IMF WORKING PAPER

WP/94/65

INTERNATIONAL MONETARY FUND

Research Department

Relative Prices and Economic Adjustment in the U.S. and the EU: A Real Story About European Monetary Union

Prepared by Tamim Bayoumi and Alun Thomas

Authorized for Distribution by Peter B. Clark

June 1994

Abstract

Structural vector autoregressions are used to analyze the relationship between real output and relative prices within the EU and the United States. Relative price variability appears to be more important for adjustment within the EU than the United States, reflecting the lower integration of goods and factor markets. In the absence of higher market integration, the lower relative price variability implied by the introduction of a single currency in the EU could well cause significant economic disruption.

Keywords:
Relative prices, common currency, EMU

JEL Classification Numbers:
F15, F33, R11

1/ This paper has benefitted from the comments of participants at a seminar in Georgetown university, particularly those of Matthew Canzoneri and Susan Collins, as well those of Peter Clark, Chris Towe, and Mark Griffiths at the Fund.

Table of Contents

List of Tables

List of Charts

Summary

The prospect of European Economic and Monetary Union (EMU) has created interest in a number of issues associated with the operation of monetary unions. The most basic effect of a common currency will be to eliminate the ability to vary bilateral exchange rates within the union. It is a widely held view that this loss of the exchange rate instrument will reduce the ability of the participating economies to absorb disturbances.

This paper looks at the empirical relationship between fluctuations in relative prices and real output across the European Union (EU) and across regions of the United States using structural vector autoregressions. A comparison of the behavior of EU countries, which have close economic ties but separate currencies, with regions within the United States--a currency union of roughly comparable economic magnitude--can be expected to shed light on how the existence of a currency union influences the response of the economy to underlying disturbances.

The results indicate that the United States has significantly more integrated goods and factor markets than the EU. As a result, relative price variability is more important for adjustment within the EU than it is within the United States, despite the fact that the size of the underlying disturbances is relatively similar. The paper finds that adjustment occurs quickly within the EU, largely within a year or two, presumably reflecting the flexibility in relative prices implied by adjustable nominal rates of exchange. In the United States adjustment is much slower, plausibly reflecting the greater importance of factor mobility in adjustment.

Exploring the implications for EMU, the paper suggests that by adopting a single currency the EU is likely to reduce the short-run flexibility of relative prices, making it more difficult and costly to adjust to underlying disturbances. In the longer term, increasing integration of EU goods and factor markets should reduce the need for large movements in relative prices. Institutional changes, such as the recent completion of the single market in the EU, are important in promoting this integration. In addition, the paper notes that EMU itself will probably promote greater flexibility than has been seen in the past.

Having said this, it does not appear likely that the EU will achieve anything like the levels of integration of U.S. regions in the immediate future. In the short run, disruptive relative price adjustments can probably be best avoided by reducing the size of underlying disturbances in demand for regional products. Coordination of domestic aggregate demand policies across EU countries, such as the fiscal restraints incorporated in the Maastricht treaty, is one method of moderating the teething problems likely to be associated with EMU.

I. Introduction

The prospect of European Economic and Monetary Union (EMU) has created interest in a whole host of issues associated with the operation of monetary unions. 1/ The most basic implication of adopting a common currency is that the countries that participate are no longer able to vary their bilateral exchange rates. It is a widely held view that the loss of the exchange rate instrument will reduce the ability of the economies to absorb disturbances. For example the 1992 Economic Report of the President (of the United States) states "A single currency would prevent exchange rate adjustments among European countries from absorbing external economic shocks or differences in domestic economic policies".

