IMF WORKING PAPER

WP/91/86

INTERNATIONAL MONETARY FUND

European Department

The Effect of the ERM on Participating Economies

by Tamim Bayoumi *

Authorized for Distribution by Desmond Lachman

September 1991

Abstract

The effect of membership of the ERM on macroeconomic performance is analyzed using vector autoregression techniques. The results indicate that while the ERM has had little effect on the nature of the shocks hitting the economies, it has had a significant effect on the response of member countries to these shocks. In addition, long-time members of the ERM have significantly more correlated shocks than other countries. These results conform to the thesis that the ERM represents a move by countries with relatively similar underlying shocks to coordinate macroeconomic policy.

JEL Classification Numbers:
E63, F33, F36

---

* The author would like to thank Morris Goldstein, Charles Adams, John Odling-Smee and the participants at a seminar in the European Department of the IMF for helpful comments and suggestions.

Contents

Summary

One branch of the extensive literature looking at the effect of ERM membership on participants uses raw data on variables, such as inflation and real output, to measure the effect of ERM membership on their macroeconomic performance. Although useful, the comparison of the raw data conflates the effect of changes in the nature of shocks hitting an economy and changes in responses to these shocks. This paper seeks to remedy this drawback by distinguishing between underlying shocks and responses, using vector autoregression (VAR) techniques. Two types of shocks are identified, those to aggregate demand, which have temporary effects on output, and those to aggregate supply, whose effects on output are permanent.

The results indicate that while the ERM has had little effect on the nature of the shocks hitting the economies, it has had a significant effect on the response of member countries to these shocks, making them both more prolonged and more similar. Long-time members of the ERM, and to some extent the United Kingdom, have relatively correlated supply shocks compared with the other economies studied, and this is as true of the pre-ERM period as it is of the 1980s. Similarly, the interrelation between shocks and the ratio between demand and supply shocks do not appear to be affected by ERM membership. This similarity of shocks may be one reason for the desire to move to more fixed exchange rates across members, although the ERM itself has not affected the nature of the underlying shocks.

Turning to the responses of ERM members to shocks, members of the ERM in the 1980s appear to have made both more prolonged and more correlated responses to shocks than comparisons with either their own past behavior or the responses of non-ERM countries in the 1980s would suggest. It appears that the ERM, by taking away the flexibility afforded by floating exchange rates, has lowered the speed at which members respond to shocks and at the same time has made these responses more coordinated across members.

These results, that ERM members have relatively symmetric underlying macroeconomic shocks and that membership have produced more prolonged and correlated responses to these shocks, conform to the thesis that the ERM represents a move by countries with relatively similar structures to coordinate macroeconomic policy by limiting monetary independence, at the cost of lower flexibility in the face of shocks. They also indicate that the core ERM members have at least some of the characteristics desirable for a common currency area.

I. Introduction

With the recent entry of Spain and the United Kingdom into the Exchange Rate Mechanism of the European Monetary System (ERM), together with the prospective entry of Greece and Portugal as part of stage two of the transition to European economic and monetary union, the issue of the effect of membership of the ERM on participating economies becomes a particularly pertinent question. There is now an extensive literature looking at the effect of ERM membership on participants. 1/ One branch of this literature uses raw data on variables such as inflation and real output to measure the effect of ERM membership on macroeconomic performance of participants. 2/ The conclusions from this work is that the ERM has produced convergence of nominal variables, and in particular that inflation rates have been reduced to German levels, but there is less evidence of convergence in terms of the behavior of real variables.

While useful, the comparison of the raw data has one major drawback, namely that it conflates the effects of changes in the nature of shocks hitting an economy and changes in responses to these shocks. This paper seeks to remedy this drawback by distinguishing between underlying shocks and responses to these shocks using vector autoregression (VAR) techniques. Two types of shocks are identified, those to aggregate demand, which have temporary effects on output, and those to aggregate supply, whose effects on output are permanent. The shocks and responses are distinguished using the methodology of Blanchard and Quah (1989). Shocks and responses of economies both within and outside the ERM are presented, and compared with the predictions from a theoretical model.

Distinguishing between the underlying shocks and the response to these shocks allows two issues in the literature on the ERM and transition to EMU to be explored. The first is the degree to which the shocks hitting the ERM countries are symmetric; the literature on optimal currency areas emphasizes the point that a common currency area is more efficient the more correlated the underlying shocks, since the more correlated the shocks the smaller the need for independent macroeconomic policies. 3/ The second is the degree to which ERM, but limiting monetary independence, has lead to policy

---

1/ A useful survey is given in Haldane (1991). As far as the behavior of exchange rates is concerned, there is considerable evidence that the ERM has succeeded in lowering the variability of real and nominal exchange rates between members, although the evidence on effective exchange rate indices is more mixed (for example Artis and Taylor, 1988).

2/ Examples of this approach include Ungerer et al. (1983 and 1986), Cohen and Wyplosz (1989) and Weber (1990).

3/ See Mundell (1961). More recent discussions in the context of EMU include Van der Ploeg (1989a and 1989b) and Cohen and Wyplosz (1989).

coordination across different countries. This is measured by exploring the degree to which the ERM has made responses to shocks more similar. 1/

The plan of the paper is as follows. The next section outlines the estimation framework, and explains the econometric methodology used to distinguish between demand and supply shocks. Section III then presents a theoretical model illustrating some of the possible effects of entering a fixed exchange rate regime. Estimation results are presented in Section IV, and analyzed in Section V. Section VI contains conclusions.

II. The Estimating Strategy

Consider the familiar aggregate demand and aggregate supply diagram, reproduced as the top panel in Chart 1. The aggregate demand curve (AD) is downward sloping in the price output plane, reflecting the fact that lower prices, by raising money balances, boosts demand. The short-run aggregate supply curve (SRAS) is upward sloping, reflecting the assumption that prices are sticky and hence higher prices imply lower real wages. The long-run supply curve (LRAS) is vertical, since real wages adjust to changes in prices in the longer run. 2/

The effect of a shock to aggregate demand are shown in the left half of the lower panel. The aggregate demand curve shifts from AD to AD', resulting in a move in the equilibrium from initial point A to the new intersection of the short-run curves, D'. This involves a rise in both output and prices. Subsequently, as the aggregate supply curve becomes more vertical over time, the economy moves from the short-run equilibrium D' to its new long-run equilibrium, D''. This movement along the aggregate demand curve involves the return of output to its initial level, while the price level continues to rise to a level which is permanently higher. (Depending on the nature of the price mechanism, there could be some cycling around the new long-run equilibrium.) Hence the response to a positive demand shock is a short-term rise in output, followed by a gradual return to its initial level, and a permanent rise in prices.

The effect of a supply shock is shown in the right-hand bottom panel of the Chart. Assume that the long-run level of potential output is increased, say by a favorable technology shock. Both the short- and long-run supply curves move rightward by the same amount, as shown in SRAS' and LRAS'. The short-run effect is to raise output and lower prices, as the equilibrium moves from A to S'. As the supply curve becomes more vertical over time, the economy moves from point S' to S'', implying further increases in output and reductions in prices. Hence, unlike demand shocks, supply shocks result

---

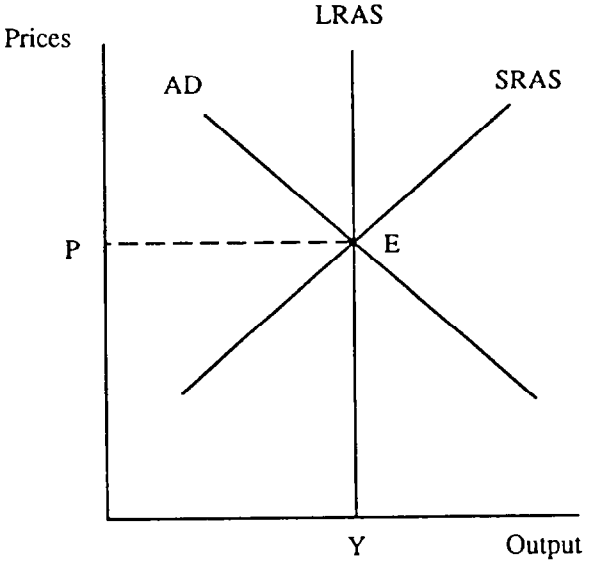
1/ For discussions on the role of the ERM in producing policy coordination see Fratianni and von Hagen (1990) and Portes (1990), and the references therein.

