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SHOCKING ASPECTS OF EUROPEAN MONETARY UNIFICATION

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ABSTRACT

Data on output and prices for 11 EC member nations are analyzed to extract information on underlying aggregate supply and demand disturbances using a VAR decomposition. The coherence of the underlying shocks across countries and the speed of adjustment to these shocks are then compared to the results from US regional data. We find that the underlying shocks are significantly more idiosyncratic across EC countries than across US regions, which may indicate that the EC will find it more difficult to operate a monetary union. However a core of EC countries, made up of Germany and her immediate neighbors, experience shocks of similar magnitude and cohesion as the US regions. EC countries also exhibit a slower response to aggregate shocks than US regions, presumably reflecting lower factor mobility.

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I. Introduction

From all appearances the process of European monetary unification (EMU) continues to gather momentum. Nearly four years have passed since the last significant realignment of exchange rates of EMS members. All significant controls on capital movements among member countries have been removed. Discussions of the establishment of a European central bank and a single currency are proceeding apace. If the current time table is observed the transition will have been completed by the end of the decade.

At the same time there remain serious questions about the advisability of EMU, voiced in the most recent round of discussions by the governments of Britain and Spain. By definition, EMU involves a sacrifice of monetary autonomy. In response to country-specific shocks, governments will no longer have the option of adopting a monetary policy which differs from that of the union as a whole. Insofar as monetary policy is useful for facilitating adjustment to disturbances, adjustment problems may grow more persistent and difficult to resolve.

These concerns are reinforced to the extent that one believes that completion of the internal market will place new limits on the use of fiscal policy. Not only will individual governments have lost autonomy over the use of seigniorage to finance budget deficits but, insofar as the 1992 process renders factors of production increasingly mobile, constraints will be placed on their ability to impose tax rates significantly different from those of their neighbors. Limits on their ability to tax in the future will limit their ability to run budget deficits in the present; hence all important fiscal instruments may be constrained.1/ The sacrifice of monetary autonomy is all the more serious.

The weight that should be attached to these arguments depends on the incidence of shocks. If disturbances are distributed symmetrically across countries, symmetrical policy responses will suffice. In response to a negative aggregate demand shock that is common to all EMU countries, for example, a common policy response in the form of a common monetary and fiscal expansion should be adequate. Only if disturbances are distributed asymmetrically across countries will there be occasion for an asymmetric policy response and may the constraints of monetary union bind. This has been widely understood, of course, since the seminal work on the theory of optimum currency areas by Mundell (1961).

In light of the attention attracted by EMU, we possess remarkably little evidence on the incidence of shocks to the European economy. In this paper we therefore analyze data on output and prices for 11 EC member nations in order to extract information on aggregate supply and aggregate demand disturbances. We use the structural vector autoregression approach to isolating disturbances developed by Blanchard and Quah (1989), as extended by Bayoumi (1991). We examine the time-series behavior of real GDP and the price level. To recover aggregate supply and demand disturbances, we impose the identifying restrictions that aggregate demand disturbances have only a temporary impact

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1/ The argument that deficit spending will be constrained follows from the observation that investors will hesitate to purchase the additional bonds issued by a jurisdiction running a budget deficit if the implied debt service exceeds its capacity to raise revenues. The force of this argument is disputed. For reviews of the debate see Eichengreen (1990a), Bayoumi and Russo (1991) and Goldstein and Woglom (1991).

on output but a permanent impact on prices, while aggregate supply disturbances permanently affect both prices and output.

In assessing the magnitude of disturbances to the European economy, a metric is required. Here the United States provides an obvious standard of comparison. The U.S. is a smoothly functioning monetary union. Its local authorities possess fiscal autonomy. It can be divided into regions that approximate the economic size of EC nations, and supply and demand disturbances to each region can be calculated. If it turns out, for example, that supply shocks are less correlated across U.S. regions than across EC members, then there can be no presumption that asymmetric shocks will necessarily threaten the success of EMU. If on the other hand shocks to EC countries are significantly more asymmetric than shocks to U.S. regions, then adoption of a single currency could give rise to serious problems.

The empirical framework allows us not just to identify aggregate supply and demand disturbances but to examine the economy's speed of adjustment. Comparing the responses of U.S. regions and EC nations provides suggestive evidence on the structural implications of the single market. If the responses of U.S. regions are more rapid than those of European countries, this would suggest that creation of a unified internal market, like that which the U.S. possesses, will encourage factor mobility and create other mechanisms facilitating the EC's adjustment to shocks. U.S. evidence is useful therefore for gauging the extent to which monetary unification and the rest of the 1992 program is likely to accelerate the response to shocks, as argued by Commission of the European Communities (1990).2/

The remainder of this paper is organized as follows. Section II reviews the theoretical literature on optimum currency areas and what it says about asymmetric shocks. It surveys previous empirical work on the issue. Section III sets out the framework used to identify supply and demand disturbances. Section IV describes our data and its properties, while Section V reports the results of the statistical analysis. Section VI concludes.

II. Optimum Currency Areas: Theory and Evidence

The point of departure for the literature on optimum currency areas was Mundell (1961).3/ Mundell observed that an exchange rate adjustment which permitted the pursuit of different monetary policies in two countries (the U.S. and Canada) was of little use if the disturbance in response to which the policies were adopted depressed one region within both nations (say, Western Canada and the Western United States) while simultaneously stimulating other

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2/ This change in response could take place through a number of different mechanisms. Horn and Persson (1988) suggest that EMU, by increasing the credibility of policymakers' commitment to price stability, might enhance wage flexibility. Commission of the European Communities (1990) argues similarly that EMU, by increasing the credibility of fiscal authorities' commitment not to bail out depressed regions, will encourage workers in such areas to moderate wage demands. Marsden (1989) suggests that increased product market integration, by reducing product market power at the national level, will make the derived demand for labor more price elastic, rendering wage setting more responsive to market conditions. Bertolla (1988) presents arguments suggesting that once exchange rates are immutably fixed, workers will respond by adjusting on other margins, notably interregional migration.

3/ Here we review only selected aspects of the literature on optimum currency areas as they bear to the issues at hand. A more comprehensive survey is Ishiyama (1975).

regions within both (say, Eastern Canada and the Eastern U.S.). In this case there exists an efficiency argument for forming one currency area comprised of the western portions of the two nations and a second currency area comprised of their eastern portions. In response to this disturbance, the western regions can then adopt one policy, the eastern regions another, and the exchange rate between them can adjust accordingly, while preserving the advantages of a common currency in the form of reduced exchange rate risk and lower transaction costs within the Eastern and Western regions. In Mundell's framework, then, the incidence of disturbances across regions is a critical determinant of the design of currency areas.4/

One strand of subsequent literature explored the determinants of the incidence of shocks. Kenen (1969) highlighted the degree of industry or product diversification as a determinant of the symmetry of disturbances. When two regions are highly specialized in the production of distinct goods whose relative prices are affected very differently by disturbances, he

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4/ Symmetry of shocks is not the only criterion for the choice of an optimal currency area. Other factors such as the cost of operating an independent currency, size of trade with other regions, and (possibly) similarity of public preferences are also important. When comparing the current EC with the US, however, many of these differences are relatively small. In particular, both regions represent continent-wide indutrial areas with a high degree of internal trade and similarly sized populations. Accordingly, this paper will focus on the issue of the symmetry and size of the underlying shocks in EC countries as compared with those across US regions.

argued, asymmetric shocks are more likely than when the two regions have the same industrial structure and produce the same goods.5/

A second direction taken by the subsequent literature analyzed mechanisms other than exchange-rate-cum-monetary policy that might facilitate adjustment. Following Meade (1957), Mundell emphasized labor mobility. The greater the propensity for labor to flow from depressed to prosperous regions, he argued, the less the need for different policy responses in the two regions to prevent the emergence of pockets of high unemployment. Ingram (1973) noted that even where labor remains imperfectly mobile, capital mobility has typically reached high levels.6/ Hence capital flows can substitute for labor migration as a mechanism for reallocating resources across regions. But physical capital mobility eliminates the need for labor mobility only under restrictive assumptions.7/

Given that markets for labor and physical capital cannot respond instantaneously to region-specific shocks, a number of authors have analyzed market mechanisms and policy measures that can insure against region-specific risk. Atkeson and Bayoumi (1991) explore the extent to which financial

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5/ Commission of the European Communities (1991) presents evidence on the similarly of industrial structure across EC countries and argues that product market integration will increase the scope of intra-industry trade, rendering national industrial structures increasingly similar over time. Krugman (1991) suggests in contrast that completion of the internal market may lead to greater regional specialization and thereby magnify geographical differences in industrial structure.

6/ The essence of this argument appears also in Scitovsky (1967).

7/ Essentially, constant returns to scale in production are required. If technology exhibits increasing returns, a shock which requires the expansion of one sector at the expense of another may require the intersectoral reallocation of both factors of production for full efficiency to be achieved. See Eichengreen (1991b). A taxonomy of cases is provided by Helpman and Krugman (1985).

capital mobility can substitute for physical capital mobility. In their model, agents can diversify away the risk of region-specific shocks by holding financial assets whose returns are uncorrelated with region-specific sources of labor and capital income. Sachs and Sala-i-Martin (1991) have suggested that regional problems can be alleviated through transfers of purchasing power from booming to depressed regions accomplished by federal fiscal systems. This creates a presumption that currency areas should coincide with fiscal jurisdictions.