Much of the academic analysis on EMU also assumes that the nominal exchange rate acts as a buffer in reducing disturbances; indeed, this is the basis of most of the theory of optimum currency areas. For example, work measuring the asymmetry of economic shocks in the EU 2/ assumes that a currency union is less efficient at absorbing asymmetric disturbances across different countries than a regime involving individual currencies, as does much of the literature on the fiscal implications of EMU (surveyed in Bean, 1992). Krugman (1992) also assumes that the exchange rate adjusts to moderate shocks when he argues that there will be a greater need for national exchange rates in a future more integrated Europe because of the increased likelihood of asymmetric output imbalances due to regional specialization. In a slightly different vein, macroeconomic simulations of the impact of EMU (surveyed in Masson and Symansky, 1993) compare a regime in which each individual country has a fixed monetary target with a situation in which a there is a single European currency and hence a single monetary target. In practice, this amounts to assuming that the nominal exchange rate operates as a buffer under the flexible exchange rate regime.

This paper looks at the empirical relationship between fluctuations in relative prices and real output using structural vector autoregressions, focusing on behavior across European Union (EU) countries and across regions of the United States. 3/ Such a comparison of the behavior of EU countries, which have close economic ties but separate currencies, with regions within the United States, a currency union of roughly comparable economic magnitude, can be expected to shed light on how the existence of a currency union influences the response of the economy to underlying disturbances.

The rest of the paper is planned as follows. The next section discusses the underlying theory. Section III discusses the estimation techniques, while Section IV contains a description of the salient features

---

1/ There is a rapidly expanding literature on almost every aspect of EMU. For a survey see Eichengreen (1992).

2/ Wyplosz and Cohen (1989), Weber (1991), and Bayoumi and Eichengreen (1993).

3/ We are unaware of any earlier empirical work of this type. Minford (1989) looks at this issue, but not from an empirical point of view.

of the raw data. Estimation results are reported in Section V, while Section VI concludes.

II. Theory

Movements in relative prices are one of the ways that economies buffer themselves against shocks to output. Consider the standard demand and supply model for a single industry shown in the top panel of Chart 1. A shock which moves the demand curve outward leads to a smaller rise in output than the overall shift in the curve because the relative price of output rises, reducing the full impact of the demand shock. In a similar manner, a positive supply shock leads to a fall in relative output prices, reducing the underlying output disturbance.

The same diagram can be used to analyze regional behavior. However, there is an important difference between the analysis of an industry and the analysis of a region. For a single industry it is reasonable to assume that changes in the incomes of workers and owners in the industry have negligible effects on the demand for the products from that industry, because they form such a small part of overall demand. In a region, on the other hand, regional incomes are an important determinant of the demand for regional goods (due, at least in part, to the existence of nontraded goods). This requires a more complex model than standard demand and supply analysis.

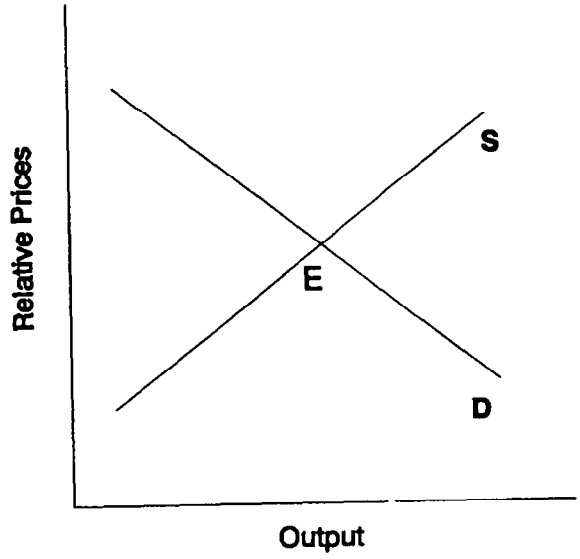
Appendix I contains a simple macroeconomic model of regional supply and demand. In the short-run it is assumed that any changes in regional income accrue to owners of capital, whose consumption demand is highly diversified. Hence, the standard demand and supply analysis is adequate. Over time, however, much of the change in regional income is reflected in changes in labor income. The causes an endogenous change in the demand for home goods since workers are assumed to consume only these goods. Initial increases in regional output are therefore associated with a subsequent endogenous rise in demand for home goods, falls in output with a fall in demand for home goods.