2/ Textbook descriptions of this model include Dornbusch and Fischer (1986) Chap. 11, and Hall and Taylor (1988) Chaps. 4-5.

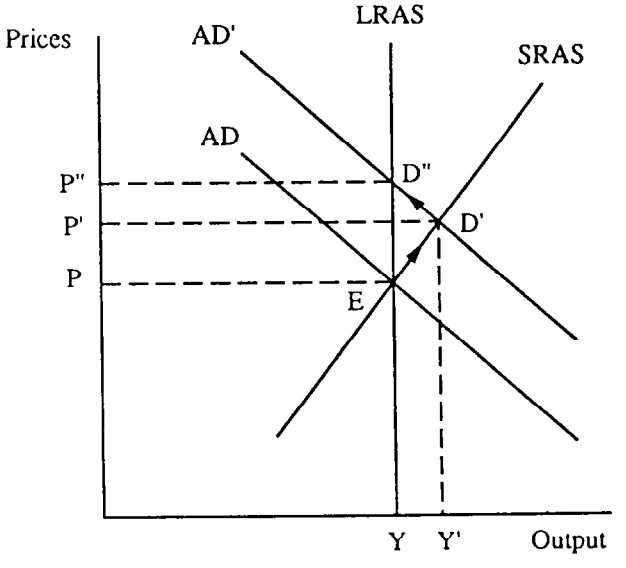
Chart 1

The Aggregate Demand and Supply Model

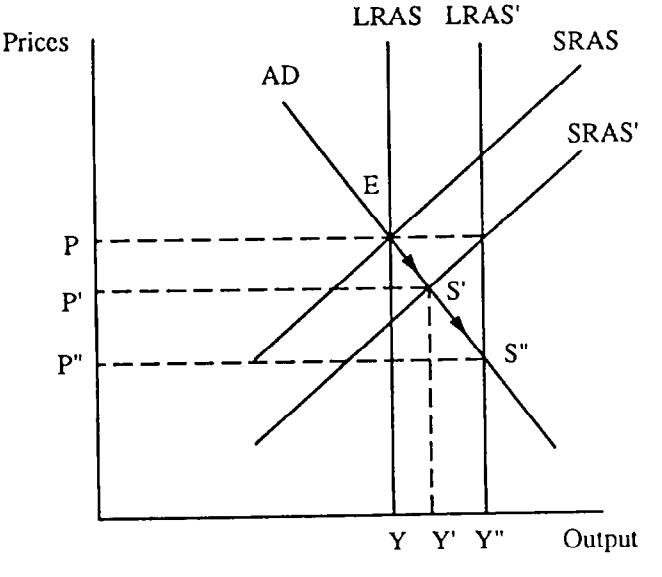
(a) The Model



(b) A Demand Shock



(c) A Supply Shock



in permanent changes in output. In addition, demand and supply have different effects upon prices; positive demand shocks raise prices while positive supply shocks lower them.

This framework is estimated using a procedure proposed by Blanchard and Quah (1989) for decomposing permanent and temporary shocks to a variable using a VAR. Consider a system where the true model can be described in terms of an infinite moving average representation of a (vector) of variables, X_t, and an equal number of shocks, ϵ_t. Formally, using the lag operator L, this can be written as:

$$X_t = A_0\epsilon_t + A_1\epsilon_{t-1} + A_2\epsilon_{t-2} + A_3\epsilon_{t-3} \ldots . = \sum_{i=0}^{\infty} L^i A_i \epsilon_t \qquad (2.1)$$

where the matrices A_i represent the impulse response functions of the shocks to the elements of X.

More specifically, let X_t be made up of the change in output and the change in prices, and ϵ_t be demand and supply shocks. Then the model becomes,

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \epsilon_{dt} \\ \epsilon_{st} \end{bmatrix} \qquad (2.2)$$

where y_t and p_t represent the logarithm of output and prices, ϵ_{dt} and ϵ_{st} are supply and demand shocks, and a_{11i} represents element a_{11} in matrix A_i.

The framework implies that while supply shocks have permanent effects on the level of output, demand shocks only have temporary effects (both have permanent effects upon the level of prices). Since output is written in first difference form, this implies that the cumulative effect of demand shocks on the change in output (Δy_t) must be zero. Hence the model implies the restriction,

$$\sum_{i=0}^{\infty} a_{11i} = 0. \qquad (2.3)$$

The model defined by equations (2.2) and (2.3) can be estimated using a vector autoregression, in which each element of X_t is regressed upon lagged values of all the elements of X. Using B to represent these estimated coefficients the estimating equation becomes,

$$\begin{aligned} X_t &= B_1 X_{t-1} + B_2 X_{t-2} + \ldots + B_n X_{t-n} + e_t \\ &= (I - B(L))^{-1} e_t \\ &= (I + B(L) + B(L)^2 + \ldots) e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots \end{aligned} \tag{2.4}$$

where e_t represents the residuals from the equations in the vector autoregression. In the case of the model being considered, e_t is made up of the residuals of a regression of lagged values of Δy_t and Δp_t on current values of each in turn; these residuals being labeled e_{yt} and e_{pt}, respectively.

In order to convert equation (2.4) into the model defined by equations (2.2) and (2.3), the residuals from the VAR, e_t, must be transformed into the demand and supply shocks, ϵ_t. Writing $e_t = C\epsilon_t$, it is clear that in the two by two case being considered four restrictions are necessary, in order to define the four elements of the matrix C. Two of these restrictions are simple normalizations, the convention being that the variance of the shocks ϵ_{dt} and ϵ_{st} are set equal to unity. A third restriction comes from assuming that the demand and supply shocks are orthogonal. These three restrictions define the matrix C to be any matrix such that $CC' = \Sigma$, where Σ is the variance covariance matrix of e_t.

The final restriction, which allows the matrix C to be uniquely defined, is that demand shocks have only temporary effects on output. 1/ As noted above, this implies equation (2.3). In terms of the VAR representation, it implies,

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & . \\ . & . \end{bmatrix} \tag{2.5}$$

This restriction allows the matrix C to be uniquely defined, and hence the demand and supply shocks to identified. 2/

1/ This is where the analysis here, based on the work of Blanchard and Quah (1989), differs from other decompositions of VAR models. The more usual decomposition assumes that the variables in the VAR can be ordered in such a way that all the effects which could be attributed to, say, either variable a_t or b_t are attributed to whichever comes first in the ordering. This is achieved by a Choleski decomposition (Sims, 1980).

2/ This is done by noting from equation (2.4) that the long-run impact of the shocks on output and prices is equal to $(I-B(1))^{-1}$. The restriction that the long-run effect of demand shocks on output is zero implies a simple linear restriction on the coefficients of this matrix.