This predominantly theoretical literature suggests an agenda for empirical research: (i) identifying the incidence of shocks, (ii) isolating their underlying determinants, and (iii) analyzing the market and policy response. A remarkable feature of the scholarly literature -- and of the debate over EMU -- is how little empirical analysis has been devoted to these questions.

One approach to gauging the extent of asymmetric shocks has been to compute the variability of real exchange rates, since changes in relative prices reflect shifts in demand or supply affecting one region relative to another. Poloz (1990) compared regional real exchange rates within Canada with national real exchange rates between France, the U.K., Italy and Germany. He found that real exchange rates between Canadian provinces were more variable than those between the four EC countries. Since Canada runs a successfully monetary union, the implication is that the EC should be able to do the same. Eichengreen (1990a) extended Poloz's analysis to four U.S. regions (using consumer price indices for the North East, North Central, South and West) and 10 EC member states, reaching a different conclusion. He found that real exchange rates within the EC have been more variable than real exchange rates within the U.S., typically by a factor of three to four. De Grauwe and Vanhaverbeke (1991) similarly considered real exchange rates of regions within European nations. Using data on unit labor costs for Germany, France, Spain, the UK and the Netherlands in 1977-85, they found that real exchange rates were significantly less variable within European countries than between them. One interpretation is that the European Community is significantly further from being an optimum currency area than existing European states.

In a related analysis, Eichengreen (1990a) analyzed the covariance of real share prices in Toronto and Montreal and in Paris and Dusseldorf. In theory, the prices of equities should reflect the present value of current and expected future profits. If shocks are asymmetric, profits will rise in one market relative to the other. Real share prices in Toronto and Montreal were found to move more closely together than real share prices in Dusseldorf and Paris. There was strong evidence of convergence between Paris and Dusseldorf over time, but even in the 1980s the ratio of real share prices between Paris and Dusseldorf was five times as variable as the ratio for Toronto and Montreal.

A limitation of these approaches focusing on relative prices, as pointed about by Eichengreen (1990a), is that they conflate information on the symmetry of shocks and on the speed of adjustment. If real share prices in two regions move together, this may indicate either that the two regions experience the same shocks or that capital is quick to flow from the region where the rate of return has fallen to the one where it has risen. Similarly, if the relative prices of the products of two regions show little variability, this may reflect either that their product markets experience the same supply and demand disturbances or that factors of production are quick to flow out of the region where prices have begun to fall and into the region where they have begun to rise, thereby minimizing relative price variability.

This has led other authors to focus on the behavior of output rather than prices. Cohen and Wyplosz (1989) were first to use the time-series behavior of output to investigate the asymmetry of shocks.8/ They transform data on real GDP for France and Germany into sums and differences, interpreting movements in the sum as symmetric disturbances, movements in the difference as asymmetric disturbances. They remove a trend component from the sum and the difference using a variety of time-series techniques, and interpret the standard deviation of the detrended series relative to the standard deviation of the original series as a measure of the contribution of temporary disturbances to overall variability. They find that symmetric shocks are much larger than asymmetric shocks. (In other words, the variability of the sum is larger than the variability of the difference.) By their interpretation, symmetric shocks are predominantly permanent, while asymmetric shocks are predominantly temporary. (Detrending the sum eliminates much of its variability, while detrending the difference has a smaller effect.)

8/ Weber (1990) has extended their analysis to other EC countries.

The limitation of this approach focusing on output is much the same as that focusing on prices. Observed movements in real GDP reflect the combined effects of shocks and responses. Using this methodology it is impossible to distinguish their separate effects.9/

Independent evidence on the response to disturbances may permit one to back out information on the symmetry and magnitude of shocks. Recent investigations have focused on the responsiveness of labor markets. OECD (1985) assembled studies comparing interregional labor mobility within the U.S. and within EC nations. Its tabulations suggest that mobility within the U.S. has been two to three times as high as mobility within European nations. In a more recent study, De Grauwe and Vanhaverbeke (1991) found a much higher degree of interregional labor mobility in Northern European countries such as Germany, the UK and France than in Southern countries like Spain and Italy. While they do not provide comparisons with the U.S., their numbers are consistent with those of the OECD study.

The problem with such evidence, again, is that a high degree of observed labor mobility may reflect either an exceptionally responsive labor market or exceptionally asymmetric regional labor market shocks. Eichengreen (1990b) therefore estimated time-series models of regional unemployment differentials

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9/ De Grauwe and Vanhaverbeke (1991) study the variability of output across regions within European nations, arguing that this holds economic policies constant. But since it fails to hold the responsiveness of market adjustment mechanisms constant (such as, for example, internal migration and wage flexibility), which may themselves vary across regions, it remains difficult to distinguish disturbances from market responses. Eichengreen (1991) estimated models of internal migration for Britain, Italy and the United States and similarly found support for the hypothesis of great labor mobility in the U.S.

for both Europe and the United States. He examined the speed with which unemployment in EC countries converges to its long-run relationship to EC-wide unemployment, compared to the speed with which regional unemployment rates in the U.S. converged to the U.S. average. The results suggest that regional unemployment rates adjust to one another about 20 per cent more rapidly in the U.S. than national unemployment rates adjust to one another within the EC.

Given the costs of migration, the movement of labor is a plausible mechanism mainly for adjusting to permanent shocks. Work on responses to temporary disturbances has focused on portfolio diversification and fiscal redistribution. Using data for U.S. regions, Atkeson and Bayoumi (1991) estimate that recipients of capital income succeed in using portfolio diversification to insure against a significant proportion of region-specific income fluctuations, but that recipients of labor income do so only to a very modest extent.

On the effects of fiscal federalism, Sachs and Sala-i-Martin (1991) conclude that the U.S. fiscal system offsets about a third of a decline in regional personal incomes relative to the national average. In other words, when incomes in one U.S. region fall by $1 relative to incomes in the nation as a whole, the fall in tax payments by that region to Washington, D.C. plus inward transfers from other regions via the expenditure side of the government budget is about 33 cents. Disposable income therefore falls by only 67 cents.10/

These studies uniformly point to the conclusion that adjustment to region-specific shocks, whether by markets or policy, is faster in the U.S. than in Europe. Hence, the lesser variability of output and prices across regions in the U.S. than across nations in Europe may reflect either faster response to larger, more asymmetric shocks in the U.S., or faster response to smaller, less asymmetric shocks in the U.S. The approaches utilized in previous studies thus fail to provide enough information to distinguish disturbances from responses.

III. Methodology

It is for this reason that we take an alternative approach to identifying disturbances. Our point of departure is the familiar aggregate demand and aggregate supply diagram, reproduced as the top panel in Chart 1. The aggregate demand curve (labelled AD) is downward sloping in the price output plane, reflecting the fact that lower prices, by raising money balances, boost demand. The short run aggregate supply curve (SRAS) is upward sloping, reflecting the assumption that wages are sticky and hence that higher prices