Clearly, this is a very simple model. Not all short-run changes in income accrue to owners of capital, nor do workers spend all their money on local goods. At the same time, it does capture some stylized facts about the real world. Profits are indeed the most cyclically sensitive component of income, and their impact on the demand for local products is probably relatively small. 1/ More generally, the high short-term elasticities on activity in most estimated import equations also imply that external sources are an important provider of goods in response to short-term changes in income.

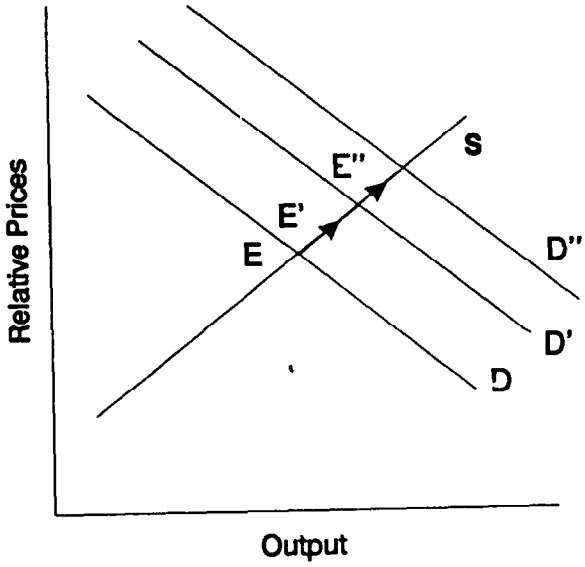
1/ Profits can be either retained, spent on investment goods (which have a import component), or distributed to investors who need not live in the region. None of these uses is likely to have a particularly large short-term impact on the relative demand for local products.

Chart 1. The Model

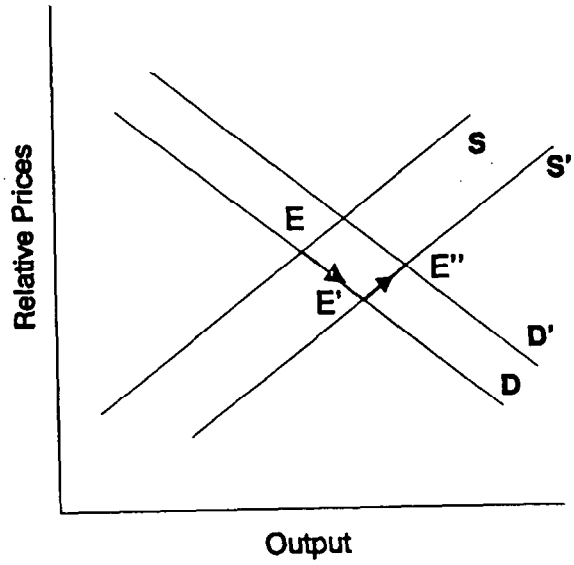
Initial Equilibrium



Demand Disturbance



Supply Disturbance



The bottom panels of Chart 1 shows the impact of these considerations on the original demand and supply analysis. The left-hand panel shows the response to a rise in the demand for regional products, such as an increase in the demand for automobiles in the United States (which would raise the demand for products from the Great Lakes region), or a fiscal expansion in an EU country. The initial rise in demand from D to D' causes an increase in both regional output and the relative price of regional goods. The rise in local wage income which follows this increase in regional output causes a further expansion in the demand for regional goods, which moves the economy towards its long-run equilibrium at E''. Hence, the induced increase in demand moves both regional real output and the relative price of regional goods further away from their initial values.

The right-hand panel shows the effect of a positive supply shock, such as a technological break-through in the computer industry or a change in labor market regulations. The supply curve shifts rightwards from S to S', which results in a rise in real output and a fall the relative price of regional goods, as shown by point E'. This increase in real output again implies an expansion in local incomes (measured in terms of local goods) and a subsequent expansion in the demand for regional goods. The induced shift in the demand curve (from D to D') causes a further expansion in regional output. However, unlike the earlier example, where the relative price of regional goods continued to diverge from their original values, in this case the induced increase in demand causes the relative price of regional goods to move back towards its original value, as shown in the new long-term equilibrium E''.

