2. The (relative) money and financial market shocks that would be eliminated by the formation of a currency union were not being transmitted to the goods markets; these countries should not expect a substantial stabilization gain from EMU.

On the other hand, if we think that the neutral shock reflects aggregate supply and demand disturbances, then a critic of EMU could give the variance decompositions a much less sanguine interpretation: it might be argued that nominal exchange rates were so effective at absorbing these shocks that they were not allowed to destabilize relative outputs to any measurable degree. We are somewhat skeptical of this extreme interpretation, and the literature on optimal currency areas does not explain why exchange rates should absorb some goods market shocks and not others. Nevertheless, this interpretation can not be ruled out on the basis of the VARs presented here.

If progress were to be made on these issues, we would need to find a VAR system with a classification of shocks that is more consistent with the Mundell-Flemming model. We turn to that in the next section.

III. IDENTIFYING SHOCKS IN THE MUNDELL-FLEMMING MODEL

The Mundell-Flemming model provides the theoretical foundation for the theory of optimal currency areas. First, we review its implications for the behavior of relative outputs, the nominal exchange rate, relative product prices, and the real exchange rate. Then, we look at impulse response functions of the VARs presented in the last section to see if the neutral shock can be interpreted as a money and financial markets shock. Finally, we discuss ways in which 3-variable VARs might be identified to produce a classification of shocks that is more consistent with the Mundell-Flemming model; we suggest three different VAR structures.

Implications of the Mundell-Flemming Model --

The key assumptions of the Mundell-Flemming model are: (1) sticky price and output adjustment, and (2) national outputs that are imperfect substitutes in consumption. The real exchange rate is the relative price of two countries' products. Clarida and Gali (1994) provide an exposition of the model that is well suited to our purposes; here, we will just summarize the results that are of interest to us.[10]

First, it should be emphasized that we are only interested in "asymmetric" or relative shocks. Common or "symmetric" shocks do not require any adjustment in the real exchange rate, and are therefore not part of the optimal currency area argument. The shocks in the Mundell-Flemming model can be put into three categories: "money and financial markets" shocks, ϵ_f; "aggregate demand" shocks, ϵ_d; and "aggregate supply" shocks, ϵ_s. Sometimes we refer to the last two collectively as "goods market" shocks. ϵ_f shocks include changes in the ratio of home and foreign money supplies, relative velocity shifts, and such things as time varying risk premia (or more generally, speculative currency attacks). ϵ_d shocks are relative absorption shocks, such as a change in the ratio of home to foreign government spending. ϵ_s shocks are relative supply shocks, such as a change in the ratio of home to foreign productivity.

The model's implications for these shocks can be summarized as follows:

ϵ_d: A positive relative absorption shock creates an excess demand for home output relative to foreign output. In the short run, both real and nominal exchange rates appreciate, the relative product price rises, and relative output increases; in the long run, relative output returns to its full employment level and the real exchange rate appreciates if the shock is permanent.

ϵ_s: A positive relative supply shock creates an excess supply for home output relative to foreign output. In the short run, both real and nominal exchange rates depreciate, the relative product price falls, and relative output increases; in the long run, relative output goes to a higher full employment level and the real exchange rate depreciates if the shock is permanent (as suggested by most of the real business cycle literature).

ϵ_f: A positive relative money or financial markets shock lowers the home interest rate relative to the foreign interest rate. In the short run, both real and nominal exchange rates depreciate, the relative product price rises, and relative output increases; in the long run, relative output returns to its full employment level, and there is no effect on the real exchange rate.

Interpretation of the Neutral Shock in the 2-variable VARs --

The 2-variable VARs presented in the last section were identified by a single long run restriction: the neutral shock has no effect on output. This is the only restriction that was imposed on the data. We can use the results outlined above as "overidentifying" restrictions to interpret the neutral shock in terms of the Mundell-Flemming model. In particular, if over the sample period ϵ_n was primarily a positive (negative) money and financial markets shock, then it should have depreciated (appreciated) the exchange rate and expanded (decreased) relative output in the short run. On the other hand, if ϵ_n was primarily a positive (negative) aggregate demand shock, then it should have appreciated (depreciated) the exchange rate and increased (decreased) relative output in the short run. We can use the impulse response functions from the VARs to test these overidentifying restrictions.

Figure 1 shows the exchange rate impulse response functions for the neutral shock, along with their two standard deviation confidence intervals. In each case, ϵ_n causes a significant depreciation. Figure 3 shows the impulse response functions for relative output. In some cases, ϵ_n appears to increase relative output, which (when coupled with the exchange rate's depreciation) suggests a positive money and financial markets shock; in others, ϵ_n appears to decrease relative output, which (when coupled with the exchange rate's depreciation) suggests a negative aggregate demand shock. In no case however is the response more than marginally significant. Our tests of the overidentifying restrictions are basically inconclusive. Our confidence in the labeling of the two shocks has to ride on our belief in the long run restrictions that were used to identify the VARs in the first place, and here we have a problem. In the Mundell-Flemming model, both the money and financial markets shock and the aggregate demand shock are generally thought to be neutral in the long run; they both look like our neutral shock, ϵ_n.

This means that the 2-variable VARs -- while capable of providing an answer to Question 1 -- are open to conflicting interpretations, as suggested at the end of the last section. Some other identification procedure might produce a separation between money and financial markets shocks and goods market shocks, but we do not know what that identification procedure might be. Reluctantly, we conclude that the parsimonious 2-variable VARs will not suffice. To identify all three of the shocks in the Mundell-Flemming model, using the Blanchard Quah (1989) methodology, we need to go on to 3-variable VARs.

Identifying 3-variable VARs --

If we could observe ϵ_d directly, then we could work with the three dimensional vector $\Delta x_t = [\Delta e_t, \Delta\epsilon_{dt}, \Delta y_t]'$. ϵ_{dt} is however an unobserved combination of aggregate demand shocks. Our first approach is to choose an important source of aggregate demand shocks and hope that it is a good proxy for ϵ_d.

Letting g_t be the (log of the) ratio of government spending in the two countries, we set $\Delta x_t = [\Delta e_t, \Delta g_t, \Delta y_t]'$.[11] Following the procedure outlined in the last section, we now need three long run identifying restrictions. We assume that neither the money and financial markets shock nor the government spending shock has a long run effect on output; furthermore, we assume that the money and financial markets shock has no long run effect on government spending:

$$(5)\quad \begin{bmatrix} \Delta e_t \\ \Delta g_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) \\ 0 & C_{22}(1) & C_{23}(1) \\ 0 & 0 & C_{33}(1) \end{bmatrix} \begin{bmatrix} \epsilon_{ft} \\ \epsilon_{gt} \\ \epsilon_{st} \end{bmatrix}.$$

This 3-variable VAR is fully identified. We will present variance decompositions from it in the next section, and we will look at the impulse response functions to see if the 3-variable VAR does a better job of separating the money and financial markets shock from the goods market shocks than the 2-variable system.

We also looked at two other 3-variable systems. One is inspired by Clarida and Gali (1994). Letting p_t be the (log of the) relative product price (so that $e_t + p_t$ is the real exchange rate), we set $\Delta x_t = [\Delta e_t, \Delta p_t, \Delta y_t]'$. Following Clarida and Gali, the long run identifying restrictions are that neither the money and financial markets shock nor the aggregate demand shock has an effect on output, and that the money and financial markets shock does not have an effect on the real exchange rate:

$$(6)\quad \begin{bmatrix} \Delta e_t \\ \Delta p_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) \\ C_{21}(1) & C_{22}(1) & C_{23}(1) \\ 0 & 0 & C_{33}(1) \end{bmatrix} \begin{bmatrix} \epsilon_{ft} \\ \epsilon_{dt} \\ \epsilon_{st} \end{bmatrix},$$

where $C_{11}(1) + C_{21}(1) = 0$.

The last VAR system we identify is in a sense analogous to the first; it uses a proxy for the money and financial markets shock instead of the aggregate demand shock. Letting v_t be the (log of the) ratio of velocities in the two countries, we set $\Delta x_t = [\Delta e_t, \Delta v_t, \Delta y_t]'$. The long run identifying restrictions are that neither the velocity shock nor the aggregate demand shock has an effect on output, and that the demand shock does not have an effect on velocity:

$$
(7)\quad \begin{bmatrix} \Delta e_t \\ \Delta v_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) \\ 0 & C_{22}(1) & C_{23}(1) \\ 0 & 0 & C_{33}(1) \end{bmatrix} \begin{bmatrix} \epsilon_{dt} \\ \epsilon_{vt} \\ \epsilon_{st} \end{bmatrix}.
$$

IV. ANSWERS TO QUESTIONS 1 & 2 FROM A 3-VARIABLE SYSTEM

Three different VAR systems were identified in the last section. The first -- the one with $\Delta x_t = [\Delta e_t, \Delta g_t, \Delta y_t]'$ -- seems to have performed the best.[12] We focus on it in this section. We will return to the problem of identification at the end of the section.

Bilateral Relationships with Germany --

We look at the same bilateral relationships as before; that is, we look at Germany vis-a-vis Austria, The Netherlands, France, Italy, Spain and the United Kingdom. And as before, we use quarterly data from the OECD's Main Economic Indicators: cross country differences in the log of real GDP for relative output; the log of quarterly averages for the exchange rate; and cross country differences in the log real government consumption for relative government spending. The data runs from 1970:1 to 1985:4. The VARs include a constant and four lags.