Notice that this restriction affects the response of output to the two shocks, but says nothing about their effect on prices. The aggregate demand and supply model implies that demand shocks should raise prices in both the short and long run, while supply shocks should lower prices. Since these responses are not imposed by the estimation procedure, they can be thought of as overidentifying restrictions useful in testing whether the shocks that have been identified from their effect on output actually correspond to the demand and supply shocks in the model. 1/

III. A Model of the Effects of Different Exchange Rate Regimes

This section looks at the likely effects of changing from a floating exchange rate system to a (quasi) fixed exchange rate system such as the "hard" ERM. 2/ A simple open economy macroeconomic model is presented, and the response of the economy to various shocks is computed for reasonable parameter values under both a fixed and a floating exchange rate regime. This allows the probable effects of the change in regime on the response of the economy to various shocks to be analyzed. In addition, the effect of the change in regime on the types of shocks faced by the economy is discussed in a rather less formal manner.

The effect of the change in regime is analyzed using a variation on the exchange rate overshooting model originally due to Dornbusch (1976). This framework was chosen because it represents a simple sticky price open economy model based on the IS/LM framework outlined above, which has been used to analyze a variety of issues.

The model, which is made up of equations (3.1 to 3.4) below, represents a small open economy with sticky prices and forward looking behavior in the exchange rate market. The equations represent the IS curve, money demand, a Phillips curve and uncovered interest rate parity respectively; 3/ where y represents the logarithm of actual output, Y potential output, e the exchange rate, p the price level, E_t the expectations operator at time t, Δ

1/ Blanchard and Quah (1989) use output and unemployment in their VAR, with the same identifying restrictions in terms of the effect of shocks on output. Since unemployment would be expected to move in the same way in response to both demand and supply shocks, their implied overidentifying restriction has somewhat less power than the one used in this paper.

2/ The results in this section pertain to a completely fixed exchange rate system, rather than the bands that have operated in the ERM. It seem probable, however, that any characteristics of a completely fixed exchange rate system will also tend to be true for members of the ERM, at least since the hardening of the system in the early 1980s. Earlier the ERM had the characteristics of a 'crawling peg' exchange rate regime.

3/ The use of the nominal, as opposed to real, interest rate in the IS curve is made for analytic convenience. A real interest rate specification produces the same qualitative results.

the first difference operator, foreign variables are denoted by asterisks, and Greek letters represent coefficients.

IS Curve	$y_t = \alpha(e_t+p^*_t-p_t) - \beta i_t$	(3.1)
Money Demand	$m_t = p_t + \Psi y_t - \delta i_t$	(3.2)
Phillips curve	$\Delta p_t = \Phi(y_t-Y)$	(3.3)
UIRP	$E_t e_{t+1} = e_t + i_t - i^*_t$	(3.4)

The model can be solved for both a fixed and a floating exchange rate system. In the case of a floating exchange rate, it is assumed that a fixed money supply rule is followed. The model was solved using the techniques discussed in Taylor (1986). In the case of the fixed exchange rate regime, the model effective collapses to equations (3.1) and (3.3), and the simulations are easy to compute. In order to make concrete comparisons of the responses, the model was solved for a specific set of parameter values. The following values were chosen; the elasticity of demand with respect to the exchange rate, $\alpha = 0.25$; the interest rate semi-elasticity of demand, β=0.5; the elasticity of money demand with respect to output, Ψ=1; the semi-elasticity of money demand with respect to the interest rate, δ=0.5; and the coefficient on the Phillips curve, Φ=0.5. These coefficients were chosen to represent an approximate central value of available empirical estimates for an annual model. 1/ When alternative parameter values were used it was found that the qualitative conclusions of the model were insensitive to the specific choice of values.

Two types of shocks are analyzed, namely a permanent rise in potential output, and a permanent shift in foreign interest rates. 2/ The former is a shock to aggregate supply. The latter represents one possible shock to aggregate demand. Clearly, other demand shocks could have been used, however in most cases such alternative shocks have no impact in one or other exchange rate regime. For example, shocks to money demand have no effect on output or prices under the fixed exchange rate system; on the other hand, shocks to the IS curve are ineffective in the floating exchange rate system (at least in this particular model). The implications of this ineffectiveness of different shocks will be discussed further below.

Chart 2 below shows the impulse response functions (the path traced out in response to a unit shock in potential output or foreign interest rates) for real output and prices under both a fixed and floating exchange rate regime. Looking at the responses, the most striking feature of the Chart is that a fixed exchange rate regime produces a much more gradual adjustment of both output and domestic prices in response to shocks. This reflects the sticky price assumption. Under a floating exchange rate system the flexibility of the exchange rate allows the economy to respond relatively

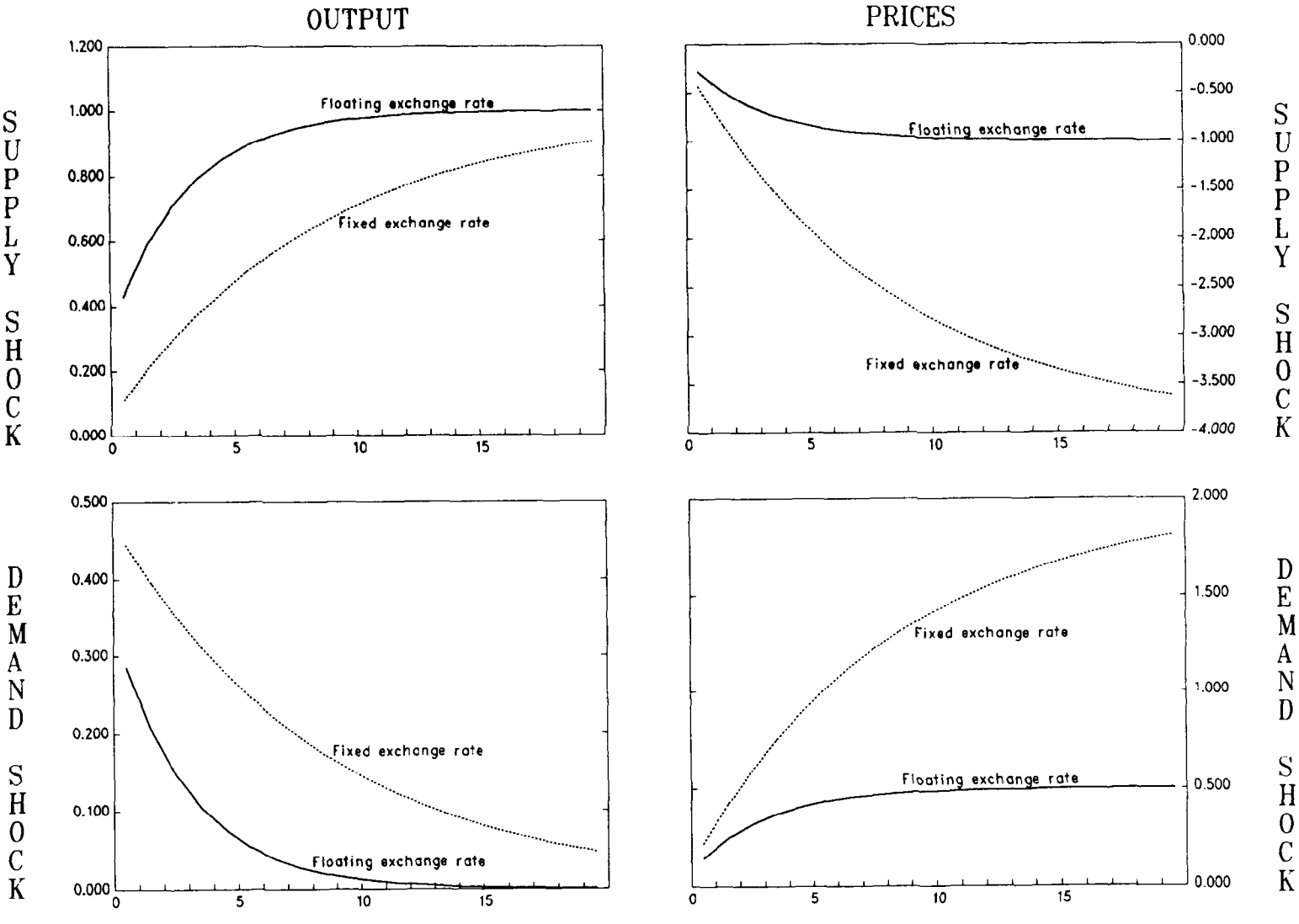
---

1/ Further details of the choice of parameters can be obtained from the author.