While these dynamics complicate the adjustment path, they do not detract from the role of relative prices in reducing output fluctuations, particularly in the short-run. The importance of relative prices in this process depends upon the integration of regional goods markets and factor markets. If regional goods and factor markets are highly integrated, so that the demand and supply curves are relatively flat, relative price changes in response to disturbances will be relatively small. Hence, relative prices could be expected to be a less important part of adjustment in the U.S., with its highly integrated markets, than in the EU, with its less integrated goods and factor markets.

If relative prices are unable to adjust sufficiently fast to underlying disturbances, due, for example, to nominal rigidities in prices or wages, then this slow adjustment can cause significant disruption to the local economy. 1/ Good examples would be the boom and bust in employment experienced by the South West of the United States in the 1980s due to the rise and fall in oil prices, the difficulties experienced by (then) members of the ERM in 1992 and 1993 in the wake of German unification, as well as regional problems within European countries, such as the persistent differences in unemployment rates between the northern and southern regions

---

1/ Mussa (1990) discusses the role of flexible nominal exchange rates in real exchange rate variability.

of the United Kingdom and Italy. The remainder of this paper estimates the role of relative price movements (or, in other words, movements in real exchange rates) in the process of adjustment between members of the EU, and compares it to the role of relative price movements in the United States, a smooth functioning currency union.

III. Estimation Methodology

The model shown in Chart 1 is estimated using a structural vector autoregression of the type proposed by Blanchard and Quah (1989), in which underlying disturbances are identified through their long-run responses to endogenous variables. 1/ Specifically, a bivariate vector autoregression involving real output and the relative output prices is estimated, and the underlying supply disturbances are identified by assuming that they have only a temporary effect on relative output prices, while demand disturbances are allowed to have a permanent effect. Hence, the estimation assumes that the long-term equilibrium for a supply disturbance (point E'' in the bottom right-hand panel of Chart 1) involves the same relative price as the initial equilibrium. Details of the estimation procedure are given in Appendix II.

Clearly, identifying disturbances with only a temporary impact on the relative prices as supply disturbances and those with a permanent impact on relative prices as demand disturbances is a strong assumption. The underlying supply and demand framework only implies a tendency for relative prices to return to their initial level in response to a supply disturbance. However, as long as the long-term effect of a supply disturbance on relative prices is small in relation to the effect of a demand disturbance, the procedure will approximate the correct model. 2/ There are at least two reasons for believing that this is indeed the case. First, as discussed earlier, the induced changes in demand caused by movements in local incomes will tend to exacerbate long-run relative price movements caused by demand disturbances while reducing those due to supply disturbances. Second, it seems reasonable to assume that goods markets are more highly integrated than factor markets. This implies that the underlying supply curve will be steeper than the demand curve, which in turn implies larger relative price movements in response to demand disturbances than to supply disturbances.

The advantage of using the structural vector autoregression approach is that it allows more structure to be put on the empirical analysis than would be possible from a more atheoretical examination of the data. In particular, as will be discussed in more detail below, it implies that most of the differences in macroeconomic adjustment between the United States and the EU can be attributed to relatively intuitive differences in the slopes of the underlying curves and sizes of the underlying disturbances.

1/ A vector autoregression is a system of two or more variables in which each variable is related to lagged values of all of the variables in the system (Sims, 1980).

2/ This is proved in the technical appendix of Blanchard and Quah (1989).

As a further check on the results, two "over-identifying" restrictions which are implied by the underlying framework but are not imposed in the estimation can also be used to test the plausibility of the results. The first is the sign of the relative price movements in response to each shock. The model implies that positive demand shocks should increase real output and raise the relative price of local output, while supply shocks which raise real output should lower the relative price of output. Second, as can be seen in Chart 1, the underlying supply curve is traced out both by the response to a demand disturbance and by the longer-term part of the response to a supply disturbance. These restrictions, which can be seen as additional tests of the reasonableness of the results, are broadly confirmed by the estimation.