Tables 3 and 4 show average variance decompositions at different forecast horizons for the two variables of interest: relative output and the exchange rate. They also report the standard errors at each forecast step. These were obtained from a Monte Carlo exercise of 100 draws from the posterior distribution of the estimated VAR.

Table 3 shows the variance decompositions for relative national outputs. In all of the bilateral relationships, and at all of the time horizons, the most important shock by far is the relative supply shock, ϵ_s. As before, we are most interested in horizons of one or at most two years. Reading across the table, relative supply shocks explain 71-86% of the variation in relative output after one year (or four quarters), and 81-92% of the variation after two years. By contrast, almost none of the variation in relative output is explained by the money and financial markets shock,

ϵ_f. Reading across the table, this shock explains only 4-10% of the variation after one year, and only 2-6% after two years.

This provides a clear answer to Question 2. For any one of these countries, eliminating the money and financial markets shock (by entering into a monetary union with Germany) would be expected to reduce macroeconomic imbalances with Germany by at most 5-10%. These imbalances seem to be explained almost entirely by the shocks to aggregate supply and demand[13].

Moreover, the results of Table 3 allow us to state Question 1 more precisely: can most of the variation in exchange rates be explained by the shocks to aggregate supply and demand, which collectively explain more than 90% of the variation in relative national outputs? Table 4 suggests that (even after excluding Italy) the answer is more ambiguous here than was with the 2-variable VARs. Excluding Italy, shocks to aggregate supply and demand explain 19-33% of the variation in exchange rates after one year, and 31-41% after two years.

While the evidence presented in Tables 3 and 4 is much weaker than in Tables 1 and 2, it may still be the case that (with the exception of Italy) it would not be costly for any one of the countries considered to enter into a monetary union with Germany. The decisions that have to be made by the end of the decade are however more complicated than that. If EMU comes about, it will most likely consist of a subset, or core, of the EU member states. The relevant issue will be which, if any, of the countries on the periphery should be admitted. With this in mind, we define cores of various sizes, and look at bilateral relationships between periphery countries and the core.

Bilateral Relationships with the Core --

The smallest core we consider -- CORE 1 -- consists of Germany, Austria and the Netherlands.[14] This is a natural choice since these countries already have a de facto monetary union that severely limits exchange rate movements, even in our sample period. This is evident from the impulse response functions pictured in Figures 5, 6 and 7; none of the shocks produce a very large exchange rate response in these countries. As mentioned in Section II, the variance decompositions for Austria and the Netherlands may not be very informative for our purposes.

As before, the VARs include (logged changes in) the exchange rate, relative government consumption, and relative output. Core output and core government consumption are the sums of the individual member country variables, using 1990 PPP weights; core exchange rates are effective nominal exchange rates, using real GDP (in PPP terms) as weights.

Table 5 shows the variance decompositions from these VARs. The money and financial markets shock, ϵ_f, explains very little of the variation in relative output -- only 4-8% after one year and 2-4% after two. And, excluding Italy, the shocks that explain most of the variation in relative output, ϵ_g and ϵ_s, explain relatively little of variation in exchange rates -- only 20-25% after one year and 25-30% after two. In the case of Italy, however, ϵ_g and ϵ_s do explain almost 40% of the variation in exchange rates at both horizons. Here, it is interesting to note, the results are stronger than they were in bilateral relationships with Germany, and almost as strong as they were with the 2-variable VARs. With the possible exception of Italy, it seems that any one of the countries could join CORE 1 at low cost.

Does it continue to make sense for periphery countries to join as we sequentially add more countries to the union? CORE 2 adds France to the union, and then CORE 3 adds Spain. Tables 6 and 7 report the variance decompositions from the corresponding VARs. The basic message does not change, and once again the results are much stronger than they were in the original bilateral relationships with Germany (Tables 3 and 4). With the possible exception of Italy, it seems that any of the periphery countries could join the union at low cost.

The variance decompositions from the bilateral relationships with any of the cores (Tables 5, 6 and 7) seem quite consistent with the variance decompositions from the 2-variable VARs (Tables 1 and 2). Results from the 3-variable bilateral relationships with Germany are more ambiguous. We are not sure why. However, we have already noted that the Austrian and Dutch exchange rate impulse response functions do not show a large response for any of the shocks. These countries have in effect already formed a monetary union with Germany, and it probably makes sense to think of Germany, Austria and the Netherlands as a single unit for our purposes.

Testing the Overidentifying Restrictions --

So far, we have just taken our identification of the three shocks -- ϵ_f, ϵ_d, and ϵ_s -- for granted. However, we can once again use the short run implications of the Mundell-Flemming model as overidentifying restrictions, and we can see if the 3-variable VARs do a better job of identifying the money and financial markets shock, and setting it apart from the goods market shocks, than the 2-variable VARs.

Figures 5 through 7 show the impulse response functions for the exchange rate, and their two standard deviation confidence intervals. In each case, ϵ_f causes a significant depreciation in the short run. If ϵ_f is indeed a money and financial markets shock, then it should also increase relative output in the short run. Figures 8 through 10 show the impulse response functions for relative output. In some cases ϵ_f causes relative output to rise while in others it causes relative output to fall, but in no case does the response appear to be significant. The results are similarly inconclusive for the other two shocks. In each case, ϵ_s causes a significant increase in relative output. If ϵ_s is indeed a supply shock, then it should cause the exchange rate to depreciate. However, the exchange rate response is insignificant in five of the six cases; for Italy, it appears to cause a significant depreciation, at least in the very short run. And finally, in each case ϵ_d causes insignificant responses in both relative output and the nominal exchange rate.

There is some evidence in these figures that ϵ_f is indeed a pure money and financial markets shock, and that it is not contaminated by demand shocks that were not included in ϵ_d. In all cases, ϵ_f causes a significant depreciation, and in all cases ϵ_d has an insignificant effect on the exchange rate. There can be no doubt that ϵ_d itself is an aggregate demand shock; government spending is an important component of aggregate demand. If shocks to the other components of aggregate demand have a similarly insignificant effect on the exchange rate, then the significant depreciations we attribute to ϵ_f suggest that another shock -- ie. the money and financial markets shock -- is at work here.

However, our formal tests of the overidentifying restrictions are basically uninformative. They neither confirm or deny our identification of the shocks. Our confidence in the identification of the three shocks has to ride largely on our a priori belief in the long run restrictions that were used to identify the VARs in the first place.

V. SUMMARY AND DISCUSSION OF THE EMPIRICAL RESULTS

Using quarterly data from 1970 to 1985, we looked at bilateral relationships between Germany and six other European countries -- Austria, the Netherlands, France, Italy, Spain and the UK; we also looked at bilateral relationships between a core (composed of Germany, Austria and the Netherlands) and four periphery countries -- France, Italy, Spain and the UK. To do this, we estimated a 2-variable VAR that was general and parsimonious, and a 3-variable VAR that was designed to capture the shocks defined by the Mundell-Flemming model.

The 2-variable VARs told much the same story as the 3-variable VARs for the bilateral relationships with the core. They showed that the money and financial markets shock explains less than 10% of the short run variation in relative national outputs; in many cases, it was less than 5%. On the other hand, the money and financial markets shock explained 70-80% of the variation in the nominal exchange rates at those horizons; in most cases it was more than 75%. Italy was the only exception to this; for Italy, the shocks that explained most of the relative output movements also explained close to half of the variation in exchange rates. Supply shocks alone accounted for about 85% of the variation in relative output, but (excluding Italy) they accounted for less than 20% of the variation in exchange rates.

In summary, for our sample period from 1970 to 1985, we give a negative answer to Question 1 (with the possible exception of Italy): the shocks that caused international macroeconomic imbalances do not seem to have been the shocks that were moving nominal exchange rates. And we also give a negative answer to Question 2: the shocks that would be eliminated by joining a currency union do not seem to have been an important source of international macroeconomic imbalances.

These results lend support to what we have called the Asset Price Hypothesis: during our sample period from 1970 - 1985, nominal exchange rates seem to have been acting as asset market prices, responding to financial market pressures that did not ultimately lead to macroeconomic imbalances; they do not seem to have been shock absorbers for goods market disturbances. If this interpretation is correct, then our results probably understate the importance of financial market shocks in exchange rate determination today, since free capital mobility was established in Europe well after 1985. In any case, it seems hard to argue (except possibly in the case of Italy) that exchange rates have moved to correct international macroeconomic imbalances in Europe.

If however one distrusts our identification of the money and financial markets shock in the 3-variable system, then a less sanguine interpretation is possible. A critic of EMU might argue that what we call the money and financial market shock, ϵ_f, is actually an aggregate demand shock, and that exchange rates have been so successful at absorbing these shocks that they have not passed on to destabilize relative outputs. This is an extreme interpretation of our results, and we find it rather implausible.

Our work in this paper complements a growing empirical literature that has tried to document the potential costs of EMU. This literature -- as exemplified by Bayoumi and Eichengreen (1993), De Grauwe and Vanhaverbeke (1993), and Ballabriga et al. (1995), and von Hagen and Neumann (1994) -- finds large asymmetric shocks and volatile real exchange rate movements across the countries of Europe. Given the sluggish nature of price levels, the implication would seem to be that flexible nominal exchange rates are needed to achieve the real exchange rate adjustments that smooth national macroeconomic imbalances.