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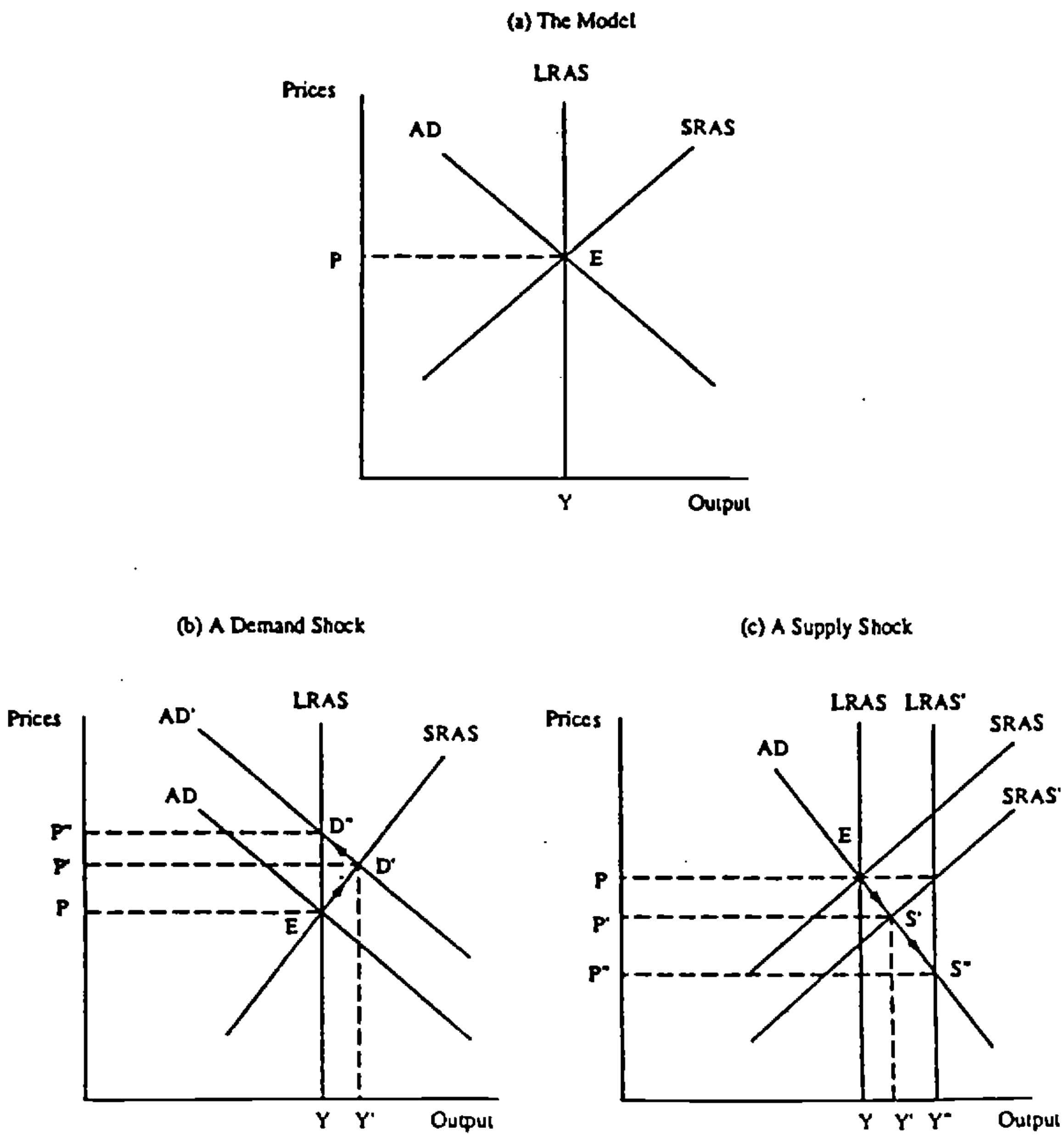
10/ Using different econometric methods, von Hagen (1991) has suggested that regional coinsurance in the U.S. is closer to one tenth than one third. In either case fiscal redistribution across U.S. regions is much more extensive than across EC member nations. In terms of the automatic stabilizer response to cyclical movements within regions, Atkeson and Bayoumi (1991) present evidence that the behavior of US regions and EC countries is similar.

Chart 1

The Aggregate Demand and Supply Model



imply lower real wages. The long run supply curve (LRAS) is vertical, since real wages adjust to changes in prices in the long run.11/

The effect of a shock to aggregate demand is 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 with the short run curves, D'. This raises both output and prices. As the aggregate supply curve becomes more vertical over time, the economy moves gradually 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 rises to a level which is permanently higher. (Depending on the price mechanism, there could be some cycling around the new long rum equilibrium.) Hence the response to a permanent (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 rises, say because of a favorable technology shock. The short- and long-run supply curves move rightwards by the same amount, as shown by SRAS' and LRAS'. The short run effect raises output and reduces prices, shifting the equilibrium from A to S'. As the supply curve becomes increasingly vertical over time, the economy moves from S' to S'', implying further increases in output and reductions in prices. Unlike demand shocks, supply shocks result in permanent

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11/ Although this is usually thought of as a closed economy model, it can be extended to include trade and the exchange rate. Textbook descriptions of the model include Dornbusch and Fischer (1986) Ch. 11, and Hall and Taylor (1988) Ch. 4-5.

changes in output. In addition, demand and supply have therefore different effects on prices; positive demand shocks raise prices while positive supply shocks reduce 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, as extended by Bayoumi (1991).12/ Consider a system where the true model can be represented by 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:

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

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

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

12/ Quah (1991) discusses the issue of identifying restrictions for VARs. An important assumption which is required to ensure uniqueness of the decomposition is that the underlying series (growth and inflation in this case) are fundamental in a Wold sense, as pointed out by Lippi and Reichlin (1990).

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

where y_t and p_t represent the logarithm of output and prices, ϵ_{dt} and ϵ_{st} are independent 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. The model implies the restriction,

$$\sum_{i=0}^{\infty} a_{11i} = 0. \tag{2.3}$$

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

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

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

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 demand and supply shocks, ϵ_t. Writing $e_t = C\epsilon_t$, it is clear that, in the two-by-two case considered, four restrictions are required to define the four elements of the matrix C. Two of these restrictions are simple normalizations, which define the variance of the shocks ϵ_{dt} and ϵ_{st}. A third restriction comes from assuming that demand and supply shocks are orthogonal.13/

The final restriction, which allows the matrix C to be uniquely defined, is that demand shocks have only temporary effects on output.14/ As noted above, this implies equation (2.3). In terms of the VAR it implies,

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13/ The conventional normalization is that the two variances are set equal to unity, which together with the assumption of orthogonality implies $C'C = \Sigma$, where Σ is the variance covariance matrix of e_y and e_p. However, when we wish to calculate the variance of the shocks themselves, we report results using the normalization $C'C = \Gamma$, where Γ is the correlation matrix of e_y and e_p. These two normalizations gave almost identical paths for the shocks, except for a scaling factor, and hence are used interchangeably.

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

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

This restriction allows the matrix C to be uniquely defined and the demand and supply shocks to identified.15/

Note that this restriction affects the response of output to the two shocks, but says nothing about their impact on prices. The aggregate-demand-aggregate-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, they can be thought of as over-identifying restrictions useful for testing our interpretation of the results.

IV. Data

Annual data on real and nominal GDP spanning the period 1960-88 were collected from the OECD Annual National Accounts for the 12 members of the EC. This same source provided an aggregate measure of output and price performance for the EC as a whole.16/ These same data were collected for 11 additional OECD countries: six EFTA members (Sweden, Switzerland, Austria, Finland, Norway and Iceland) plus the United States, Japan, Canada, Australia and New

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15/ Note 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.

16/ Two different measures of the EC aggregate are available from the OECD, one based on conversions of local currency data using 1985 dollars, and a second based on a weighting of the EC real GDP and GDP deflator indices. Since the two data sets gave very similar results, only those based on 1985 dollar exchange rates are reported.

Zealand. For each country growth and inflation were calculated as the first difference of the logarithm of real GDP and the implicit GDP deflator. The GDP deflator was used to measure prices since it reflects the price of output rather than the price of consumption. This distinction is particularly important for regional U.S. data since the integration of the domestic goods markets minimizes differences in regional CPIs.17/

For U.S. regions, annual data on real and nominal gross state product were collected for 1963-86. The gross state product series, produced by the U.S. Commerce Department, is described in the *Survey of Current Business* (May 1988). It measures gross output produced by each state and hence represents the regional equivalent of the gross domestic product series in the OECD data set. The data were aggregated into the eight standard regions of the United States used by the Bureau of Economic Analysis, namely New England, the Mid-East, the Great Lakes, the Plains, the South East, the South West, the Rocky Mountain states and the Far West. As is the case for EC countries, these regions differ in considerably in size; the Rocky Mountain region is smallest, with under 3 percent of U.S. population, while the Mid-East, South East and Great Lakes each contain around 20 percent of the U.S. population. Growth and inflation for each region were calculated in the same way as for the OECD, namely as the first difference in the log of real gross state product and of the gross-state-product deflator.

Before analyzing these data, it is useful to consider them in unprocessed form. Table 1 shows standard deviations and correlation coefficients for the

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17/ For evidence and comparisons with Europe, see Eichengreen (1990a).

Table 1. Standard Deviations and Correlation Coefficients with Anchor Areas: Logarithmns of Raw Data

	Growth		Inflation	
	Stan Dev	Correlation	Stan Dev	Correlation
		EC Countries		
Germany	0.022	1.00	0.017	1.00
France	0.018	0.74	0.031	0.47
Belgium	0.022	0.73	0.024	0.57
Netherlands	0.022	0.79	0.028	0.68
Denmark	0.025	0.67	0.023	0.69
United Kingdom	0.021	0.54	0.052	0.48
Italy	0.023	0.52	0.054	0.33
Spain	0.027	0.56	0.044	0.26
Ireland	0.022	0.09	0.050	0.49
Portugal	0.034	0.57	0.074	-0.07
		U.S. Regions		
Mid-East	0.025	1.00	0.020	1.00
New England	0.031	0.94	0.020	0.98
Great Lakes	0.040	0.88	0.022	0.98
Plains	0.027	0.85	0.023	0.94
South East	0.027	0.76	0.022	0.72
South West	0.022	0.40	0.035	0.89
Rocky Mountains	0.024	0.27	0.024	0.84
Far West	0.033	0.66	0.018	0.96

Notes: All variables are measured in logarithms, so that 0.0.27 indicates a standard deviation of approximately 2.7 percent.

logarithm of the growth in output and of inflation across the countries of the EC and the regions of the United States for the full data period.18/ The correlations are measured with respect to Germany in the case of the EC and the Mid-East in the case of the US. 19/ The standard deviations indicate that output fluctuations have generally been somewhat smaller across EC countries than across US regions, while inflation variability has been higher in Europe. The correlation coefficients indicate that output growth is generally more highly correlated across US regions than EC regions, although two regions (the Southwest and the Rocky Mountains) have relatively idiosyncratic behavior. For inflation, the correlation coefficients are much more highly correlated across US regions than EC countries, presumably reflecting the existence of a common currency.