2/ Permanent shocks are analyzed in order to make the results comparable to the impulse response functions calculated in the empirical work.

CHART 2

RESULTS FROM THE SIMULATION MODEL



quickly to shocks; when the exchange rate is fixed, on the other hand, the lack of exchange rate to flexibility leads to a more sluggish response.

Two further points are worth noting. While the policy response in a fixed exchange rate regime is uniquely defined, the floating regime covers a wider set of possible responses. The impulse response functions illustrated in Chart 2 assume that monetary policy involves adhering to fixed monetary targets. An alternative, and more general class of policy functions, could involve varying the money supply with deviations of prices from their expected level, for example a policy $(m_t-M)=\eta(p_t-P)$. Given this diversity in possible responses, it might be expected that the impulse response functions between different countries in a fixed exchange rate regime would be more similar that between countries with floating exchange rates. 1/ In addition, the fact that different shocks have different effects under the two policy regimes may mean that the types of shocks which affect the economy depend upon the regime in place. For example, if aggregate demand shocks were dominated by shifts in money demand, the importance of such shocks might be lower in a fixed exchange rate system than in a floating one.

While a model of a single economy is useful for looking at how the choice of exchange rate regime affects the response of a single economy, many of the issues involved in the choice of exchange rate regime depend on the relationship between different economies. For example, it is generally acknowledged that a fixed exchange rate system is most effective when the shocks which hit the system are symmetric across different economies. Hence, countries which experience similar shocks might tend to join together in a fixed exchange rate regime. On the other hand, the causation may run in the opposite direction, with a fixed exchange rate regime actually causing idiosyncratic country shocks to affect other members of the exchange rate system more than under a floating rate, since the exchange rate "buffer" is no longer available. 2/ Finally, it has often been alleged that the core country in a fixed exchange rate regime (in this case Germany) in far less constrained in terms of the conduct of economic policy than other participants. 3/ As will be seen below, no strong evidence is found that leadership makes the effect of the ERM on macroeconomic performance different in Germany from other members.

To summarize, the ERM might have five effects on the macroeconomic performance of members. (1) By constraining the flexibility of exchange rates, it may elongate the response to shocks. (2) By reducing monetary

---

1/ Indeed, one of the main arguments in favor of the ERM is that, by reducing monetary independence, it enforces a more coordinated policy response across members (see Fratianni and von Hagen, 1990).

2/ See Canzoneri (1982), van der Ploeg (1989a and 1989b) and Cohen and Wyplosz (1990) for theoretical discussions of these points.

3/ For example Giovannini (1988). There is a large empirical literature on the German leadership hypothesis (see Weber (1990).

independence, it may make responses to shocks more alike. (3) The relative size of different types of shocks may also depend upon the exchange rate regime. (4) The relationship between the ERM and the correlation of the underlying shocks is somewhat ambiguous: on the one hand, countries with similar shocks may be more likely to join a fixed exchange rate regime; on the other hand, the regime itself may cause shocks to become more contemporaneously correlated. (5) Finally, the ERM may cause macroeconomic shocks across members to become more interrelated across time.

IV. Results

Quarterly data on real and nominal GDP (or GNP) were collected for the seven major industrial countries, namely the United States, Japan, Canada, the United Kingdom, Germany, France, and Italy. 1/ The first three countries are non-European countries with floating exchange rates, while the last three are all members of the ERM. The United Kingdom represents an intermediate case, being within Europe, but not being a member of the ERM over the available data period. Comparisons of the behavior of the ERM and non-ERM economies, both before and after its inception, allow the effects of the ERM on macroeconomic performance to be quantified.

The data were divided into two periods: one corresponding to the floating exchange rates prior to the introduction of the ERM (1971:2-1979:2, hereafter the 1970s) and the other to the period since the hardening of the ERM in the early 1980s (1982:1-1990:1, hereafter the 1980s). The ERM was introduced in mid-1979, hence the end point of the first period, whose starting point approximates to the breakup of the Bretton Woods fixed exchange rate regime. The second period corresponds to the time since the strengthening of the ERM, which is usually placed in 1982 or 1983 (an early date being chosen so as to maximize the length of the time series) and goes up to the end of the available data. The two periods are of equal length, which aids comparison. 2/

Vector autoregressions of the change in the logarithm of real output and the output deflator, plus a constant, were estimated for each country

---

1/ The data come from OECD Quarterly National Accounts. The data are seasonally adjusted except for Germany and Japan, which were seasonally adjusted by the author.

2/ Limited experimentation with different time periods indicates that the exclusion of 1982 has little effect on the results. Without the 1971 data, however, the 1970s period becomes dominated by the 1974 oil shock, and the responses to demand shocks become small and unstable.

for both time periods. 1/ The results were transformed into demand and supply disturbances using the decomposition described above. 2/

The cumulative impulse response functions from this procedure are shown in Chart 3. These illustrate the effect of a unit shock in demand/supply on the level of output/prices. The left-hand side represents the results for the 1970s, the right-hand side the results for the 1980s; they have been graphed on the same scale so that the relative importance of shocks in the two periods can be inferred. The results are shown for two sets of countries: the ERM members (Germany, France and Italy) and the rest (the United States, Japan, Canada, and the United Kingdom). The first panel shows the effect of demand and supply shocks on output; the second the effects upon prices.

The output responses reflect the restrictions imposed in the estimation. Demand shocks result in a temporary rise in output, which then comes back to zero, (with some cycling in the case of Japan and Italy) while supply shocks generally result in a gradual rise in output. The price responses to demand and supply shocks are in almost total accord with the predictions of the model, with positive demand shocks causing prices to rise and supply shocks resulting in reductions in the price level. The only deviation from the expected results is that in two cases in the 1970s (Germany and Italy) the long-run response to a supply shock is incorrectly signed or very small. Given that no constraints were imposed upon the price responses, these results represent some confirmation that the decomposition being used is actually differentiating between aggregate supply and demand shocks. Furthermore, since the results hold both for the 1970s and for the period starting in 1982, they cannot simply be ascribed to the effect of the oil shocks in the 1970s.

The impulse response functions are almost universally higher in the 1970s than the 1980s, indicating that shocks played a larger role in determining the levels of output and prices in the earlier period. 3/ In addition, some of the predictions from the theoretical section appear to be confirmed. Comparing the impulse response functions of the ERM in the 1980s with the other response functions, they do appear to be more elongated and more correlated. These issues are be explored in a more formal manner below.

1/ Likelihood ratios tests were constructed to test for the optimal lag length. All of the values came to between 3 and 6; in the interests of standardizing, and to conserve degrees of freedom, all lags were set to 4.

2/ The decomposition matrix gives a useful method of assigning current data into demand and supply shocks; simply work out the implied residuals from the VAR and transform the residuals using the matrix C. This could be a useful way of analyzing the types of shocks affecting the current state of the economy.

3/ A comparison of the variance of real growth and inflation over the two periods also shows this effect.