We think our results are consistent with the earlier findings, but they have a very different implication. We have argued that it is hard to relate nominal exchange rate movements to the shocks that cause national macroeconomic imbalances. What then is the source of the real exchange rate volatility that has been observed by others? Our results suggest to us that the real exchange rate volatility has been caused by volatility in nominal exchange rates, which have been acting like asset market prices, and responding to shocks in money and financial markets. Under this interpretation, the bulk of the real exchange rate movements has been exogenous to the goods market; and fortunately, our results suggest that this real exchange rate volatility has not gone on to create additional macroeconomic imbalances.

Our results are also consistent with a number of recent empirical studies. A large body of work -- exemplified by Baxter and Stockman (1989), European Commission (1990), Erkel-Rousse and Mélitz (1995), Flood and Rose (1995), Rose (1995), Gros (1996), and Viñals and Jimeno (1996) -- finds little evidence to suggest that moving from a floating rate regime to a fixed rate regime would worsen real macroeconomic performance; in fact, some of these studies find no discernable effect on macroeconomic variables of switches in the exchange rate regime. Kim and Roubini (1995) use a VAR with contemporaneous restrictions, and find that monetary policy shocks are of relatively little importance in explaining the output movements of G-7 countries. Canova and Di Nocoló (1995) employ large VARs to explain the movements of a variety of real and financial variables; they report that movements in exchange rates are explained almost entirely by their own innovations.

Our results do appear to differ substantially from those of Clarida and Gali (1994). Using VAR techniques that are similar to our own, Clarida and Gali find (in some cases anyway) that aggregate demand shocks explain much more of the variation in real exchange rates than do money and financial market shocks. Clarida and Gali put different variables in their VAR, they look at different countries than we do, and they use different long run restrictions to identify their shocks.[15] Still, we find the disparity in results discomforting.

VI. CONCLUSIONS AND POLICY IMPLICATIONS

As the time for making decisions on EMU draws near, much of the discussion -- in both academic and political circles -- has focused on the potential costs of losing the exchange rate and national monetary policies as tools of macroeconomic stabilization. So far, most of the empirical work on the issue has gone into documenting the existence of asymmetric shocks (which are thought to cause macroeconomic imbalances) and the existence of large real exchange rate movements (which are thought to be needed to address the imbalances). The general conclusion has been that a small union centered around Germany (including the Benelux countries and possibly France) might be viable, but that a wider union would probably be too costly.

Our main conclusion for policy is that larger unions may also be viable. Starting with a small union composed of Germany, Austria and the Netherlands, we showed the stabilization efforts of France, Spain, or the UK would not be much affected by a loss of the exchange rate tool if those three countries were to be also part of the union. Aggregate supply and (non-monetary) demand shocks explain over 90% of the variation in relative output between these countries and the "core", but these shocks explain only about 25% of the variation in exchange rates. The exchange rate seems to be acting more like an asset price than the "shock absorber" described by the literature on optimal currency areas. Moreover, the money and financial market shocks explain less than 10% of the variation in relative output. When we expanded the union to include France, we got much the same answer. Spain and the UK could join the union at low cost.

We also looked at Italy, and it seems to be a border line case. Aggregate supply and (non-monetary) demand shocks explain at least 95% of the variation in Italy's output relative to either definition of the core, but these shocks also explain about 40% of the variation in its nominal exchange rate. Even in the case of Italy, we suspect that the cost of EMU would be small.

Two final comments should be made about our analysis. The first suggests that our results, if anything, understate the role of financial shocks in moving exchange rates. We looked at data from 1970 to 1985, because we wanted to a period in which exchange rates could reasonably be described as flexible. However, this was also a period in which capital flows were much more restricted than they are now. If our interpretation of the data is correct, we should expect to see exchange rates act even more like asset prices in the future. The second comment suggests caution. We have looked at "average" shocks and their effect on the stabilization effort. It might be argued that flexible exchange rates are needed for the big shocks that come, say, once a decade. Our methodology is obviously not well suited to analyze this question.

All in all, however, we conclude that exchange rates do not seem to have played the "shock absorber" role that the literature on optimal currency areas suggests, nor do they seem likely to in the future. While assessing the overall desirability of EMU is a very complex issue which involves an evaluation of both costs and benefits, the costs of EMU appear to us to have been exaggerated.

ENDNOTES:

1. Bayoumi and Eichengreen (1993) provide a nice survey of the literature.

2. See for example Polo (1990), Eichengreen (1990), De Grauwe and Vanhaverbeke (1991), and von Hagen and Neumann (1994).

3. For example, the lower variability typically found in US regional relative prices may be due to smaller asymmetric shocks, or it may be due to the higher labor mobility and the faster adjustment of real wages that also characterize the US economy.

4. See also Cohen and Wyplosz (1988) and Ballabriga, Sebastián, and Vallés (1995).

5. Erkel-Rousse and Mélitz (1995) is a notable exception. Erkel-Rousse and Mélitz extend the VARs of Bayoumi and Eichengreen, trying to identify monetary and fiscal policy shocks. They argue that monetary shocks go primarily to prices in Europe, and not to quantities. Thus, they conclude, little would be lost by adopting a common currency. There has also been some experimentation with large structural models. See for example Minford, Rastogi, and Hughes Hallet (1993) for a much less sanguine assessment of EMU.

6. These are the implications of the Mundell-Flemming model; they come from a literature that parallels the "Poole" literature (on whether it is better to fix a nominal interest rate or a monetary aggregate). Buiter (1995) is a recent example.

7. There is of course a substantial literature that has failed to link the nominal exchange rate to economic fundamentals at horizons of one or two years, and one might interpret this literature as having already rendered a verdict on the issue. We will discuss how our work relates to the wider empirical literature in a later section.

8. The use of sticky price models has of course been questioned, on both theoretical and empirical grounds. We are not taking a stand on that issue here. The Mundell-Flemming model is necessarily a maintained hypothesis in the present paper; if we simply dismiss the Mundell-Flemming model (on either logical or empirical grounds), then there is no basis for the optimal currency areas argument, or the potential costs of EMU that it identifies.

9. We also checked for cointegrating vectors. In no case could we reject the null of no cointegration at the 10% level using the Johansen (1991) maximum likelihood procedure. We performed the cointegration tests with two lags and allowed for an intercept in the cointegrating relationship and a deterministic trend in levels.

10. In some cases, results depend on parameter restrictions; see Clarida and Gali (1994). We simply state what are usually taken to be the implications of this well known model.

11. Once again, we require stationarity in the variables that go into the VAR. Standard stationarity tests (Dickey-Fuller and Phillips-Perron) support our use of first differences. We also could not reject the null hypothesis of no cointegration at the 10% significance level for all the countries except in Spain using Johansen's (1991) maximum likelihood procedure. We performed the cointegration tests in the system [Δy, Δg, Δe] with two lags and allowing for an intercept in the cointegration relation and a deterministic trend in levels. In the Spanish case we could not reject the null of no cointegration at the 5% significance level when we included in the above specification a trend in the cointegration relation.

12. With the other two systems -- [Δe_t, Δp_t, Δy_t]' and [Δe_t, Δv_t, Δy_t]' -- we had problems with the short run overidentifying restrictions, and the variance decompositions were implausible for some countries. For example, ϵ_f explained 40-50% of the variation of relative output in the cases of the UK and Spain (vis-a-vis Germany); nowhere in the literature, published or unpublished, have we been able to find comparable results for monetary disturbances.

13. If we were able to disentangle relative monetary shocks into relative money supply shocks and relative money demand shocks, we would expect the sum of those two shocks to be more important in explaining relative output. We would expect the same result if monetary shocks could affect in the long run public consumption through the intertemporal government budget constraint.

14. We are of course limiting our definition of the core to countries that are in our data set.

15. Their VAR consists of: relative national output, relative price levels, and the real exchange rate. Their long run identifying restrictions are: money/financial market shocks have no long run effect on relative output or the real exchange rate, and aggregate demand shocks have no long run effect on relative output. All of their bilateral relationships are with the US.