Tables 2 and 3 extend the analysis of correlations across EC countries and US regions, respectively. They report the share of the variance of output growth and inflation explained by the first principal component (the orthogonal component most correlated with the underlying series) for different groups of countries or regions over several time periods. The results confirm the greater coherence of price and output movements among U.S. regions than among EC countries. For the full period, the first principal component explains 74 per cent of the variance in output movements for U.S. regions but

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18/ Since the data are in logarithms, a standard deviation of 0.012 implies an average deviation of 1.2 percent.

19/ Germany is the largest economy in Europe, and has played the anchor role in the ERM, making it the obvious standard for comparison. The Mid-East, which is the most important region in the US financially and, arguably, economically, is taken as the analogous "anchor" region of the US. These choices are retained in all subsequent analysis.

Table 2. Percentage of Variance Explained by the First Principal Component Across Different Groups of Countries: Raw Data

	EC11	Other 11	EC Core	EC Peri-phery	EFTA	Control Group
			Growth			
Full Period	57	42	73	49	43	49
1963-71	40	39	73	35	51	49
1979-79	62	39	82	49	43	53
1980-88	44	46	54	42	42	57
			Inflation			
Full Period	59	54	64	70	53	57
1963-71	44	37	46	38	42	36
1972-79	39	46	58	52	44	59
1980-88	73	61	82	69	68	58

Notes: Since the percentage of variance explained varies with the number of countries in the group, it is not useful to compare the results from the first two columns with those in the subsequent columns. The control group comprises US, Japan, Canada, Australia, New Zealand and Iceland.

only 57 per cent for EC countries. For inflation the comparable figures are 92 and 59 per cent.

For both the U.S. and the EC the first principal component explains the largest ehare of the variance in output in the 1970s, the smallest share in the 1960s. This presumably reflects the fact that all countries and regions experienced an unusually severe recession following the first oil shock. For both the U.S. and the EC the first principal component explains the largest share of the variance in inflation in the 1980s, presumably reflecting the extent to which price-level trends in both the U.S. and Europe were dominated by disinflation after 1980.

Table 2 contrasts the behavior of output and prices in the EC and with that in the 11 other industrial economies in our sample. Although the first principal component explains a larger share of the variance of output in the EC than in the other industrial countries, this is due to the similar reaction of EC members to the oil shock and to other events in the 1970s, rather than to the EMS and firet steps toward completion of the internal market in the 1980s. In contrast, there is weak evidence of the effects of the EMS in the larger share of the variance of inflation explained for the EC than for the other economies in the 1980s.

The failure to discern a large difference in the coherence of output movements between the EC 11 and the other industrial economies reflects divergent movements not among what might be regarded as the "core" members of the EC (Germany, France, Belgium, Luxembourg, the Netherlands and Denmark) but between the core and the EC "periphery" (the U.K., Italy, Ireland, Greece,

Table 3. Percentage of Variance Explained by the First Principal Component Across Different Groups of U.S. Regions

	All Eight U.S. Regions	Six "Core" Regions	Six "Peripherai" Regions
		Growth	
Full period	74	85	73
1966-72	79	88	78
1973-79	92	94	92
1980-86	78	92	74
		Inflation	
Full period	92	93	92
1966-72	84	90	83
1973-79	70	77	67
1980-86	98	99	98

Notes: The core regions comprise the Mid-East, New England, Great Lakes, Plains, South East and Far West, the peripheral regions the Mid-East, Plains, South East, South West, Rocky Mountains and Far West.

Portugal and Spain). In each sub-period, the first principal component explains much less of the variance in output growth among peripheral countries, and generally less for inflation. The coherence of price and output trends among the EFTA countries is similar to that among the members of the EC periphery. The final column of Table 2 reports the results for a control group, made up of the five countries in our sample which are not members of the EC or of EFTA plus Iceland. Iceland, an EFTA member, is included in the control group in order to make the number of countries in each group equal.20/ Again, the behavior of this control group is not dissimilar from that of the EC periphery.

Table 3 reports analogous breakdowns for the United States. The second column, which excludes the Southwest and Rocky Mountains, can be thought of as the U.S. "core."21/ The third column, which excludes the Great Lakes and New England, is intended to simulate a U.S. "periphery." The second column confirms that output movements are more closely synchronized, most notably in the 1980s, when the Southwest and Rocky Mountains are removed. This presumably reflects the very different composition of production in these two regions (dominated by oil in the Southwest and by other minerals and raw materials in the Rocky Mountain states). There is less difference in the

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20/ We include six regions in each column to preserve the same number of regions and therefore render our principal-components analysis as consistent as possible. Since growth and inflation rates are relatively variable in Iceland, and since its supply and demand shocks are fairly loosely correlated with those of other countries, its inclusion will tend to make shocks to other countries appear coherent compared to the control group. For details, see Bayoumi and Eichengreen (1991).

21/ We show below that the two excluded regions respond differently to shocks than does the rest of the U.S.

behavior of inflation, as if the integration of product markets encompasses even those regions where the composition of local output is different.

The third column confirms that the picture is reversed when the Great Lakes and New England are removed. Compared to Table 2, however, the contrast between columns is quite small, substantiating the view of greater coherence of price and output trends among U.S. regions than within the EC and among other countries.

V. Results

To identify supply and demand disturbances, we estimated bivariate VARs for each country and region in the sample. In all cases, the number of lags was set to 2, since the Schwartz Bayesian information criterion indicated that all of the models had an optimal lag length of either one or two.22/ A uniform lag of two was chosen in order to preserve the symmetry of the specification across countries. For the EC and other countries, the estimation period was 1963-88, while for US regions it was 1966-86. For the OECD countries, the estimation period includes a potential change in regime, namely the break-up of the Bretton Woods fixed exchange rate system in the early 1970s. However, Chow tests of the structural stability produced no evidence of a shift in the early 1970s. Limited analysis using data sets which excluded the Bretton Woods period showed similar results to those reported.

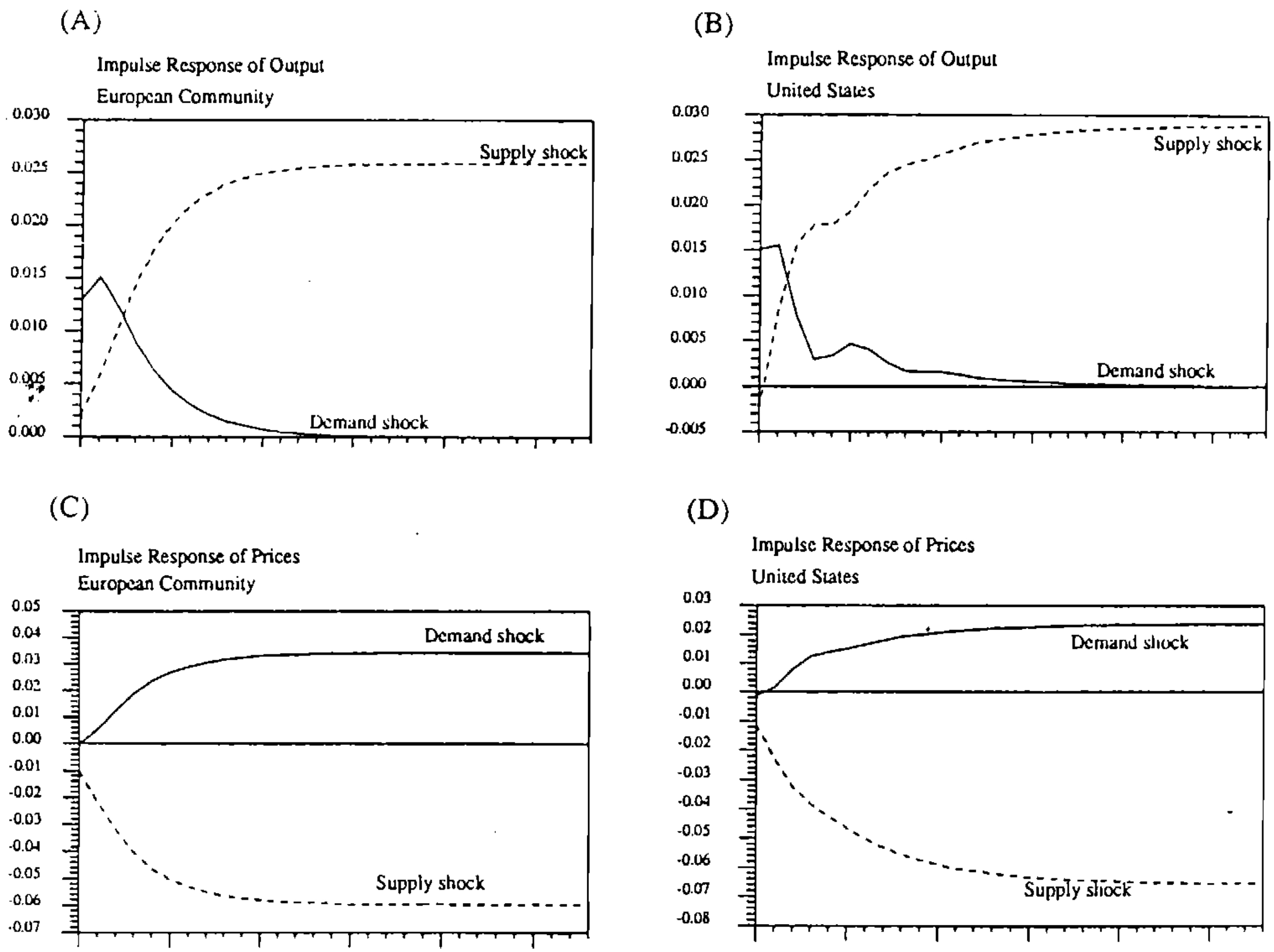
22/ We also estimated VARs with three lags because, in contrast to the Schwartz Bayesian statistic, the Akaike information criterion showed the optimal lag to be above 2 in some of the models; this specification produced very similar results.