IV. Data

Annual data on real and nominal output in dollars were collected for eleven EU countries and eight U.S. regions. 1/ For the EU the data came from the *OECD Annual National Accounts*. Real dollar GDP was calculated using 1985 prices and exchange rates, while nominal dollar GDP used current prices and exchange rates. The EU sample period is 1961-89. 2/ Regional real and nominal Gross State Product, the regional equivalent of GDP, were collected for the 8 standard regions of the United Sates defined by the Bureau of Economic Analysis from 1963-89. 3/

Relative prices were calculated by taking the implicit output deflators for each EU country or U.S. region and dividing them by the corresponding deflator for the remainder of the EU or U.S. (i.e., the EU or U.S. aggregate less the country or region has been excluded). Hence, they measure relative output prices within the region, the proper concept for a demand and supply analysis. Output growth was also measured relative to behavior in the rest of the EU or U.S. Hence, the data represent intra-regional movements in relative prices and output across U.S. regions and EU countries. It is important to exclude the effects of the rest of the world from the analysis since, while U.S. regions have a fixed rate of exchange against each other, the United States as a whole has a variable exchange rate against the rest

---

1/ The eleven EU countries include every country except Luxembourg, which apart from being very small was also in a currency union with Belgium over the period.

2/ This period includes the collapse of the Bretton Woods exchange rate system in the early 1970s. Since Chow tests indicated no significant change in behavior in the early 1970s, the full data set was used to conserve degrees of freedom in the estimation.

3/ New England, the Mid-East, Great Lakes, Southeast, the Plains, Southwest, Rocky Mountains, and Far West.

of the world. Similarly, EMU will only fix intra-EU rates of exchange, not rates of exchange with the rest of the world. 1/

Before considering the estimation results, it is useful to consider the characteristics of the raw data. Table 1 reports the standard deviation of the growth of real output and the change in the relative price of output (measured as the change in the logarithm of the underlying variables). 2/ To get an idea of the impact of adjusting by the regional aggregate, the standard deviations for the unadjusted data are shown in parentheses.

For the EU, the standard deviation of relative output growth varies considerably from 0.010 to 0.027 (about 1.0 to 2.7 percent per annum since the data are in logarithms). The original members of the EU (Belgium, France, Germany, the Netherlands and Italy) all have lower variation in their output growth rates than those who joined later, with France having a particularly low value. The unadjusted data, shown in parentheses, generally show more variation than the adjusted data, indicating a common cycle. The results from the regional data for the United States are shown in the bottom part of Table 1. The variability of intra-United States output growth is generally smaller than the variability of intra-EU output, although the absolute values are similar. This suggests that fluctuations are more synchronized with aggregate behavior across the U.S. than across the EU. However, this is not true for the South West and Rocky Mountain regions, whose output is heavily dependent on raw material production. In these regions adjusting by the U.S. aggregate has no impact on variability, indicating that growth is relatively uncorrelated with aggregate U.S. behavior.

The standard deviation of relative prices in the EU varies from 0.032 in Denmark to 0.072 in the United Kingdom. 3/ There is a clear split between the original members of the EU plus Ireland and Denmark, which have relatively low standard deviations, and the higher variation experienced by the United Kingdom, Spain, Portugal, and Greece. Table 2 shows the contribution of variability in national price levels and variability in nominal exchange rates to overall relative price variability for members of the EU. The major difference between the original EU members, Ireland, and Denmark and the remaining countries is the lower level of nominal exchange rate variability in the first group (shown in the third column of figures), presumably reflecting the greater desire in these countries to stabilize

---

1/ As a result, external disturbances, such as the oil shocks of the 1970s, will only have an influence in so far as the individual regions or countries reacted in a different way from the region as a whole.

2/ Results for the period after the break-up of the Bretton Woods system are very similar to those for the whole period.

3/ In every case the values in parentheses, which show relative price variability against the United States, indicate much higher variation, presumably reflecting movements in the nominal exchange rate of the dollar over the period.