Table 1
SOURCES OF FLUCTUATIONS FOR RELATIVE OUTPUT

	AUSTRIA		NETHERLANDS		FRANCE	
	ϵ_n	ϵ_p	ϵ_n	ϵ_p	ϵ_n	ϵ_p
Forecast Step						
1	4.5	95.4	2.9	97.1	9.2	90.7
	(6.5)	(6.5)	(4.1)	(4.1)	(13.5)	(13.5)
2	7.5	92.4	3.5	96.4	10.7	89.2
	(7.4)	(7.4)	(4.1)	(4.1)	(11.8)	(11.8)
4	7.3	92.6	4.0	95.9	7.9	92.0
	(5.2)	(5.2)	(3.4)	(3.4)	(11.4)	(11.4)
6	5.1	94.8	4.3	95.6	6.1	93.8
	(3.4)	(3.4)	(3.3)	(3.3)	(9.9)	(9.9)
8	4.3	95.6	3.9	96.0	4.8	95.1
	(3.0)	(3.0)	(3.1)	(3.1)	(8.3)	(8.3)
20	2.1	97.8	2.2	97.8	1.9	98.0
	(1.9)	(1.9)	(2.0)	(2.0)	(2.8)	(2.8)

	ITALY		SPAIN		UK	
	ϵ_n	ϵ_p	ϵ_n	ϵ_p	ϵ_n	ϵ_p
Forecast Step						
1	15.4	84.5	20.9	79.0	10.0	89.9
	(13.7)	(13.7)	(15.7)	(15.7)	(13.9)	(13.9)
2	8.8	91.1	17.4	82.6	8.3	91.6
	(9.2)	(9.2)	(14.4)	(14.4)	(12.5)	(12.5)
4	4.6	95.3	14.6	85.3	6.9	93.0
	(4.2)	(4.2)	(13.2)	(13.2)	(10.6)	(10.6)
6	3.9	96.0	8.9	91.0	5.3	94.6
	(3.5)	(3.5)	(9.9)	(9.9)	(8.7)	(8.7)
8	3.4	96.5	6.1	93.8	4.1	95.8
	(3.1)	(3.1)	(7.4)	(7.4)	(7.0)	(7.0)
20	1.6	98.3	2.3	97.6	1.6	98.3
	(1.7)	(1.7)	(2.6)	(2.6)	(2.4)	(2.4)

Notes:

The sample period is 1970:1 - 1985:4. The VAR includes a constant and four lags of changes in relative output (Δy_t) and changes in the nominal exchange rate (Δe_t).

In each column we present the percentage of the variance decomposition for the level of relative output due to ϵ_{nt} and ϵ_{pt} shocks. In parenthesis is the estimated standard deviation computed from Monte Carlo simulations.

Table 2
SOURCES OF FLUCTUATIONS FOR NOMINAL EXCHANGE RATES

	AUSTRIA		NETHERLANDS		FRANCE	
	ϵ_n	ϵ_p	ϵ_n	ϵ_p	ϵ_n	ϵ_p
Forecast Step						
1	95.2	4.7	97.0	2.9	89.3	10.6
	(5.3)	(5.3)	(4.1)	(4.1)	(14.6)	(14.6)
2	94.5	5.4	95.8	4.1	89.3	10.6
	(5.8)	(5.8)	(4.8)	(4.8)	(14.1)	(14.1)
4	89.2	10.7	93.4	6.5	88.9	11.0
	(9.1)	(9.1)	(5.4)	(5.4)	(13.8)	(13.8)
6	83.9	16.0	84.3	15.6	87.5	12.4
	(12.8)	(12.8)	(10.0)	(10.0)	(14.3)	(14.3)
8	81.3	18.6	84.7	15.2	85.9	14.0
	(14.6)	(14.6)	(10.4)	(10.4)	(14.9)	(14.9)
20	79.0	20.9	83.8	16.1	84.0	15.9
	(17.2)	(17.2)	(12.6)	(12.6)	(16.5)	(16.5)

	ITALY		SPAIN		UK	
	ϵ_n	ϵ_p	ϵ_n	ϵ_p	ϵ_n	ϵ_p
Forecast Step						
1	66.6	33.3	84.5	15.4	88.7	11.2
	(18.1)	(18.1)	(13.7)	(13.7)	(15.8)	(15.8)
2	62.8	37.1	87.6	12.3	87.6	12.3
	(18.0)	(18.0)	(12.6)	(12.6)	(15.9)	(15.9)
4	59.6	40.3	85.7	14.2	81.2	18.7
	(17.0)	(17.0)	(14.2)	(14.2)	(18.8)	(18.8)
6	59.9	40.0	84.9	15.5	81.9	18.0
	(17.4)	(17.4)	(15.4)	(15.4)	(17.6)	(17.6)
8	60.5	39.4	83.1	16.8	82.6	17.3
	(17.8)	(17.8)	(16.3)	(16.3)	(17.5)	(17.5)
20	60.6	39.3	82.0	17.9	83.1	16.8
	(19.2)	(19.2)	(18.5)	(18.5)	(18.5)	(18.5)

Notes:

- The sample period is 1970:1 - 1985:4. The VAR includes a constant and four lags of changes in relative output (Δy_t) and changes in the nominal exchange rate (Δe_t).
- In each column we present the percentage of the variance decomposition for the level of relative output due to ϵ_{nt} and ϵ_{pt} shocks. In parenthesis is the estimated standard deviation computed from Monte Carlo simulations.

Table 3
SOURCES OF FLUCTUATIONS FOR RELATIVE OUTPUT

	AUSTRIA			NETHERLANDS			FRANCE		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step									
1	4.2	11.2	84.5	1.8	16.6	81.5	8.5	30.8	60.6
	(5.9)	(13.4)	(15.1)	(2.4)	(18.6)	(19.0)	(9.0)	(23.8)	(23.5)
2	6.2	10.3	83.4	2.6	14.0	83.2	7.4	22.5	69.9
	(6.5)	(11.8)	(14.5)	(2.2)	(15.0)	(15.9)	(5.6)	(20.8)	(21.5)
4	6.4	8.2	85.3	3.8	10.6	85.5	4.1	19.0	76.8
	(5.2)	(9.9)	(12.2)	(2.6)	(10.2)	(11.0)	(4.0)	(20.2)	(20.8)
6	4.5	5.8	89.6	3.5	8.0	88.3	3.0	14.7	82.1
	(3.4)	(7.0)	(8.3)	(2.2)	(7.0)	(7.7)	(2.7)	(17.0)	(17.6)
8	3.6	4.5	91.8	3.2	6.7	89.9	2.3	11.7	86.8
	(2.7)	(5.1)	(6.1)	(2.3)	(5.9)	(6.4)	(2.0)	(13.4)	(13.8)
20	1.7	1.9	96.2	1.8	3.1	95.0	1.2	5.1	93.5
	(1.3)	(2.1)	(2.7)	(1.7)	(2.6)	(3.2)	(0.1)	(5.3)	(5.6)

	ITALY			SPAIN			UK		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step									
1	16.1	29.3	54.4	10.2	15.0	74.6	13.3	9.8	76.8
	(12.2)	(21.2)	(20.5)	(11.9)	(15.5)	(19.6)	(17.9)	(11.3)	(21.2)
2	9.5	22.1	68.2	8.6	15.7	75.5	11.4	7.9	80.6
	(7.9)	(18.6)	(18.6)	(10.4)	(15.5)	(19.4)	(14.5)	(8.8)	(17.5)
4	5.3	13.7	80.8	7.6	20.6	71.7	9.7	5.8	84.3
	(3.6)	(12.8)	(13.0)	(8.6)	(16.8)	(20.0)	(12.1)	(6.8)	(14.5)
6	4.1	9.4	86.4	4.8	19.4	75.6	7.4	4.8	87.6
	(2.5)	(8.5)	(8.8)	(5.7)	(16.0)	(18.3)	(9.1)	(5.3)	(11.1)
8	3.3	7.2	89.3	3.5	15.6	80.8	5.9	3.9	90.1
	(2.3)	(6.2)	(6.6)	(3.9)	(13.5)	(15.2)	(7.6)	(4.1)	(9.1)
20	1.4	2.7	95.8	1.1	5.2	93.5	2.9	2.0	95.0
	(1.4)	(2.0)	(2.7)	(1.2)	(4.8)	(5.4)	(5.5)	(2.3)	(6.4)

Notes:

- The sample period is 1970:1 - 1985:4. The VAR includes a constant and four lags of changes in relative output (Δy_t) changes in government consumption (Δg_t) and changes in the nominal exchange rate (Δe_t).

- In each column we present the percentage of the variance decomposition for the level of relative output due to ϵ_f, ϵ_g and ϵ_s shocks. In parenthesis is the estimated standard deviation computed from Monte Carlo simulations.

Table 4
SOURCES OF FLUCTUATIONS FOR NOMINAL EXCHANGE RATES

	AUSTRIA			NETHERLANDS			FRANCE		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step									
1	89.2	5.3	5.4	73.3	20.9	5.6	76.6	4.7	18.5
	(8.9)	(7.1)	(6.2)	(12.6)	(11.8)	(8.0)	(14.9)	(6.5)	(14.5)
2	85.7	7.3	6.8	72.4	20.6	6.8	74.0	5.5	20.4
	(10.4)	(8.8)	(7.0)	(12.2)	(11.0)	(8.5)	(15.4)	(7.3)	(14.8)
4	77.1	10.1	12.6	66.8	20.1	13.0	70.9	8.2	20.7
	(12.4)	(10.4)	(10.0)	(11.8)	(10.0)	(8.2)	(15.3)	(9.3)	(14.9)
6	71.3	11.0	17.5	64.7	19.4	15.8	64.0	15.9	19.9
	(14.1)	(10.8)	(12.8)	(12.5)	(10.3)	(10.5)	(15.4)	(12.2)	(14.5)
8	69.1	11.0	19.8	64.4	19.4	16.1	59.1	21.5	19.3
	(15.3)	(10.9)	(14.4)	(13.5)	(10.9)	(11.3)	(16.0)	(14.6)	(14.5)
20	66.2	10.6	23.1	64.1	18.4	17.4	50.0	28.2	21.6
	(18.2)	(11.8)	(17.3)	(16.3)	(13.0)	(14.5)	(18.3)	(18.9)	(16.7)