V. The Effects of ERM Membership on the Macroeconomy.

The ERM may cause the performance of participating economies to change in a number of ways. In this section, the five possible effects discussed in Section III are investigated: elongation of the responses to shocks; convergence of the impulse response functions; the relationship between the ERM and the underlying shocks; the effect of the ERM on the interconnection of shocks across countries; and the effect on the mix of the different types of shocks. 1/ However, first it is useful considering the basic facts to be explained.

The behavior of inflation and growth. Table 1 shows the correlations of the two variables of interest, growth and inflation, for the full set of countries over the 1970s and 1980s. 2/ The most striking feature of the data is the high correlation of inflation performance among members of the ERM in the 1980s. The correlations are stronger than those among the same countries in the 1970s, and higher than the correlations among non-ERM members in the 1980s. When the significance of these differences are formally tested, 3/ all the correlations among ERM members are significantly higher in the 1980s than in the 1970s at conventional significance levels, while the median value of the three ERM correlations is significantly higher than all but one of the other cross correlations reported in the Table. There appears to be strong evidence that the ERM has caused inflation performance to become more correlated. 4/

1/ Other empirical studies of the effects of the ERM on behavior include Weber (1990) and Cohen and Wyplosz (1989), who look at effects of the ERM using the raw data without distinguishing between shocks and responses, and conclude that the ERM is relatively closely economically integrated. Roubini (1989), Artis and Gazioglu (1989), Italianer and Pisani-Ferry (1990), and Barrel (1990) use large econometric models to look at the impact of various types of shocks under different exchange rate regimes. The overall conclusion from these studies is that the ERM makes countries more economically interdependent.

2/ Throughout this paper real growth is used as the measure of the variability of real activity in preference to some measure of the deviation of the level of output from trend because the theory implies that many of the macroeconomic shocks on the economy involve permanent changes in the level of output, making the potential level of output difficult to measure.

3/ The value $1/2\ \ln((1+r)/(1-r))$ is distributed approximately as normal with expected value $1/2\ \ln((1+\rho)/(1-\rho))$ and variance $1/(T-3)$, (Kendall and Stuart, 1967, pp. 292-93).

4/ Similar results are shown in Fratianni and von Hagen (1990). There is some controversy as to whether membership of the ERM actually helped the European disinflation in the 1980s, or whether it was part of a wider experience of all industrial countries. See Artis and Nachane (1989), Fratianni and von Hagen (1990), de Grauwe (1990) and Portes (1990).