In nearly every case, the estimation and simulation results accord with the aggregate-demand-aggregate-supply framework discussed in section III. The "over-identifying restriction" that positive aggregate demand shocks should be associated with increases in prices while aggregate supply shocks should be associated with falls in prices was generally observed. In only 3 of the 30 data cases was it impossible to interpret the results using the aggregate-demand-aggregate-supply framework, namely Norway, Ireland and the Rocky Mountain region of the United States.

Chart 2 illustrates the results. It shows the output and price impulse-response functions for the EC and the U.S. as a whole.23/ The impulse response functions for output shown in panels (a) and (b) illustrate the restriction that aggregate demand shocks have only temporary effects on the level of output while supply shocks have permanent output effects. Positive demand shocks produce a rise in output initially, which then gradually returns to its baseline level; in contrast, positive supply shocks produce a steady rise in output to a new higher equilibrium level. The impulse-response functions for prices shown in panels (c) and (d) indicate that the over-identifying restriction is satisfied. While both aggregate supply and aggregate demand shocks have long-run effects on the price level, demand shocks produce a gradual rise in prices over time, while supply shocks produce a steady decline in prices, as predicted by aggregate-demand-aggregate-supply framework.

23/ These results were obtained by estimating VARs on aggregate data for the U.S. and EC, not by aggregating results obtained using regional U.S. and national European data.

Chart 2 - Impulse Response Functions for the E.C. and U.S.

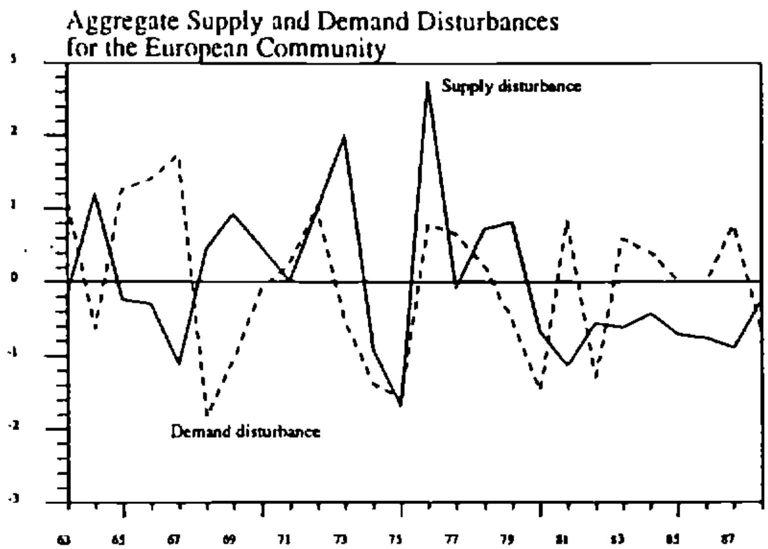


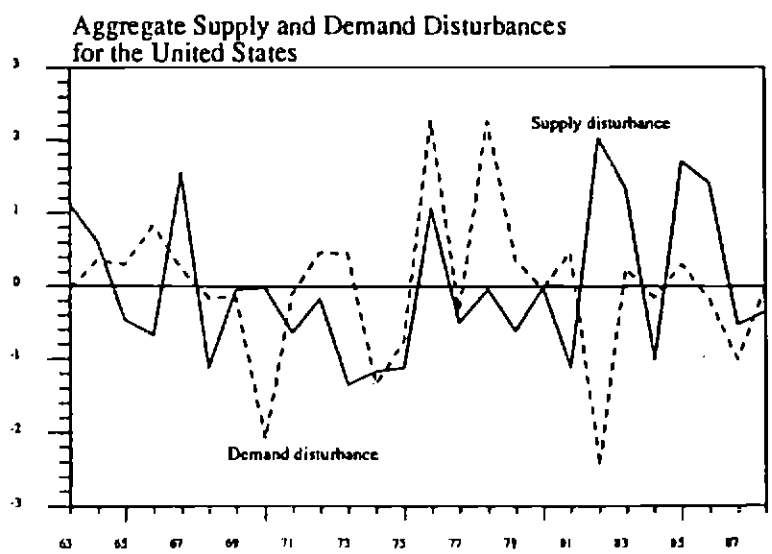
Three additional features of the impulse-response functions stand out. (1) Demand shocks are more important than supply shocks for output in the short run. (By construction, they become progressively less important over time.) No such regularity holds for prices. (2) The impulse-response functions for the U.S. appear to show a faster response to shocks than the EC data. (3) In contrast to the results for *speed* of response, the *magnitude* of response is remarkably similar for the U.S. and the EC, implying that the underlying shocks may be of a similar magnitude. (These are issues to which we will return below.)

Chart 3 displays the underlying demand and supply shocks for the EC and U.S. aggregates. In the case of the EC, large negative disturbances to supply are evident in 1973-1975 and 1979-80, corresponding to the two oil shocks, along with a large negative supply shock in 1968 which is more difficult to interpret. The demand disturbances illustrate the different response of the EC to the first and second oil crises; there is a large positive demand shock in 1977, while from 1980 onwards demand shocks are negative. In the case of the U.S., the effects of the oil crises are also clearly evident, while the rapid recovery of the 1980s seems to be associated with a series of positive supply shocks (perhaps reflecting supply-side friendly tax cuts). There is a major negative demand shock in 1982, corresponding to the policy of disinflation pursued by the Federal Reserve System.

We now turn to the results for individual EC countries and U.S. regions. We first examine the correlation of aggregate demand and supply shocks across EC members and standard U.S. regions in order to identify similarities and

Chart 3. Aggregate Demand and supply shocks for the U.S and E.C





differences between the two groups. We next consider comparisons over time in order to study whether the shocks to the EC have become more correlated as a result of macroeconomic policy convergence. Finally, we compare the magnitude of underlying demand and supply disturbances in Europe and the U.S. and contrast their speed of adjustment.

Correlations. The first column of data in Table 4 shows correlation coefficients measuring the correlation of supply shocks in Germany with those in other EC countries. German supply shocks are highly correlated with those experienced by four of its close neighbors: France, the Netherlands, Denmark and Belgium. All four have correlation coefficients of 0.5-0.7, while the other six EC countries (the UK, Italy, Spain, Ireland, Portugal and Greece) have lower correlations, on the order of -0.1 to +0.3. The bottom half of the table shows the same results for U.S. regions, with the Mid-East taken as the U.S. center analogous to Germany in the EC. The data display a similar pattern but with higher correlations than those of EC countries. The three U.S. regions neighboring the Mid-East (New England, the Great Lakes and the South East) have correlations of over 0.65, while the other four regions (the Plains, the Rocky Mountains, the Southwest and the Far West) have lower correlations. The correlation between the Far West and the Mid-East is still relatively high (over 0.5), but that between the Southwest and the Mid-East is negative (presumably reflecting the importance of the oil industry in states like Texas and Oklahoma).

Table 4. Correlation Coefficients Between Anchor Areas and Other Regions: Underlying Shocks

	Supply Shocks	Demand Shocks
	EC Countries	
Germany	1.00	1.00
France	0.54	0.35
Belgium	0.61	0.33
Netherlands	0.59	0.17
Denmark	0.59	0.39
United Kingdom	0.11	0.16
Italy	0.23	0.17
Spain	0.31	-0.07
Ireland	-0.06	-0.08
Portugal	0.21	0.21
Greece	0.14	0.19
	U.S. Regions	
Mid-East	1.00	1.00
New England	0.86	0.79
Great Lakes	0.81	0.60
Plains	0.66	0.50
South East	0.30	0.51
South West	-0.12	0.13
Rocky Mountains	0.18	-0.28
Far West	0.52	0.33

Notes: The correlation coefficients refer to the entire data period: 1962-88 for the EC data and 1965-86 for the US regions.

In effect, then, both the EC and the US can be divided into a "core" of regions characterized by relatively symmetric behavior and a "periphery" whose disturbances are more loosely correlated with those experienced by center. As in Europe, the U.S. "core" is made up of areas that are neighbors of the center region (the only exception being the Far West).