	ITALY			SPAIN			UK		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step									
1	60.0	12.7	27.1	90.4	4.9	4.6	76.8	10.8	12.3
	(17.0)	(13.2)	(18.3)	(10.5)	(7.3)	(6.8)	(20.0)	(11.8)	(16.6)
2	57.4	13.2	29.2	88.8	6.0	5.0	75.7	9.8	14.4
	(17.7)	(13.4)	(19.0)	(10.2)	(7.0)	(7.1)	(19.7)	(10.3)	(17.8)
4	53.8	11.9	34.2	81.4	9.7	8.8	67.7	8.9	23.3
	(17.5)	(11.8)	(19.7)	(13.1)	(9.2)	(10.3)	(20.6)	(8.6)	(20.3)
6	53.8	11.5	36.6	69.1	18.6	12.2	68.5	9.8	21.6
	(18.0)	(11.6)	(20.1)	(14.9)	(12.3)	(13.1)	(19.6)	(7.6)	(20.3)
8	53.4	11.6	34.8	63.3	21.9	14.7	69.2	10.3	20.4
	(18.6)	(12.0)	(20.8)	(15.0)	(12.8)	(15.1)	(19.4)	(8.4)	(20.4)
20	52.3	12.1	35.4	58.6	25.9	15.3	69.8	11.4	18.7
	(20.4)	(13.5)	(23.4)	(17.8)	(14.6)	(17.7)	(21.0)	(11.9)	(21.4)

Notes:

- The sample period is 1970:1 - 1985:4. The VAR includes a constant and four lags of changes in relative output (Δy_t) changes in government consumption (Δg_t) and changes in the nominal exchange rate (Δe_t).
- In each column we present the percentage of the variance decomposition for the level of exchange rates due to e_f, ϵ_g and ϵ_s shocks. In parenthesis is the estimated standard deviation computed from Monte Carlo simulations.

Table 5
SOURCES OF FLUCTUATIONS (RELATIVE TO CORE 1)

RELATIVE OUTPUT

	FRANCE			SPAIN			UK			ITALY		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step												
1	4.6	8.4	86.9	11.3	5.5	83.0	8.4	8.8	82.6	10.1	22.7	67.1
	(7.8)	(12.2)	(15.1)	(10.5)	(8.0)	(11.8)	(10.8)	(12.9)	(16.2)	(10.5)	(20.1)	(21.0)
2	5.9	7.5	86.4	10.8	5.0	84.1	7.9	7.4	84.6	6.5	16.0	77.4
	(6.8)	(9.8)	(13.3)	(9.5)	(3.9)	(10.7)	(9.3)	(11.3)	(14.4)	(6.2)	(15.1)	(15.6)
4	4.2	5.8	89.9	8.0	3.2	88.6	6.1	6.3	87.5	4.4	10.7	84.7
	(6.0)	(7.7)	(11.7)	(6.9)	(3.6)	(7.8)	(6.2)	(9.5)	(11.4)	(3.9)	(9.8)	(10.4)
6	3.1	4.5	92.2	4.8	2.4	92.7	5.0	5.3	89.5	3.5	8.1	88.3
	(5.1)	(6.8)	(10.8)	(4.1)	(2.2)	(4.9)	(4.5)	(7.2)	(8.7)	(3.2)	(7.0)	(7.6)
8	2.4	3.7	93.7	3.3	1.8	94.8	4.0	4.5	91.4	2.8	6.3	90.7
	(4.5)	(6.4)	(10.1)	(2.8)	(1.6)	(3.4)	(3.4)	(5.8)	(7.0)	(2.6)	(5.3)	(5.9)
20	1.2	1.8	96.8	1.1	0.6	98.1	1.8	2.4	95.6	1.2	2.4	96.2
	(3.9)	(5.1)	(8.9)	(1.1)	(0.6)	(1.4)	(1.7)	(4.1)	(4.8)	(1.2)	(2.1)	(2.5)

NOMINAL EXCHANGE RATE

	FRANCE			SPAIN			UK			ITALY		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step												
1	81.0	11.7	7.1	86.7	5.7	7.5	80.4	10.8	8.7	66.4	4.9	28.5
	(13.8)	(10.6)	(9.3)	(11.4)	(7.7)	(7.9)	(16.3)	(12.6)	(12.8)	(19.9)	(8.6)	(19.4)
2	80.0	11.6	8.3	83.5	6.6	9.8	78.4	11.3	10.1	61.8	5.6	32.4
	(14.2)	(11.2)	(10.0)	(12.9)	(7.9)	(9.7)	(16.9)	(12.5)	(14.4)	(20.8)	(8.8)	(20.4)
4	81.6	7.9	10.3	81.2	7.7	11.0	75.2	11.0	13.7	59.3	6.9	35.2
	(12.4)	(7.1)	(10.9)	(11.9)	(6.7)	(10.3)	(18.2)	(11.3)	(17.2)	(21.0)	(9.2)	(20.8)
6	75.6	8.7	15.6	75.7	12.4	11.8	75.6	10.2	14.0	58.1	7.3	34.5
	(12.7)	(6.1)	(13.5)	(13.0)	(9.3)	(11.1)	(17.2)	(10.0)	(16.5)	(20.5)	(9.2)	(20.1)
8	70.9	9.4	19.5	72.9	13.6	13.2	75.0	10.4	14.4	57.8	7.5	34.6
	(14.5)	(7.1)	(15.8)	(14.4)	(10.6)	(12.5)	(17.3)	(10.1)	(16.8)	(20.4)	(9.5)	(20.0)
20	64.0	9.6	26.2	69.3	13.6	17.0	74.1	10.5	15.2	56.1)	8.2	35.5
	(19.7)	(9.5)	(21.0)	(17.9)	(12.4)	(16.8)	(19.1)	(12.0)	(18.1)	(21.2)	(10.4)	(21.3)

Notes:

- Core 1 is formed by Germany, Austria and the Netherlands.
- See Notes in Table 4.

Table 6
SOURCES OF FLUCTUATIONS (RELATIVE TO CORE 2)

RELATIVE OUTPUT

Forecast Step	SPAIN ϵ_f	SPAIN ϵ_g	SPAIN ϵ_s	UK ϵ_f	UK ϵ_g	UK ϵ_s	ITALY ϵ_f	ITALY ϵ_g	ITALY ϵ_s
1	10.5	6.5	82.9	7.9	10.7	81.3	10.1	23.4	66.4
	(11.5)	(7.7)	(12.2)	(10.1)	(11.4)	(14.8)	(11.8)	(18.9)	(20.4)
2	9.6	5.6	84.7	7.2	8.4	84.2	7.5	16.1	76.2
	(10.3)	(6.9)	(11.0)	(8.2)	(9.3)	(12.4)	(8.8)	(14.6)	(16.2)
4	7.3	3.8	88.7	5.7	6.9	87.2	5.0	10.1	84.7
	(7.4)	(4.5)	(8.5)	(5.7)	(7.4)	(9.3)	(5.3)	(10.1)	(11.5)
6	4.3	2.9	92.7	4.9	5.9	89.1	3.8	7.4	88.7
	(4.1)	(3.0)	(5.5)	(4.4)	(5.5)	(7.1)	(3.9)	(7.4)	(8.6)
8	2.9	2.2	94.8	4.0	4.9	90.9	3.0	5.8	92.1
	(2.7)	(2.3)	(3.9)	(3.7)	(4.2)	(5.7)	(3.1)	(5.8)	(6.8)
20	1.0	0.8	98.1	2.0	2.4	95.5	1.2	2.1	96.5
	(1.1)	(1.0)	(1.8)	(1.9)	(2.1)	(3.0)	(1.3)	(2.0)	(2.5)

NOMINAL EXCHANGE RATE

Forecast Step	SPAIN ϵ_f	SPAIN ϵ_g	SPAIN ϵ_s	UK ϵ_f	UK ϵ_g	UK ϵ_s	ITALY ϵ_f	ITALY ϵ_g	ITALY ϵ_s
1	86.4	5.4	8.1	81.2	10.2	8.4	65.9	6.8	27.2
	(11.1)	(6.0)	(10.0)	(18.2)	(14.6)	(11.7)	(19.8)	(8.5)	(19.3)
2	82.6	7.2	10.0	80.3	10.0	9.6	60.8	7.9	31.2
	(11.6)	(7.2)	(10.6)	(17.7)	(13.6)	(12.0)	(19.7)	(8.6)	(19.5)
4	80.6	6.3	13.0	76.9	9.8	11.2	53.7	9.3	36.8
	(12.4)	(5.0)	(12.7)	(17.6)	(12.8)	(12.9)	(19.6)	(9.3)	(20.4)
6	76.1	8.7	15.0	76.6	10.7	12.5	53.2	10.0	36.6
	(13.5)	(5.0)	(13.9)	(16.6)	(12.3)	(13.2)	(19.5)	(9.7)	(20.4)
8	74.1	9.6	16.1	76.2	11.3	12.3	52.2	10.2	37.4
	(14.2)	(6.0)	(14.7)	(16.3)	(12.2)	(12.9)	(19.7)	(9.9)	(20.7)
20	72.4	9.4	18.1	75.7	12.0	12.1	49.3	10.9	39.7
	(16.5)	(8.5)	(16.5)	(17.3)	(12.7)	(13.8)	(21.5)	(10.7)	(22.5)

Notes:

- Core 2 is formed by Germany, Austria, The Netherlands and France.
- See Notes in Table 4.