Table 1. Growth of Output and Changes in the Relative Price of Output within the EU (1973-89) and United States, 1966-89

	Standard Deviation of the Growth of Output	Standard Deviation of the Change in Relative GDP Deflators
	Original EU members	
Belgium	0.013 (0.022)	0.036 (0.108)
France	0.010 (0.018)	0.040 (0.104)
Germany	0.013 (0.022)	0.045 (0.106)
Italy	0.019 (0.023)	0.033 (0.090)
The Netherlands	0.013 (0.022)	0.034 (0.102)
	Later EU Entrants	
Denmark	0.019 (0.025)	0.032 (0.100)
Greece	0.027 (0.035)	0.056 (0.077)
Ireland	0.026 (0.022)	0.038 (0.092)
Portugal	0.024 (0.034)	0.049 (0.090)
Spain	0.019 (0.026)	0.049 (0.110)
United Kingdom	0.019 (0.021)	0.072 (0.102)
	U.S. Regions	
New England	0.018 (0.032)	0.006 (0.020)
Mid-East	0.014 (0.025)	0.007 (0.020)
Great Lakes	0.019 (0.038)	0.006 (0.022)
Plains	0.012 (0.025)	0.012 (0.022)
South East	0.008 (0.025)	0.005 (0.023)
South West	0.023 (0.023)	0.020 (0.038)
Rocky Mountains	0.024 (0.024)	0.009 (0.026)
Far West	0.014 (0.024)	0.005 (0.019)

intra-European exchange rates, as illustrated by their long-term membership in the Exchange Rate Mechanism (ERM) in the 1980s and the snake of the late 1970s.

Table 2 illustrates two other characteristics of intra-EU relative prices between 1963 and 1989. The first is the importance of nominal exchange rates in relative price movements. The standard deviation of the change in the nominal exchange rate is larger than that of relative national prices in every country except the Netherlands, and in most cases this difference is quite large. Another feature of the EU results is that the original EU members exhibit somewhat smaller variability of national prices than do newer entrants. Intra-U.S. relative price variability, reported in the bottom half of Table 1, are yet smaller. 1/

V. Results

To identify supply and demand disturbances, structural vector autoregressions were estimated for each EU country and U.S. region by regressing the change in the logarithm of real output and of relative prices on the first and second lags of both series, and using the assumption that supply disturbances have no long-run impact on relative prices to identify demand and supply disturbances. 2/ The number of lags in the vector autoregressions were set at 2 since the Schwarz-Bayes information criterion indicated an optimal lag length of 1 or 2 in each case. 3/ The estimation period was 1963-89 for EU countries and 1965-89 for U.S. regions.

1. EU and U.S.

Chart 2, panels (a) and (b), show impulse response functions for the 11 EU countries and 8 U.S. regions. Impulse response functions illustrate the impact on output and relative prices of a supply or demand disturbance equal to one standard deviation. Hence, the path shows the response of output and relative prices to a "normal" disturbance, and the size of the response is a measure of the importance of the particular disturbance. To aid comparison, the graphs for each response have the same scale.

The response of relative prices to a supply disturbance, shown in Chart 2(a), illustrates the restriction imposed on the estimation procedure, namely these disturbances have no long-run impact on relative prices. The responses of EU entrants are generally larger than those of the original EU

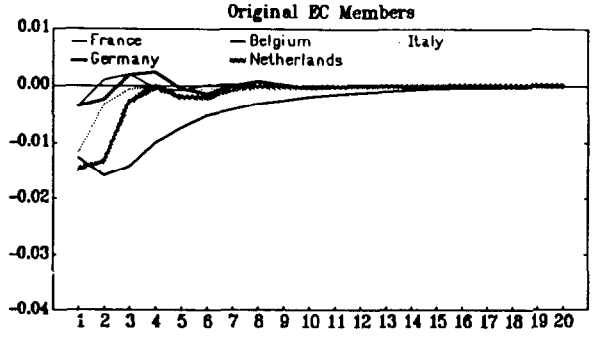
1/ Earlier work on real exchange rate variability within currency unions includes Poloz (1990) and Eichengreen (1990).