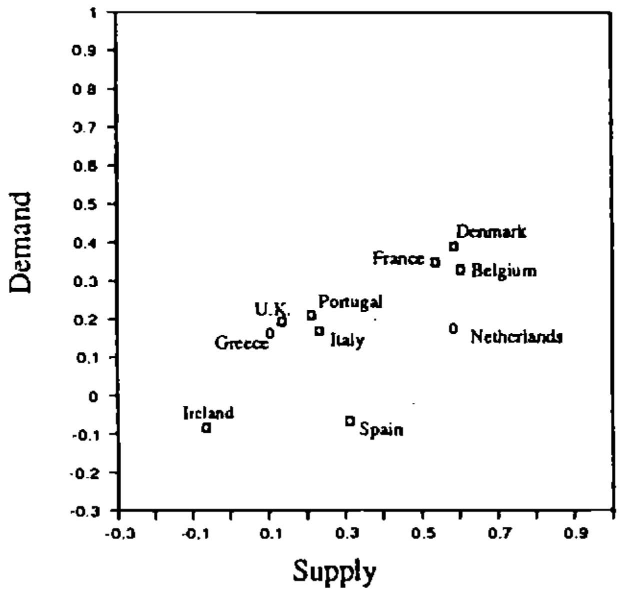
The results for demand disturbances, reported in columns 2 and 4, are more difficult to characterize. All of the correlations for EC countries are in the range -0.1-+0.4. As with supply disturbances, there is some evidence that demand disturbances are more highly correlated across core countries than among the members of the EC periphery. The simple arithmetic means of the respective sets of correlation coefficients are 0.31 and 0.10. The "core-periphery" distinction is less strong, however, for the demand shocks than for the supply shocks.

The correlation of regional demand disturbances for the U.S. is higher than the analogous correlation for Europe. This is what one would expect insofar as U.S. regions are members of a monetary union and should therefore experience similar monetary and (perhaps) fiscal shocks. The other three members of the U.S. core (New England, the Great Lakes and the South East) all have correlation coefficients with the Mid-East excess of 0.5. The Far West and the Plains have correlation coefficients of more than 0.33, while the two remaining regions (the Southwest and the Rocky Mountains) have more idiosyncratic demand shocks.

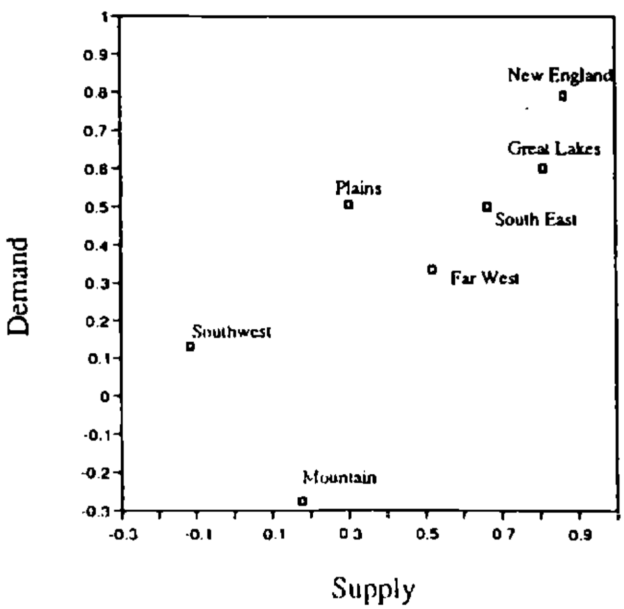
Chart 4 juxtaposes the correlation coefficients of demand shocks (on the vertical axis) and the correlation coefficients supply shocks (on the

Chart 4. Correlation of demand and supply shocks with anchor areas

Correlation of supply and demand disturbances with German supply and demand disturbances



Correlation of U.S. Supply and demand disturbances with supply and demand disturbances of mid-east region



horizontal axis). (The top panel is for Germany and the other EC countries, while the lower panel is for the Mid-East and other U.S. regions). While the distinction between "core" (with highly correlated supply shocks) and a "periphery" is evident in both panels, it is also clear that the U.S. regional data are characterized by higher correlations.

In Table 5 the correlations between demand and supply shocks are summarized using principal components analysis. Results are reported for three successive subperiods as a way of exploring the extent to which supply and demand shocks to EC member countries have grown more similar over time. The first two columns compare the 11 EC members with 11 other industrial economies. For the full sample period, the EC countries have more correlated aggregate supply and aggregate demand shocks. The first principal component explains 31 to 33 percent of the variance for the 11 EC countries; for the others it explains only 26 percent. This pattern of higher correlations among EC countries generally holds for subperiods. There is, however, little or no evidence of convergence over time. There is no apparent tendency for the difference in the percentage of the variance explained for the EC and for the other 11 industrial countries to increase over time.

In columns 3 to 5 the results are extended to distinguish the EC core (Germany, France, Belgium, the Netherlands, Denmark and Luxembourg), the EC periphery (the UK, Italy, Spain, Portugal, Ireland and Greece), and a control group of countries belonging to neither EFTA or the EC (the U.S., Japan,

Table 5. Percentage of Variance Explained by the First Principal Components for Geographic Groupings

	EC11	Other 11	EC Core	EC Periphery	Control Group	U.S. Regions
			Supply Shocks			
Full Period	33	26	54	32	33	49
1963-71	34	33	39	40	42	53
1979-79	44	41	63	41	51	65
1980-88	35	37	62	41	47	68
			Demand Shocks			
Full Period	31	26	53	36	41	51
1963-71	30	34	58	30	37	44
1972-79	40	38	50	49	48	49
1980-88	40	34	54	43	56	75

Notes: The control group comprises US, Japan, Canada, Australia, New Zealand and Iceland. The sample period is 1962-88.

Canada, Australia, New Zealand and Iceland).24/ The countries of the EC core have more correlated supply and demand shocks than either the periphery or the control group. The difference is most striking for supply shocks: the first principal component explains 54 percent of the variance for the core EC countries, compared to 32 percent for the periphery, and 33 percent for the control group. In fact, the first principal component actually explains a slightly lower percentage of variance for the EC periphery than for the control group. This is true for both supply and demand shocks and for the full data period. There is little indication, moreover, of convergence by newcomers to the EC -- in other words, of a tendency for the correlation of disturbances among members of the EC periphery to rise over time compared to the correlation of disturbances among members of the control group.

The sixth column shows the results for the eight U.S. regions. Their correlations are similar to those for the EC core but significantly higher than those for the EC periphery and the control group. The correlations are considerably higher when the Southwest and Rocky Mountains are excluded than when all 8 U.S. regions are included. When the Great Lakes and New England are excluded, the correlations fall. Thus, the correlation of supply and demand disturbances across U.S. regions is sensitive to precisely what regions

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24/ Luxembourg (which is otherwise excluded from the analysis due to its small size) was included in order to make the number of countries equal across groups. Iceland, which is a member of EFTA, was included in the control group for similar reasons. It should be stressed that the results from principal components analysis depends upon the number of series involved in the comparison. Hence it is not useful to compare the results for the EC 11 with (say) that of the six EC peripheral countries.

are included. The core EC countries are consistently near the bottom of this range defined by the correlations for these subsets of U.S. regions.

To summarize, the results for both the U.S. and EC suggest that it is possible to distinguish core regions for which supply and demand shocks are highly correlated, and a periphery in which the correlation of shocks is less pronounced. In each case the core is comprised of regions neighboring the center region (Germany in the case of the EC, the Mid-East in the case of the U.S.). Whether one compares the 8 U.S. regions with the 11 EC members or limits the comparison to the EC and U.S. cores, disturbances tend to be more highly correlated in the U.S.25/ Only if one compares the core EC countries with all 8 U.S. regions are the correlations of similar magnitude, although it should be recalled that in the case of demand shocks the higher US correlations may reflect the impact of uniform economic policies.

Size of Shocks. In addition to looking at the symmetry or correlation of shocks across regions, our methodology can also be used to estimate their relative size. The larger the size of the underlying shocks, the more difficult it may be to maintain a fixed exchange rate, and the more compelling may be the case for an independent economic policy response. This is particularly true of supply shocks, which may require more painful adjustment.

25/ This is particularly true if one takes into account the fact that several of the peripheral U.S. regions are quite small. Together the Rocky Mountains and Southwest contain less than 12 percent of the U.S. population.

Table 6 reports the standard deviations of the aggregate demand and aggregate supply disturbances for EC countries and US regions.26/ For the EC, the magnitude of supply shocks, like the correlation of supply shocks, suggests the existence of two distinct groups of countries. The core countries, Germany, France, Belgium, the Netherlands and Denmark, all have standard deviations in the range of 0.01-0.02 (1-2 percent per annum). The standard deviations for the periphery (the United Kingdom, Italy, Spain, Portugal, Ireland and Greece) all range from 0.02 to 0.04 (2-4 percent per annum). Broadly speaking, then, the peripheral countries experience supply shocks twice as large as the core countries.