Table 7
SOURCES OF FLUCTUATIONS (RELATIVE TO CORE 3)

RELATIVE OUTPUT

	UK			ITALY		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step						
1	10.8	9.6	79.5	9.3	28.0	62.5
	(16.1)	(13.7)	(21.8)	(12.2)	(19.4)	(23.4)
2	9.7	8.2	81.9	7.1	19.0	73.8
	(14.2)	(11.5)	(19.8)	(10.4)	(15.4)	(19.2)
4	7.6	6.4	85.9	4.7	11.6	83.6
	(11.0)	(8.6)	(15.1)	(7.1)	(10.9)	(11.9)
6	6.1	5.3	88.5	3.5	8.4	88.0
	(8.5)	(6.3)	(11.8)	(4.9)	(8.4)	(10.3)
8	4.9	4.4	90.6	2.7	6.5	90.7
	(6.4)	(5.1)	(9.2)	(3.6)	(6.8)	(8.2)
20	2.1	2.1	95.7	1.0	2.3	96.6
	(3.0)	(2.4)	(4.4)	(1.3)	(2.3)	(2.8)

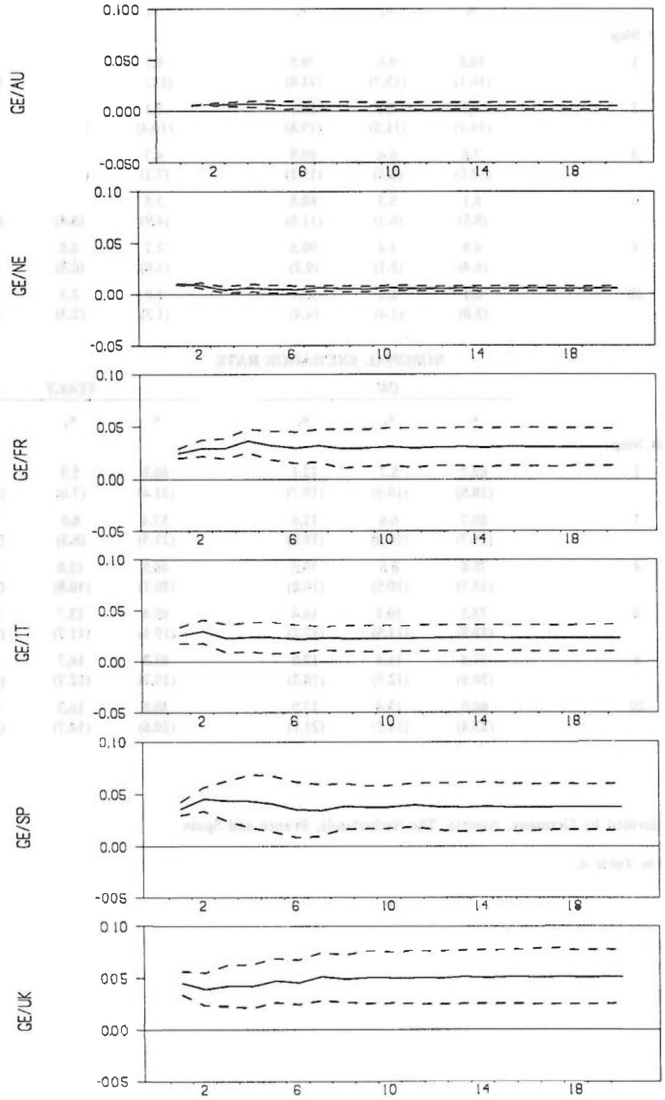
NOMINAL EXCHANGE RATE

	UK			ITALY		
	ϵ_f	ϵ_g	ϵ_s	ϵ_f	ϵ_g	ϵ_s
Forecast Step						
1	82.1	5.7	12.1	66.0	5.8	28.1
	(18.8)	(10.0)	(15.7)	(21.4)	(7.6)	(21.0)
2	80.7	6.6	12.6	57.4	8.5	34.0
	(18.7)	(10,0)	(15.8)	(21.3)	(8.3)	(21.5)
4	75.8	8.6	15.5	46.5	12.0	41.3
	(15.7)	(10.5)	(16.0)	(20.1)	(10.8)	(21.4)
6	73.3	10.2	16.4	45.4	13.7	40.7
	(18.8)	(11.5)	(17.2)	(19.1)	(11.7)	(21.4)
8	71.4	11.4	17.0	43.2	14.7	41.9
	(20.0)	(12.5)	(18.2)	(19.2)	(12.7)	(22.3)
20	68.5	13.4	17.9	38.5	16.3	45.1
	(23.4)	(14.7)	(21.0)	(20.6)	(14.7)	(24.7)

Notes:

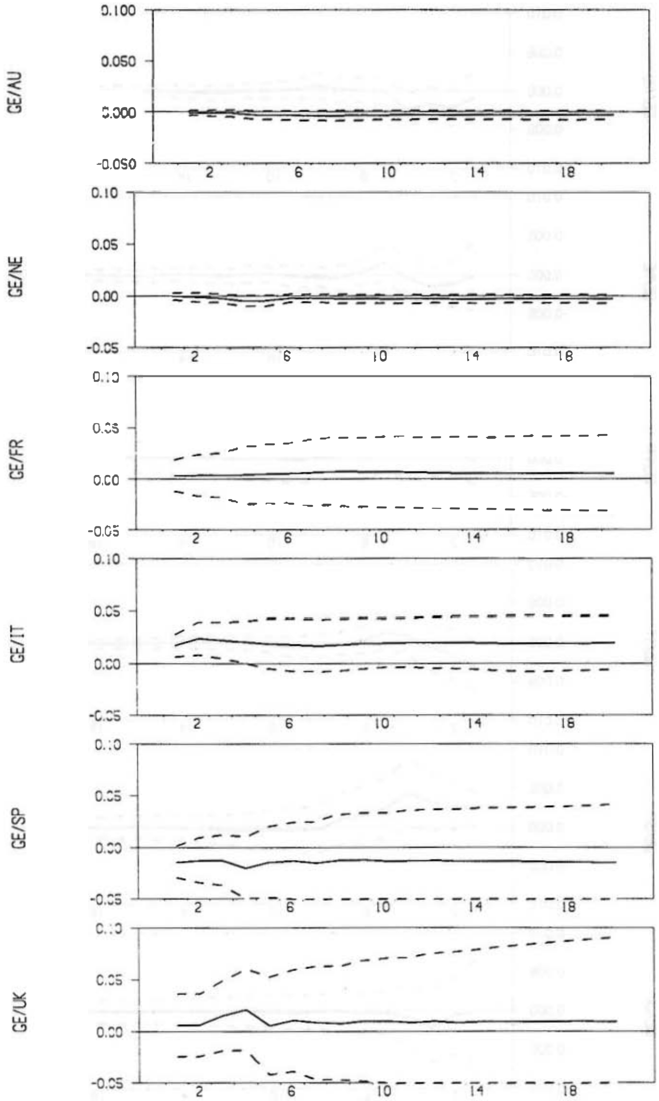
- Core 3 is formed by Germany, Austria, The Netherlands, France and Spain.
- See Notes in Table 4.

Figure 1
Nominal Exchange Rate Responses to a Neutral Shock



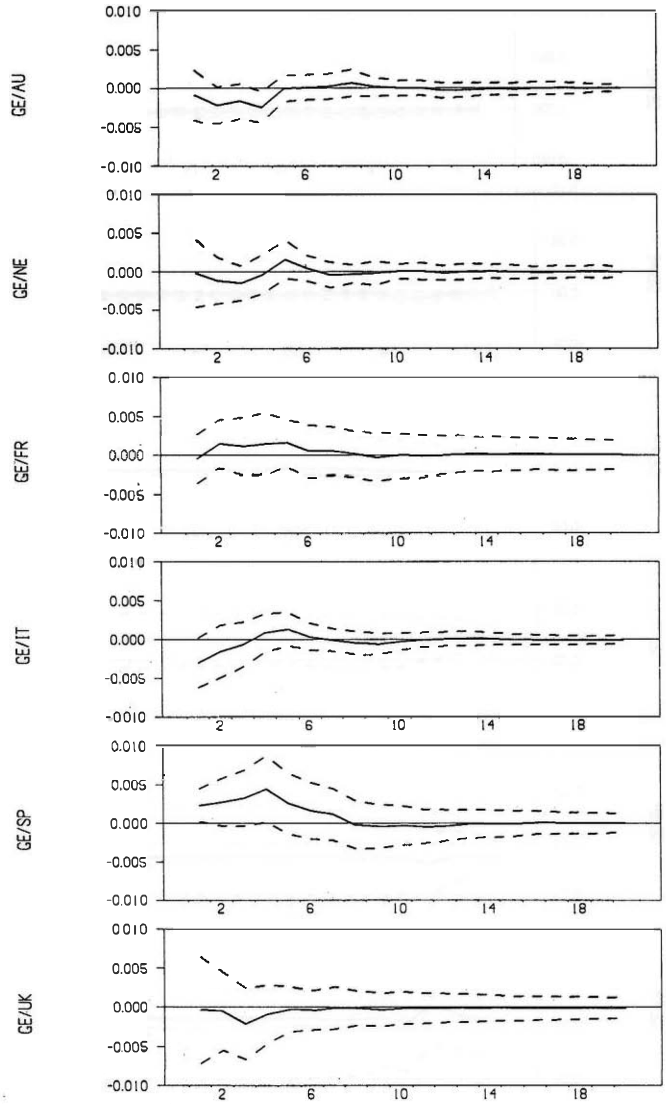
Note: Estimated nominal exchange rate responses to a neutral shock (ϵ_n). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 2
Nominal Exchange Rate Responses to a Non-neutral Shock