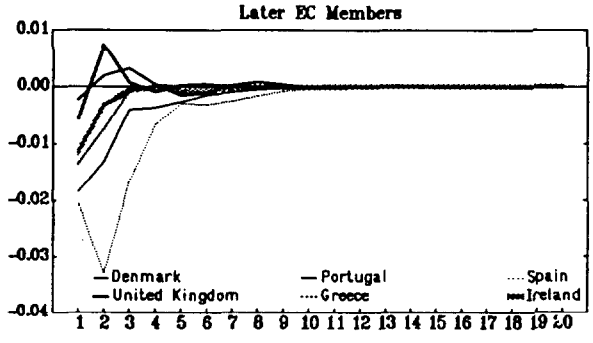
2/ For both data sets Dickey Fuller tests indicated that the logarithm of the level of both real output and relative prices were nonstationary, but that the first differences were generally stationary. Accordingly, all variables were transformed into first differences.

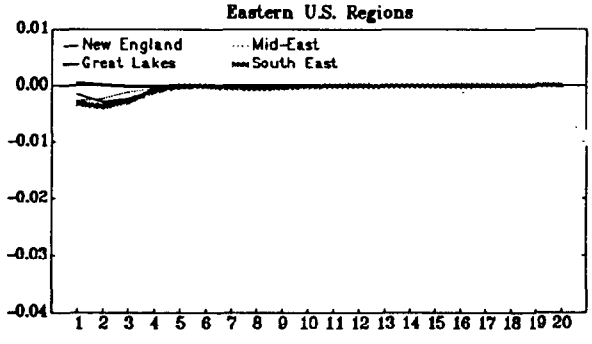
3/ A uniform lag of 2 was chosen in order to preserve symmetry across the estimation.

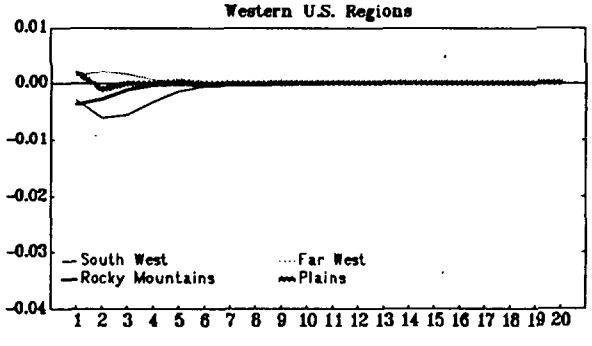
Chart 2(a). Response to Supply Disturbance