The supply shocks to U.S. regions are similar to those experienced by the EC core and uniformly lower than those of the EC periphery. The standard deviation for the U.S. Southwest, which at 0.019 is the largest for any U.S. region, is still lower than that for any of the members of the EC periphery. There is also some indication that the U.S. regions, particular those in the core, experience smaller supply shocks than members of the EC core; 5 of the 8 U.S. standard deviations are below 0.15, compared to only 1 of 5 for the EC core.

The results for demand shocks, shown in the right hand columns, are more difficult to interpret. Demand shocks in the EC core are slightly smaller than those to the EC periphery. Germany and France, for example, have the lowest standard deviations. Further generalization is difficult, however.

26/ These are calculated using the modification of the VAR decomposition discussed in footnote 14.

Table 6. Standard Deviations of Aggregate Supply and Aggregate Demand Shocks

	Supply Shocks	Demand Shocks
	EC Countries	
Germany	0.017	0.014
France	0.012	0.012
Belgium	0.015	0.016
Netherlands	0.017	0.015
Denmark	0.017	0.021
United Kingdom	0.026	0.017
Italy	0.022	0.020
Spain	0.022	0.015
Ireland	0.021	0.034
Portugal	0.029	0.028
Greece	0.030	0.016
	U.S. Regions	
Mid-East	0.012	0.019
New England	0.014	0.025
Great Lakes	0.013	0.033
Plains	0.016	0.022
South East	0.011	0.018
South West	0.019	0.018
Rocky Mountains	0.018	0.015
Far West	0.013	0.017

Notes: All variables are measured in logarithms, so that 0.27 indicates a standard deviation of approximately 2.7 percent.

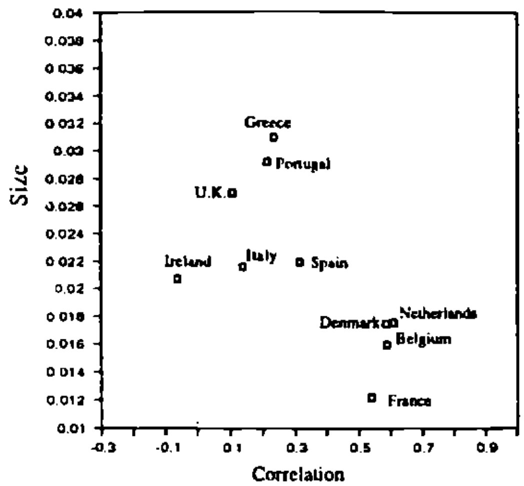
The most surprising comparison is between the U.S. and the EC. The U.S. regions have somewhat larger demand shocks than the EC countries.

This is not just a reflection of larger aggregate disturbances to the U.S. as a whole; the standard error for the U.S. aggregate, using OECD data, is 0.153, lower than that for most EC countries. The high variability of demand affecting U.S. regions may therefore reflect the greater specialization of industrial production in the U.S. (For data on the concentration of industry within the US see Krugman (1991), Appendix D). This supposition is supported by the magnitude of demand disturbances in different U.S. regions. The largest demand disturbances are those for the Great Lakes, Mid-East, Plains and New England regions, all of which are relatively specialized, while the Southeast and Far West, which are more sectorlally diversified, have lower variability. If this interpretation is correct, the evidence suggests that completion of the internal market in Europe may well magnify aggregate demand disturbances by leading to increased specialization.

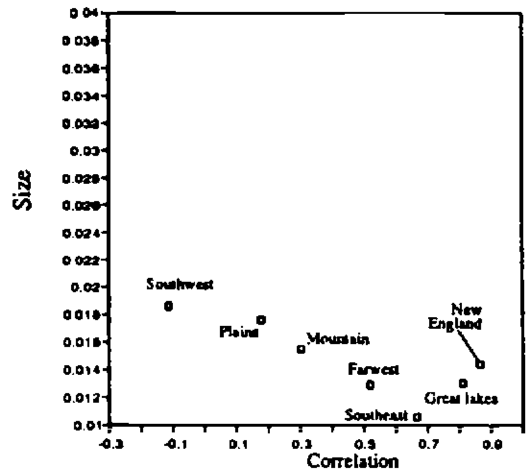
Charts 5(a)-(d) juxtapose the size of disturbances against their correlation with that of the center country or region. The vertical axis measures the standard deviation of the disturbance, while the horizontal axis shows the correlation Panel 5(a) shows the results for supply shocks to EC countries, 5(b) the results for supply shocks and US regions. Panels 5(c) and 5(d) show the same results for the demand disturbances. The panels are plotted using the same scales to aid comparison. The supply disturbance panels vividly illustrates the different behavior of the core and periphery for both the EC and the US. It is also clear, however, that the shocks

Chart 5. The size and correlation of the demand and supply disturbances

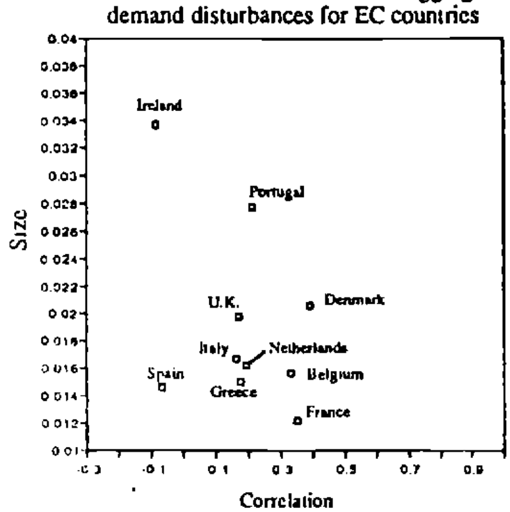
Standard deviation and correlation of aggregate supply disturbances for EC countries



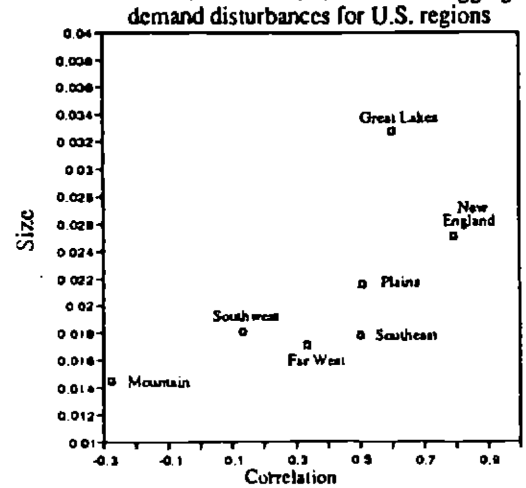
Standard deviation and correlation of aggregate supply disturbances for U.S. regions



Standard deviation and correlation of aggregate demand disturbances for EC countries



Standard deviation and correlation of aggregate demand disturbances for U.S. regions



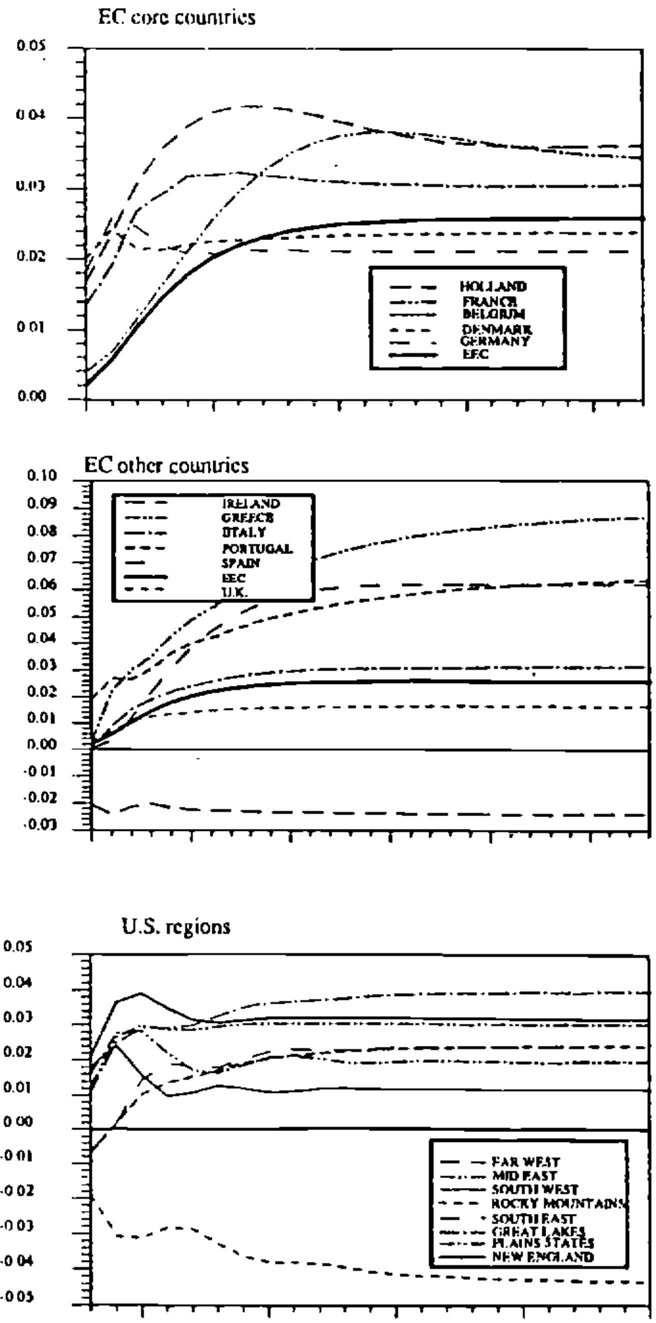
hitting the US periphery are much smaller than those hitting the EC periphery, making the lack of correlation with the anchor region somewhat less of an issue. The data for the demand disturbances, on the other hand, show relatively little pattern, although the relatively large shocks experienced by US regions is evident.