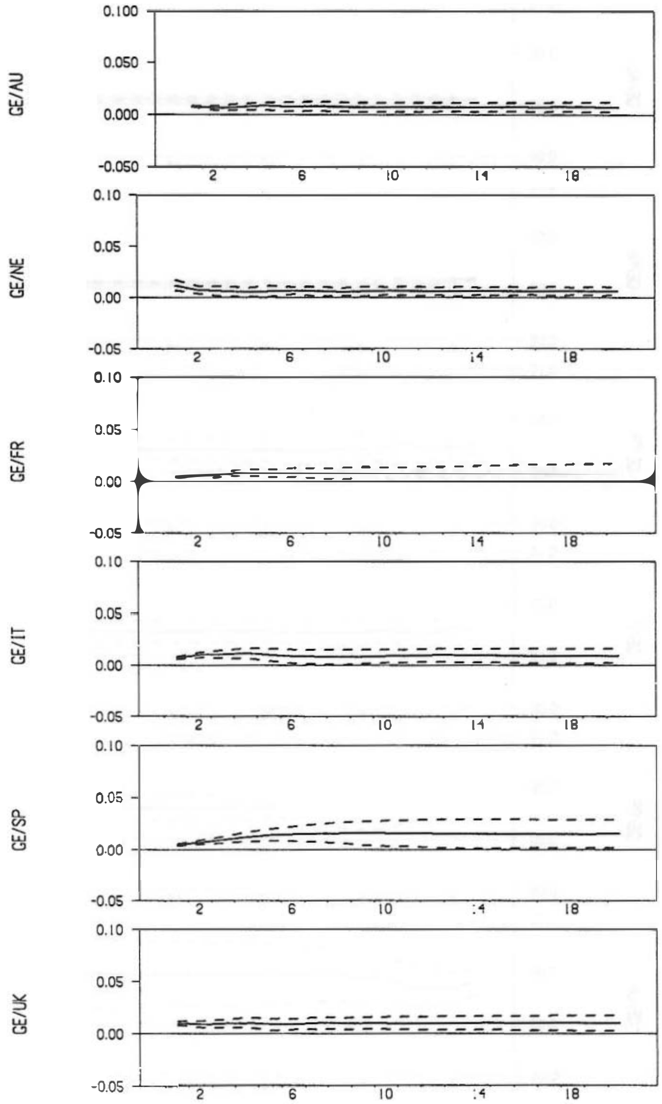
Note: Estimated nominal exchange rate responses to a non-neutral shock (ϵ_p). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 3
Output Responses to a Neutral Shock



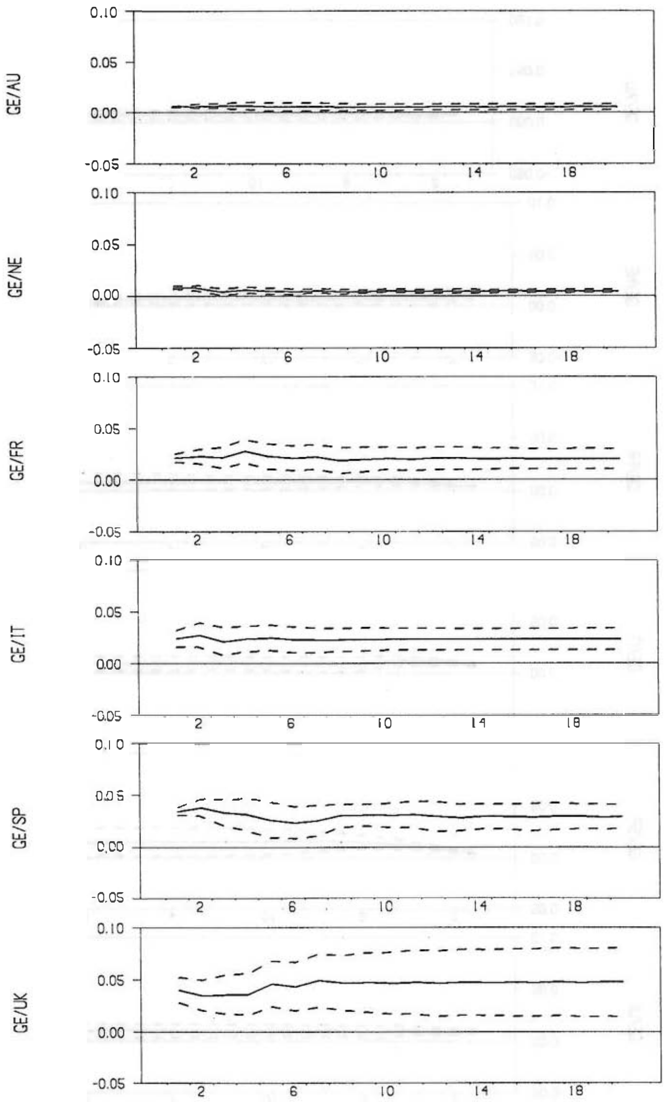
Note: Estimated output responses to a neutral shock (ϵ_{it}). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 4
Output Responses to a Non-neutral Shock



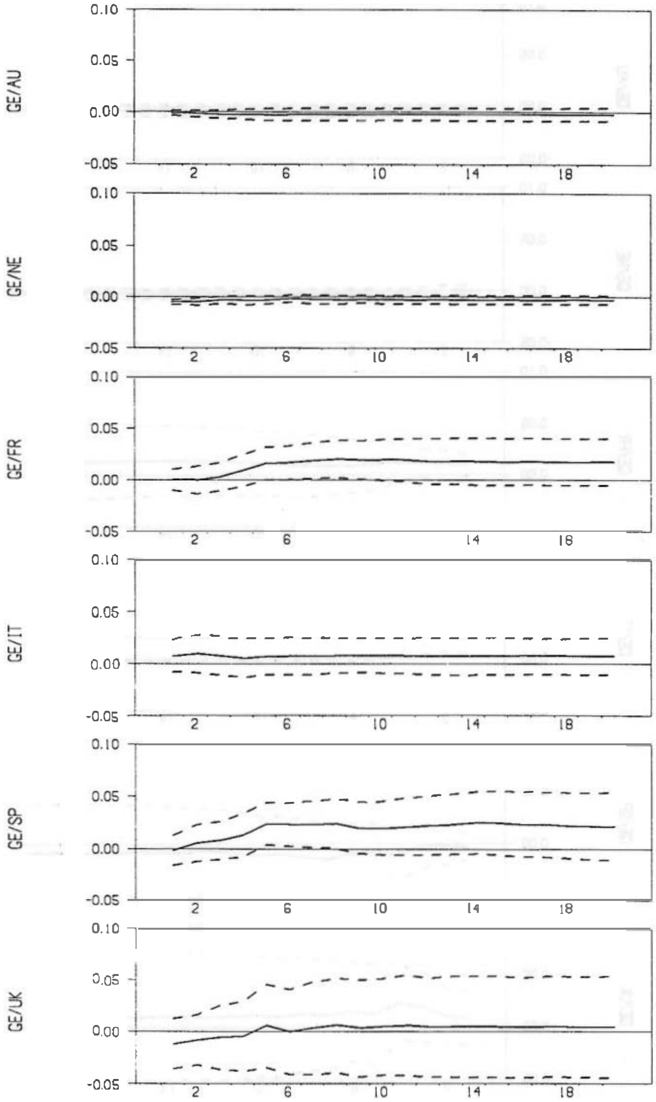
Note: Estimated output responses to a non-neutral shock (ϵ_p). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 5
Nominal Exchange Rate Responses to a Money and Financial Shock