CHART 3(a)
MAJOR INDUSTRIAL COUNTRIES

IMPULSE RESPONSE FUNCTIONS FOR OUTPUT

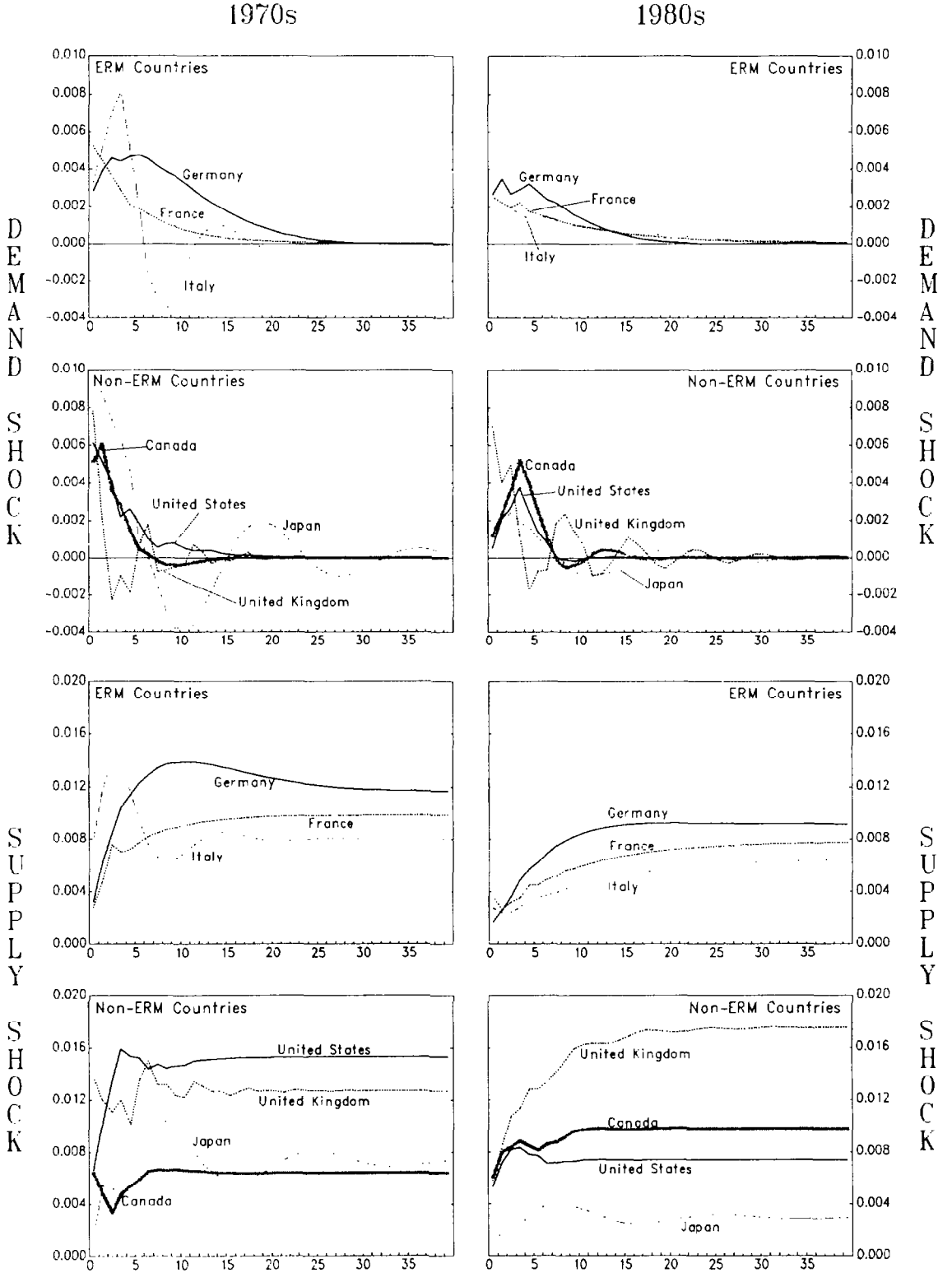


CHART 3(b)
MAJOR INDUSTRIAL COUNTRIES

IMPULSE RESPONSE FUNCTIONS FOR PRICES

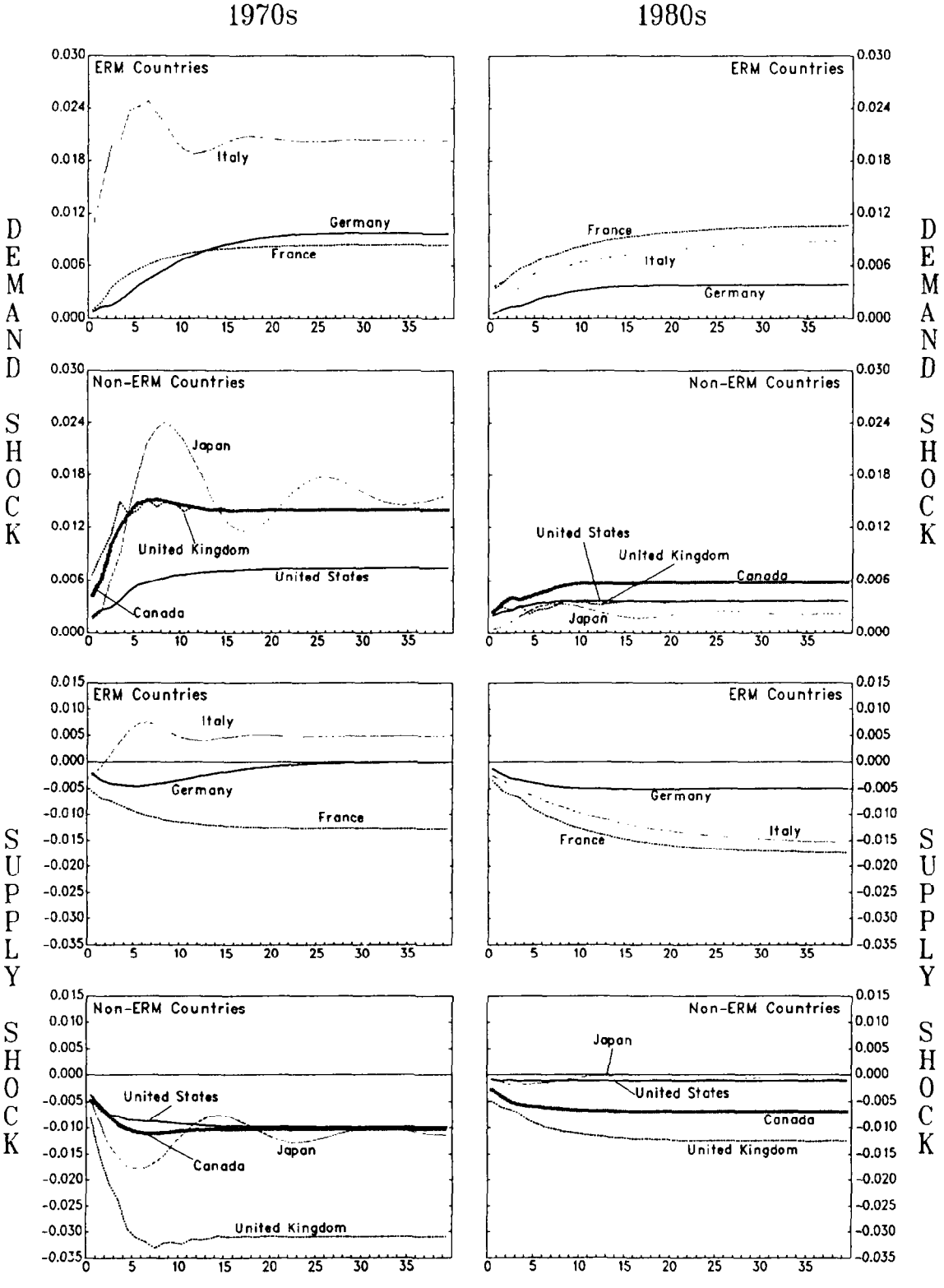


Table 1. Correlations of Growth and Inflation

Growth Rate in 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.28					
JPN	.53	.30				
GBR	.17	.32	.36			
DEU	.37	.37	.31	.35		
FRA	.44	.38	.40	.27	.66	
ITA	.26	.00	-.01	.04	.56	.56

Inflation Rate in 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.46					
JPN	.17	.63				
GBR	.47	.16	.00			
DEU	.20	.06	.31	.21		
FRA	.50	.40	.34	.57	.09	
ITA	.37	.38	.35	.21	-.13	.50

Growth Rate in 1980s

	USA	CAN	JPN	GBR	DEU	FRA
US						
CAN	.71					
JPN	.21	.31				
GBR	.05	.02	-.14			
DEU	.32	.38	.61	-.13		
FRA	-.07	-.18	.38	.06	.50	
ITA	.37	.27	.44	.27	.57	.48

Inflation Rate in 1980s

	USA	CAN	JPN	GBR	DEU	FRA
US						
CAN	.51					
JPN	.18	-.09				
GBR	.40	.42	-.16			
DEU	.37	.39	.40	.02		
FRA	.10	.09	.25	-.13	.37	
ITA	.34	.30	.19	.10	.60	.73

Notes: Shaded regions represent interaction of ERM members in the 1980s.

As far as real growth is concerned, the situation is less clear cut. Real growth is more highly correlated among ERM countries than non-ERM countries; however this is as much a feature of the pre-ERM period (the 1970s) as of the 1980s. The 1980s do not show any strengthening of this bond associated with the introduction of the ERM, although there are some weak indications that growth rates for other economies have become less correlated over time. 1/

1. Elongation of the response functions

Table 2 shows the ratio of the impulse response after four quarters to the long-run level, which is used as a simple measure of the speed with which the economy responds to shocks, for the three responses where the long-run value is not zero (recall that the long-run response of output to a demand shock is zero by construction). 2/

Comparing the ratios for the 1970s with those for the 1980s, seven of the nine ratios associated with ERM members fell between the 1970s and the 1980s. This contrasts with the results for the non-ERM countries where 6 of the 12 ratios rose and 6 fell. This provides some evidence that ERM members' responses have become more elongated. A formal nonparametric test can be constructed by assuming that in the absence of a change in behavior the ratio is equally likely to rise as to fall, as indicated by the non-ERM data. Using the binomial distribution, the null hypothesis of no fall in the ratio can be rejected at the 10 percent significance level, but not at the 5 percent level, for the ERM members.

Further evidence of a change in behavior comes from comparing the ratios for ERM and non-ERM members in the 1970s and the 1980s. The data for the 1980s indicate that the three ERM members (Germany, France, and Italy) have relatively low values for this ratio, as would be expected if their responses were more elongated. Indeed, in two cases the ERM members have the lowest three ratios among the seven reported, while in the third case they have three of the four lowest ratios in the other. The data for the 1970s, on the other hand, show no such pattern for these economies. A simple test of the significance of the results for the 1980s is to calculate the probability of the observed ranking occurring randomly. The probability of the ERM countries being the three lowest ranked countries on a random basis is less than 5 percent, while the probability of all three being represented in the lowest four rankings is less than 15 percent. This is

---

1/ Interestingly, Granger causality tests on growth and inflation do not indicate any particularly close interaction between the current and past performance of different ERM members in either period.

2/ While the choice of four quarters as the intermediate point in the measurement is somewhat arbitrary, alternative choices yield the same results.

Table 2. Evidence of the Elongation of Responses
Ratio Between the Response After Four Quarters and the Long Run

	Output Response to a Supply Shock	Price Response to: A Demand Shock	Price Response to: A Supply Shock
		1970s	
USA	1.04	0.49	0.79
CAN	0.75	0.86	0.91
JPN	0.89	0.57	1.35
GBR	0.95	1.07	0.77
DEU	0.89	0.22	23.28
FRA	0.71	0.52	0.64
ITA	1.66	1.00	0.76
		1980s	
USA	1.18	0.81	1.12
CAN	0.90	0.66	0.80
JPN	0.82	0.86	2.16
GBR	0.65	0.84	0.59
DEU	0.53	0.39	0.68
FRA	0.45	0.54	0.39
ITA	0.44	0.37	0.32

Notes: Shaded values represent ERM countries in the 1980s.

further evidence that membership of the ERM has indeed elongated the responses of participating economies to shocks. 1/

2. Correlation of the impulse response functions

Another possible effect of the ERM is that, by constraining monetary policy, it could make the response of the participating economies to shocks more similar. 2/ The visual impression from Chart 3, that the responses are indeed similar for the ERM countries in the 1980s, is confirmed by formal tests. Table 3 shows the correlation matrices for the impulse response functions of output and prices with respect to both demand and supply shocks for the 1970s and the 1980s. The most striking feature is the very high level of correlation for the ERM countries in the 1980s, both compared with their own past history and non-members. The minimum correlation for ERM members in the 1980s across both response functions is 0.89, which is higher than all of the six correlations between the same countries in the 1970s; formal tests (see footnote 3 on page 10 for details) indicate that every intra-ERM correlation rose significantly between the two periods. Turning to the comparison of ERM with non-ERM countries in the 1980s, only one of the 12 correlations between the non-ERM members are larger than the minimum correlation for that impulse between the ERM members. In the vast majority of cases the ERM correlation coefficients are significantly different from those for non-ERM members. The ERM does indeed appear to have produced a convergence in responses.