Speed of Adjustment to Shocks. In addition to isolating underlying disturbances, our procedure permits one to compare the responses of economies to shocks. This can be done by looking at the impulse response functions associated with the structural VARs. Two issues of particular interest can then be addressed. How does speed of adjustment by EC countries characterized by relatively low factor mobility but adjustable exchange rates compare with speed of adjustment by U.S. regions characterized by high factor mobility but fixed exchange rates? Is there evidence of consistent differences among EC countries associated with openness or other structural characteristics?

Charts 6 and 7 display the impulse response functions for output for the EC countries and U.S. regions. In Chart 6 the responses to supply shocks are shown; the top panel displays the impulse responses for the core EC countries, the middle panel the responses for the remaining EC economies, and the bottom panel the responses for U.S. regions.27/ A noticeable feature is the faster speed of adjustment for the U.S. regions despite the lack of the exchange rate instrument within the US currency area. The bulk of the adjustment to supply shocks by U.S. regions occurs within 3 years; for EC

27/ The larger scale required for the EC periphery is another illustration of the relative large shocks they experience.

Chart 6 - Impulse response functions
Supply shocks



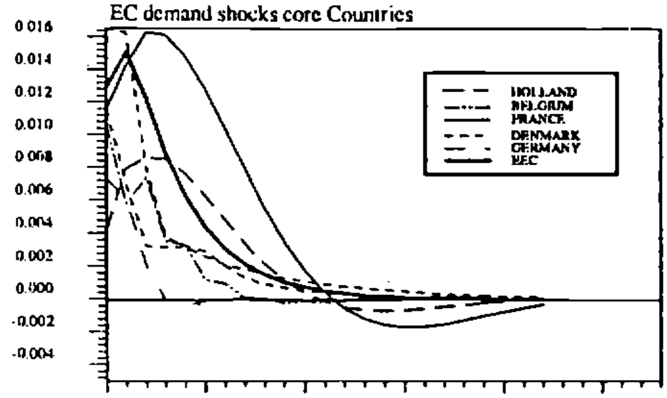
countries it typically takes substantially longer. A simple measure of the speed of adjustment is the ratio of the impulse response function in the third year to its long run level. A high value would indicate a large amount of adjustment, a low value relatively slow adjustment. The average value of this statistic across US regions is 0.94, as opposed to 0.72 across EC countries. Interestingly, the average value for the EC core is also somewhat higher than that for the periphery.

Chart 7, which displays the impulse response functions to demand shocks, shows a similar pattern. Again, the US regions appear to exhibit significantly faster responses than EC countries do. One measure of the speed of this adjustment is to take the value of the impulse response function after 5 years, with a low value now representing speedy adjustment. The values of the statistic are generally lower across US regions than EC countries, confirming the visual impression.

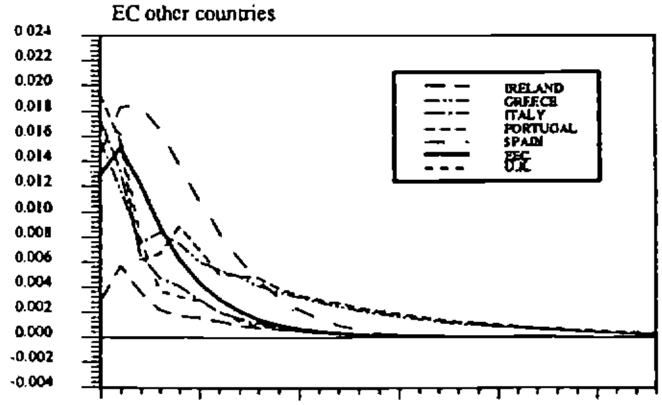
These VAR decompositions have allowed the analysis to proceed considerably further than simple comparisons of growth and inflation rates permit. The distinction between EC core and periphery is much less clear when the raw data are analyzed. For example, the standard deviations of untransformed GDP growth rates for Italy and the U.K. are quite similar to those for Germany and France, while U.S. regions tend show relatively large variability in output growth. Our decomposition, by differentiating supply and demand disturbances from responses, allows the sources of this variability to be identified more precisely. Differences among countries and regions in the extent to which output variability and its sources are correlated with

Chart 7 - Impulse Response Functions to a Demand shock

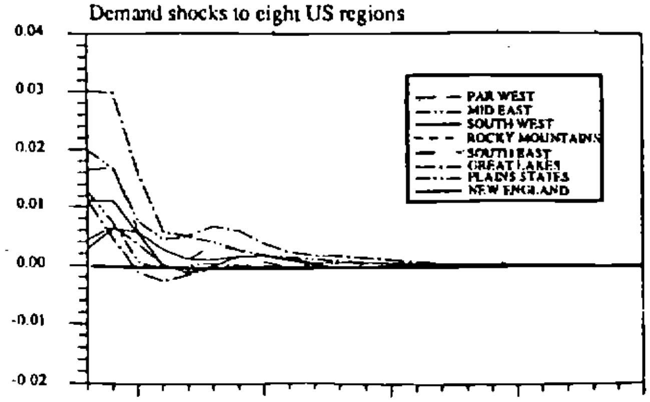
Impulse response functions
EC demand shocks core Countries



Impulse response functions
EC other countries



Impulse response functions
Demand shocks to eight US regions



analogous variables in the center country or region are less striking in the raw data than in the transformed series, rendering the former more difficult to interpret. Moreover, the calculation of the impulse response functions allow us to analyze the different set of issues revolving around speed of adjustment to shocks which cannot be addressed using the raw data.

VI. Summary and Implications

In this paper we have used structural vector autoregression to identify the incidence of aggregate supply and demand disturbances in Europe and to analyze the EC economies' response. A strong distinction emerges between the supply shocks affecting the countries at the center of the European Community -- Germany, France, Belgium, the Netherlands and Denmark -- and the very different supply shocks affecting other EC members -- the United Kingdom, Italy, Spain, Portugal, Ireland and Greece. Supply shocks to the core countries are both smaller and more correlated across neighboring countries. The demand shocks experienced by the core countries are also smaller and more intercorrelated, although the difference on the demand side is less dramatic. There is also little evidence of convergence in the sense of the core-periphery distinction becoming less pronounced over time.

Our analysis of the American monetary union similarly suggests the existence of an economic core comprised of the Eastern Seaboard, the Midwest and the Far West, along with a periphery comprised of the Rocky Mountain states and the South West. Shocks to the U.S. core and periphery show considerably more coherence than shocks to the analogous European regions.

Only if EC core is compared with the entire U.S. (core and periphery together) are the magnitude and coherence of aggregate supply and demand disturbances comparable. However, the US does contain two (relatively small) regions, the South West and the Rocky Mountains, whose underlying disturbances are relatively idiosyncratic.

Our impulse response functions indicate that the US regions adjust to shocks more quickly than do EC countries, despite the lack of the exchange rate instrument. This finding, which holds for both aggregate demand and aggregate supply shocks, plausibly reflects greater factor mobility in the United States than in Europe.

What are the policy implications of this analysis? First, our finding that supply shocks are larger in magnitude and less correlated across regions in Europe than in the United States underscores that the European Community may find more difficult to operate a monetary union than the United States. Large idiosyncratic shocks strengthen the case for policy autonomy and suggest that significant costs may be associated with its sacrifice. Our finding that the adjustment to shocks is faster in the U.S. than in Europe, presumably reflecting greater factor mobility in the U.S., underscores this point. Moreover, the finding that U.S. regions experience relatively large demand shocks compared to their European counterparts suggests that completing an internal market may heighten regional economic specialization and thereby magnify another source of shocks. This may create another set of adjustment problems for the European economic and monetary union.

Second, the strong distinction that emerges in our analysis between on the one hand a core of EC members that experience relatively small, highly-correlated aggregate supply disturbances and on the other a second group, what we have called the members of the EC periphery, whose supply disturbances are larger and more idiosyncratic, is consonant with arguments that have been advanced for a two-speed monetary union (e.g. Dornbusch 1990). Our analysis of disturbances suggests that the EC core (Germany, France, Belgium, Luxembourg, the Netherlands and Denmark) experience shocks of roughly the same magnitude and coherence as do U.S. regions. This supply-shock distinction suggests that Germany and its immediate EC neighbors come much closer than the Community as a whole to representing a workable monetary union along American lines.

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