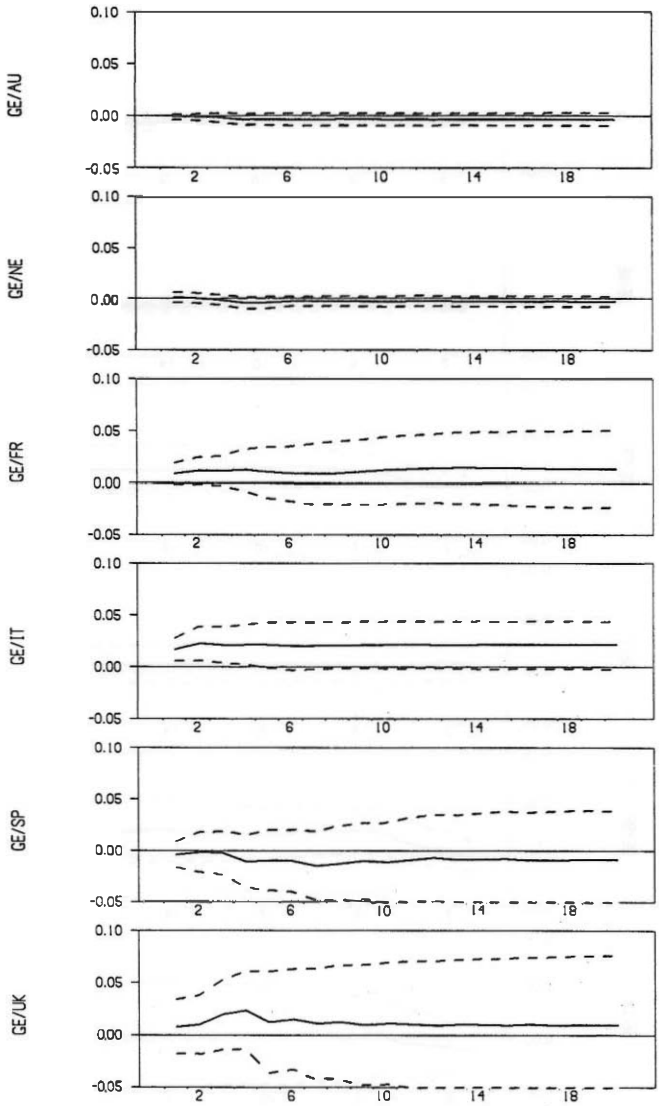
Note: Estimated nominal exchange rate responses to a money and financial shock (ϵ_f). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 6
Nominal Exchange Rate Responses to an Aggregate Demand Shock



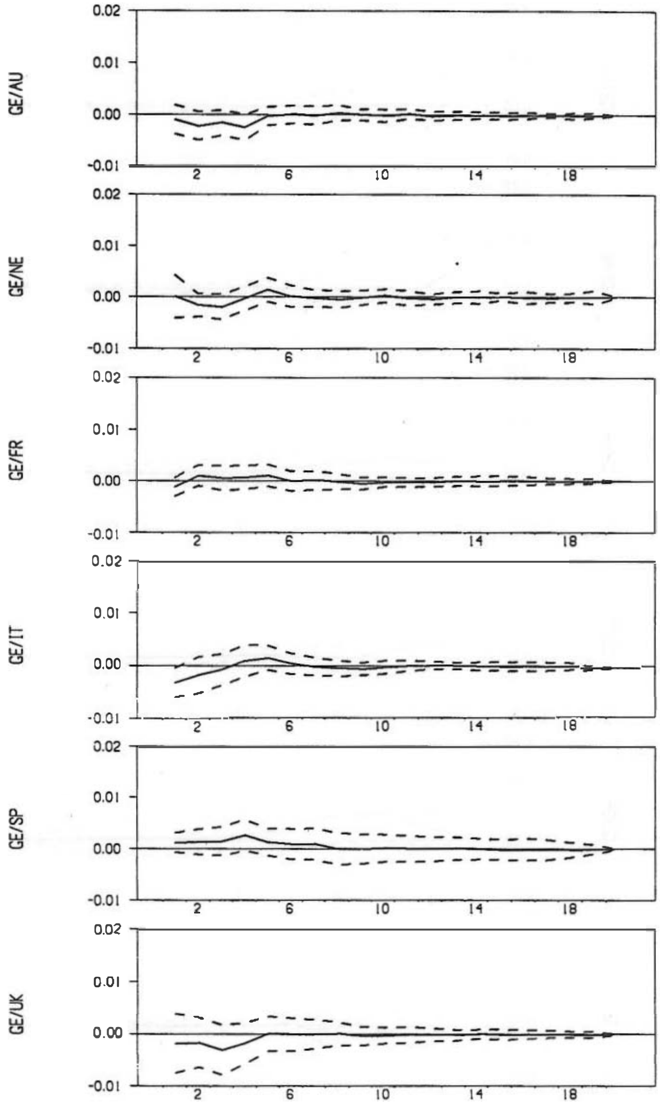
Note: Estimated nominal exchange rate responses to an aggregate demand shock (ϵ_d). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 7
Nominal Exchange Rate Responses to an Aggregate Supply Shock



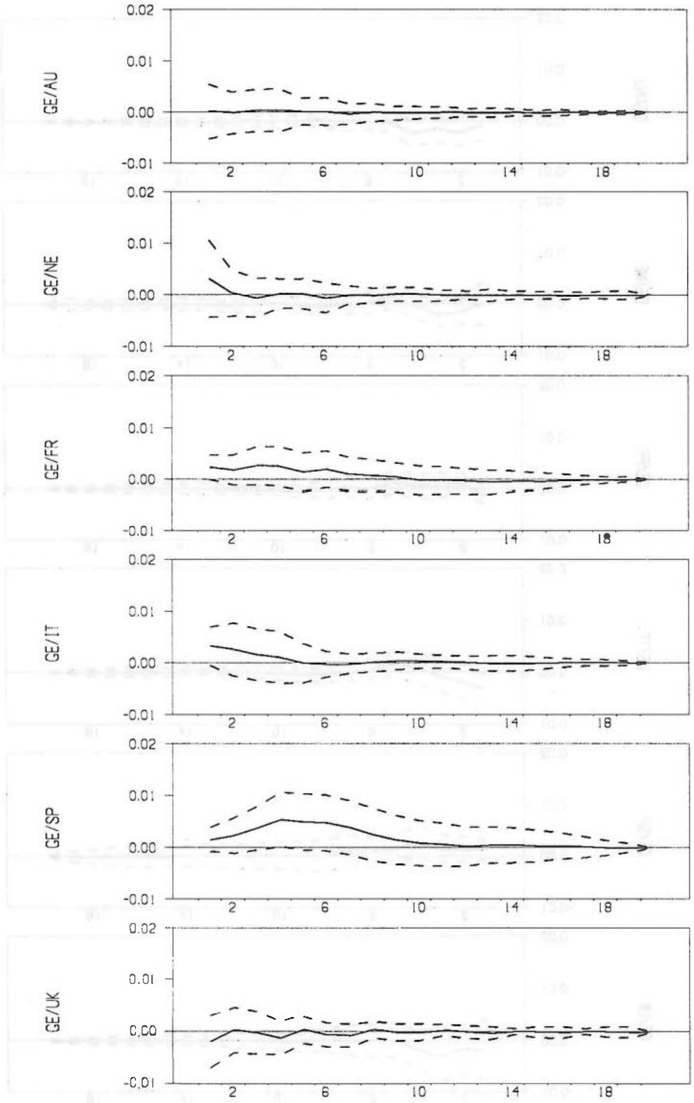
Note: Estimated nominal exchange rate responses to an aggregate supply shock (ϵ_s). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 8
Output Responses to a Money and Financial Shock



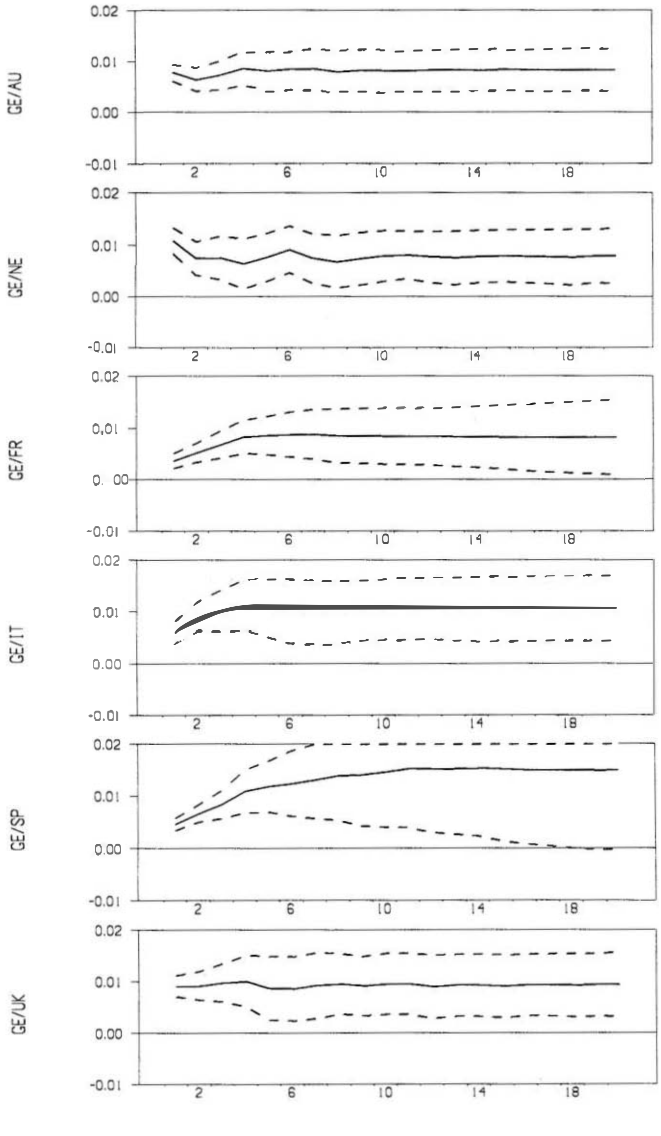
Note: Estimated output responses to a money and financial shock (ϵ_r). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 9
Output Responses to an Aggregate Demand Shock



Note: Estimated output responses to an aggregate demand shock (ϵ_D). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

Figure 10
Output Responses to an Aggregate Supply Shock



Note: Estimated output responses to an aggregate supply shock (ϵ_s). Average responses and two-standard deviation band are calculated from a Monte Carlo experiment.

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