3. Correlation of the shocks

The ERM could have two effects upon the shocks hitting members. Most authors agree that a fixed exchange rate regime is most effective if the shocks hitting the system are symmetric rather than idiosyncratic. This implies that countries which join a mechanism such as the ERM will be those subject to symmetric shocks. 3/ In addition, by increasing the interrelationship between members, it could increase the contemporaneous correlation across countries.

Variance covariance matrices for the demand and supply shocks derived from the model are shown in Table 4. The continental European countries appear to have somewhat higher correlations among themselves than other countries, however this tendency is as strong in the (pre-ERM) 1970s as in

---

1/ De Grauwe (1990) also finds evidence of prolongation of responses.

2/ See van der Ploeg (1989a and 1989b) and Cohen and Wyplosz (1990) for analyses of the effect of the ERM on policy behavior. One of the arguments for the ERM is that it enforces policy coordination which might otherwise be difficult to achieve, Portes (1990).

3/ The general issue of the effect of fixed exchange rate regimes on shocks is discussed in Canzeroni (1982) and van der Ploeg (1989a and 1989b). The specific issue of symmetric versus asymmetric shocks is discussed in Mundell (1961), Giavazzi (1989), and Cohen and Wyplosz (1989).

Table 3. Impulse Response Function Correlations

Demand Shock Response in 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.79					
JPN	.94	.88				
GBR	.50	.34	.48			
DEU	.64	.26	.44	.03		
FRA	.98	.75	.92	.48	.72	
ITA	.68	.81	.76	.04	.35	.66

Supply Shock Response in 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.54					
JPN	.23	.30				
GBR	-.12	.18	.59			
DEU	.83	.65	.51	.14		
FRA	.87	.38	.47	.06	.78	
ITA	-.16	-.38	-.35	-.61	-.49	-.47

Demand Shock Response in 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.84					
JPN	.99	.81				
GBR	.37	.57	.34			
DEU	.76	.62	.76	.52		
FRA	.76	.65	.76	.61	.97	
ITA	.70	.61	.69	.64	.95	.99

Supply Shock Response in 1980s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.28					
JPN	.44	.35				
GBR	.50	.57	.78			
DEU	.22	.44	.94	.83		
FRA	.03	.21	.84	.68	.93	
ITA	.03	.17	.82	.64	.89	.99

Note: Shaded areas represent interaction of ERM members in the 1980s.

Table 4. Correlation of Demand and Supply Shocks

Demand Shocks in the 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.16					
JPN	.32	.18				
GBR	-.05	.32	.04			
DEU	.10	.30	.24	.31		
FRA	.24	.23	.21	-.08	.46	
ITA	-.15	.11	-.21	.21	.13	.28

Supply Shocks in the 1970s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.16					
JPN	-.11	.11				
GBR	.14	.00	.16			
DEU	.23	-.02	.04	.30		
FRA	.11	-.03	.18	.29	.46	
ITA	.22	-.15	-.13	.20	.37	.31

Demand Shocks in the 1980s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.25					
JPN	.17	.01				
GBR	.11	.16	-.02			
DEU	.24	.11	-.01	-.27		
FRA	-.08	-.06	.14	.02	-.01	
ITA	.08	.07	-.03	.23	.19	.37

Supply Shocks in the 1980s

	USA	CAN	JPN	GBR	DEU	FRA
USA						
CAN	.25					
JPN	-.02	-.06				
GBR	.27	.12	-.04			
DEU	.24	.16	-.08	.13		
FRA	-.31	-.43	.13	-.22	.15	
ITA	.11	-.05	.02	.17	.38	.21

Note: Shaded areas represent interaction of ERM members in the 1980s.

the 1980s. Indeed, the most obvious example of significantly higher correlations for this subset of countries concerns supply shocks in the 1970s. The correlation between the United Kingdom and the continental economies is also consistently high in this case. The picture for the 1980s is less clear-cut, however all the continental European economies have significant positive correlations between each other, while the coefficients on the other cross correlations are positive and negative in approximately equal quantities. Demand shocks show a less obvious pattern. Of the six correlations between the continental European economies (three in the 1970s and three in the 1980s), five are significantly positive and one is insignificantly different from zero. Of the other 36 coefficients in the Table, 16 are significantly positive, 17 are insignificant, and 3 are significantly negative.

An alternative way of summarizing the data is to use principal component analysis. Table 5 shows the percentage of the variance of demand and supply shocks explained by the first principal component of the data, that is the orthogonal component most correlated with the underlying series. This is a measure of the degree to which the shocks are symmetric across groups of countries. The results are shown for each shock over both the 1970s and the 1980s. The rows indicate the four groups of countries being analyzed: the ERM members (Germany, France, and Italy); the United States, Japan, and Canada; the ERM plus the United Kingdom; and the four non-ERM members (the United States, Japan, the United Kingdom, and Canada). In analyzing the results, it is important to remember that the groups with three members will tend to show higher correlations than those with four members; hence, the results from the first two rows are not directly comparable with those in rows three and four.

As with the correlation coefficients, the principal components' results indicate that supply shocks are more correlated within the ERM members, both before and after its inception, while there is relatively little difference in the correlation of demand shocks. In the case of supply shocks, the principal component for the ERM members explains about 10 percent more of the variance than for the United States, Japan, and Canada in the 1980s, with even larger differences in the 1970s. When the United Kingdom is added to both groups, the results indicate that it is an intermediate case. Supply shocks in the United Kingdom are more correlated with the rest ERM than other countries but not as correlated as the core members of the Mechanism.

This evidence indicates that the ERM has produced no increase in the correlation of the shocks hitting members. Rather, it has attracted countries whose supply shocks are relatively similar.

4. The interconnection between shocks

While the ERM may not have made the shocks hitting its members more contemporaneously correlated, it could, by binding participants more closely

Table 5. The Percentage of Variance Explained by the First Principal Component

	1970s		1980s	
	Demand	Supply	Demand	Supply
ERM	53	59	47	50
USA/JPN/CAN	48	39	44	41
ERM+GBR	42	49	38	39
Non-ERM	38	31	33	36

Notes: The ERM represents Germany, France, and Italy; the non-ERM group is the United States, Canada, Japan, and the United Kingdom. Shaded areas show the results for ERM members in the 1980s.

together, make shocks more interrelated over time. In particular, the German leadership hypothesis would imply that shocks to the German economy would tend to affect other members of the ERM. To investigate this possibility, Granger causality tests, which measure the importance of lagged values of one variable for the outcome of another, were carried out using both the demand and supply shocks derived from the estimation. 1/ Table 6 shows the results using demand shocks; the results for supply shocks, which were similar, are not reported for the sake of brevity. For entries above the diagonal, the direction of causation runs from the country defined by the column to the country defined by the row. For those below the diagonal, the direction of causation is reversed. An asterisk indicates that the F-test for Granger causality cannot be rejected at the 5 percent significance level, while no asterisk indicates no evidence for causality. As can be seen from the Table, the data indicate very little interaction between shocks. In particular, there is no discernible difference between ERM and non-ERM countries or within ERM countries across time, and hence no evidence that the ERM has had any effect on the temporal correlation between shocks. 2/

5. The relative importance of different types of shocks

Table 7 shows the percentage of the unconditional variance of growth and inflation attributable to demand and supply shocks in the short run. No particular pattern emerges between the performance of ERM members in the 1980s and the other results, indicating that there is no evidence that the switch in regime has lead to a change in the types of macroeconomic shocks being experienced across countries. 3/

VI. Conclusions

This paper has looked at the effect of the ERM upon the macroeconomic performance of its members. In order to do this, a procedure for identifying aggregate demand and supply shocks was proposed and executed. Data on the seven largest industrial countries were used, both for the period between the breakup of the Bretton Woods fixed exchange rate system and the formation of the ERM in 1979, and for the period since 1982, when the ERM is generally felt to have been most effective, in particular in reducing the inflation rates of other members down to German levels.

The results indicate that while the ERM has had little effect on the *nature of the shocks hitting the economies*, it has had a significant effect on the response of member countries to these shocks, making them both more

---

1/ These used a VAR comprising four lags of each pair of variables. Results using VARs with two lags produced similar results.

2/ In particular, whatever the role of Germany in terms of policy making, there is no evidence for German leadership in macroeconomic shocks.

3/ Data for the long run decomposition of variance between the shocks show a similar lack of pattern.

Table 6. The Results of Granger Causality Tests on Demand Shocks

1970s

	USA	CAN	JPN	GBR	DEU	FRA	ITA
USA	X					*	
CAN		X					
JPN			X			*	
GBR				X			
DEU					X		
FRA						X	
ITA			*	*	*		X

1980s

	USA	CAN	JPN	GBR	DEU	FRA	ITA
USA	X						
CAN		X					
JPN			X				
GBR				X			
DEU					X		
FRA	*					X	
ITA	*						X

Notes: An asterisk implies Granger causality cannot be rejected at the 5 percent significance level. The shaded area represents the ERM in the 1980s.

Table 7. Percentage of Unconditional Variance Explained by Demand Shocks in the Long Run

	1970s		1980s	
	Inflation	Growth	Inflation	Growth
USA	46	19	1	83
CAN	39	43	4	41
JPN	96	8	53	17
GBR	25	39	59	18
DEU	43	10	72	14
FRA	78	3	32	47
ITA	14	94	37	65

Notes: The shaded areas represent ERM members in the 1980s.

elongated and more similar. Long-time members of the ERM, and to some extent the United Kingdom, have relatively correlated supply shocks compared to the other economies studied; however, this is as true of the pre-ERM period as it is of the 1980s. Similarly, the interrelation between shocks and the ratio between demand and supply shocks does not appear to be affected by ERM membership. The evidence from this paper indicates that members of the ERM have had, and continue to have, relatively symmetric supply shocks. This similarity of shocks may be one reason for the desire to move to more fixed exchange rates across members; however, the ERM itself has not affected the nature of the underlying shocks.

Turning to the responses of ERM members to shocks, members of the ERM in the 1980s appear to have both more elongated and more correlated responses to shocks than comparisons with either their own past behavior or the responses of non-ERM countries in the 1980s would suggest. It appears that the ERM, by taking away the flexibility afforded by floating exchange rates, has both lowered the speed at which members respond to shocks and at the same time made these responses more coordinated across members.

These results, that ERM members have relatively symmetric underlying macroeconomic shocks and that membership have produced more elongated and correlated responses to these shocks, conform to the thesis that the ERM represents a move by countries with relatively similar structures to coordinate macroeconomic policy by limiting monetary independence, at the cost of lower flexibility in the face of shocks. They also indicate that the core ERM members have at least some of the characteristics desirable for a common currency area.

References

Artis, M. and S. Gazioglu, "Modeling Asymmetric Exchange Rate Unions: A Stylized Model of the EMS", Greek Economic Review, 11:1, (1989).

_____ and D. Nachane, "Wages and Prices in Europe: A Test of the German Leadership Thesis", CEPR Discussion Paper No. 296, (March 1989).

_____ and M. Taylor, "The Achievements of the European Monetary System", The Economic and Social Review, 20:2, (January 1989).

Barrel, R., "European Currency Union and the EMS", National Institute Economic Review, 90/2 (1990).

Blanchard O. and D. Quah, "The Dynamic Effects of Aggregate Demand and Supply Disturbances", American Economic Review, 79:4 (September 1989).

Canzoneri, M., "Exchange Intervention Policy in a Multiple Country World", Journal of International Economics, 13 (1982), pp. 267-89.

Cohen, D. and C. Wyplosz, "The European Monetary Union: An Agnostic Evaluation" in R. Bryant, D. Currie, J. Frenkel, P. Masson and R. Portes ed., Macroeconomic Policies in an Interdependent World, (Washington D.C.: International Monetary Fund, 1989).

_____ "France and Germany in the EMS: the Exchange Rate Constraint", CEPR Conference Macroeconomic Policy and the External Constraint: The European Experience, conference volume forthcoming.

Dornbusch, R. and S. Fischer, Macroeconomics: McGraw Hill, 3rd Edition (1986).

Fratianni, M. and J. von Hagen, "The European Monetary System Ten Years After", Carnegie-Rochester Conference Series on Public Policy, 32 (1990).

Giavazzi, F., "The Exchange Rate Question in Europe", in R. Bryant, D. Currie, J. Frenkel, P. Masson and R. Portes ed., Macroeconomic Policies in an Interdependent World, (Washington D.C.: International Monetary Fund, 1989).

Giavazzi, F. and L. Spaventa, "The New EMS", CEPR Discussion Paper 369 (1990).

Giovannini, A., "How Do Fixed Exchange Rate Regimes Work: The Evidence From the Gold Standard, Bretton Woods and the EMS", CEPR Discussion Paper No. 282 (October 1988).

de Grauwe, P., "The Costs of Disinflation and the European Monetary System", Open Economies Review (1990).

Haldane, A., "The Exchange Rate Mechanism of the European Monetary System: A Review of the Literature", Bank of England Quarterly Bulletin (February 1991).

Hall, R. and J. Taylor, Macroeconomics: Theory, Practice and Policy, Norton (1988).

Italianer, A. and J. Pisani-Ferry, "Exchange Rate Regimes in the EC", European Economy, No. 44 (October, 1990).

Kendal, M. and A. Stuart, The Advanced Theory of Statistics, Hafner Publishing Company, Vol. 2 (New York: 1967).

Mundell, Robert, "A Theory of Optimum Currency Areas," American Economic Review (1961), pp.657-65.

van der Ploeg, F., "Fiscal Aspects of Monetary Integration in Europe", CEPR Discussion Paper No. 340 (August 1989a).

_____, "Monetary Interdependence under Alternative Exchange Rate Regimes: A European Perspective", CEPR Discussion Paper No. 358 (November 1989b).

Portes, R., "Macroeconomic Policy Coordination and the European Monetary System", CEPR Discussion Paper No. 342 (September 1989).

Roubini, N., "Leadership and Cooperation in the European Monetary System: A Simulation Approach", NBER Working Paper No. 3044 (July 1989).

Sims, C., "Macroeconomics and Reality", Econometrica, 48, (1980) pp. 1-49.

Taylor, J. B., "New Econometric Approaches to Stabilization Policy in Stochastic Models of Macroeconomic Fluctuations", Handbook of Econometrics, ed. Z. Griliches and M. Intrilligator, , Vol. 3 (North Holland, 1986).

Ungerer, H., O. Evans and P. Nyberg, The European Monetary System: The Experience 1979-1982, Occasional Paper No. 19 (Washington: International Monetary Fund, 1983).

_____, H., O. Evans, T. Mayer, and P. Young, The European Monetary System: Recent Developments, Occasional Paper No. 48 (Washington: International Monetary Fund, 1986).

Weber, A., "EMU and Asymmetries and Adjustment Problems in the EMS: Some Empirical Evidence", CEPR Discussion Paper No. 448, (August 1990).