Relative Price Response

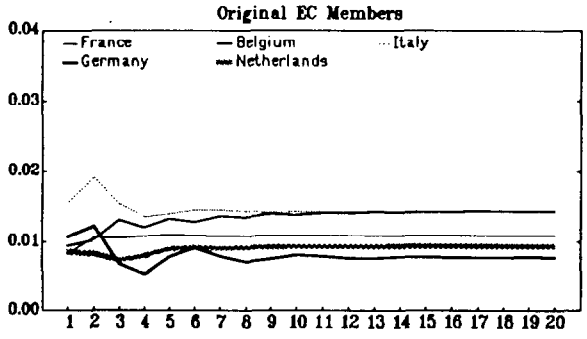


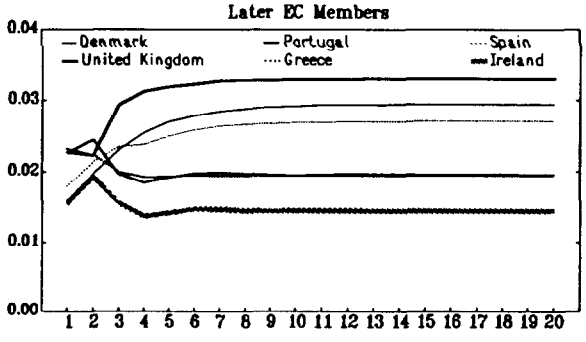


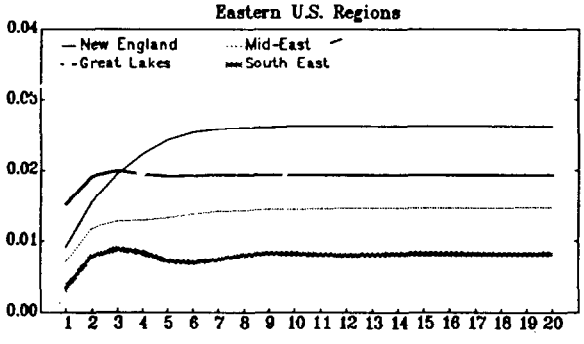




Output Response







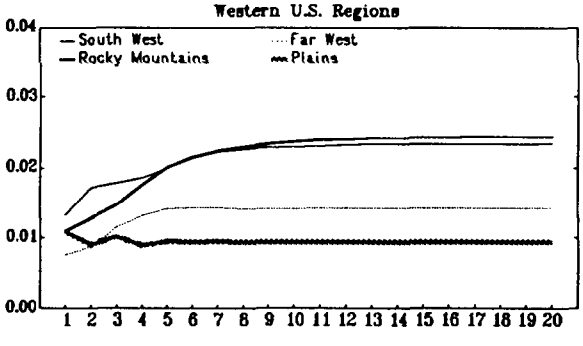
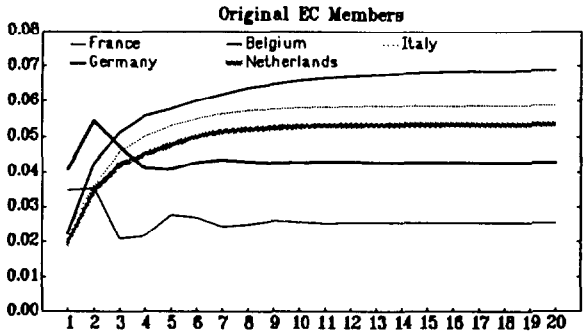
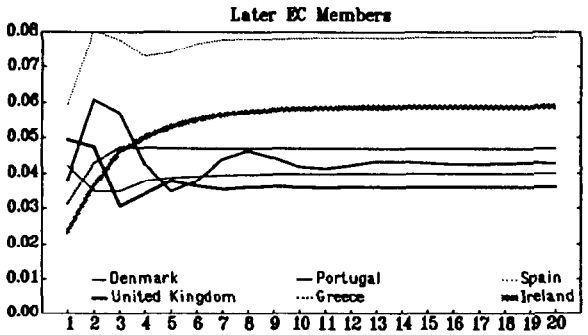
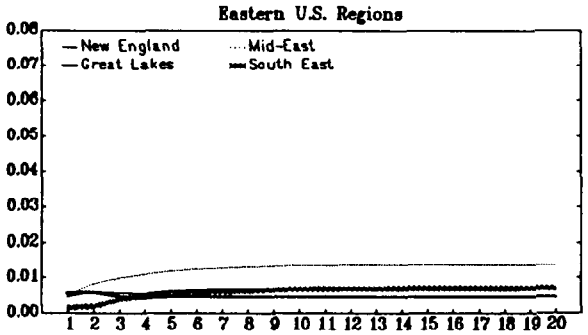


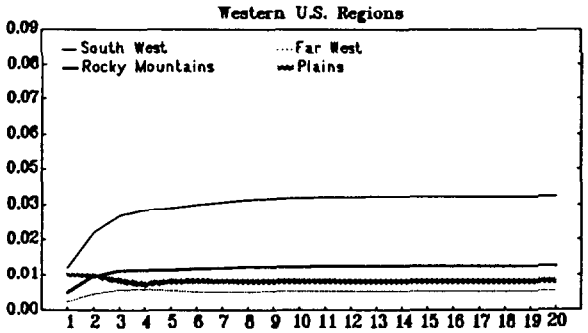
Chart 2(b). Response to Demand Disturbance

Relative Price Response

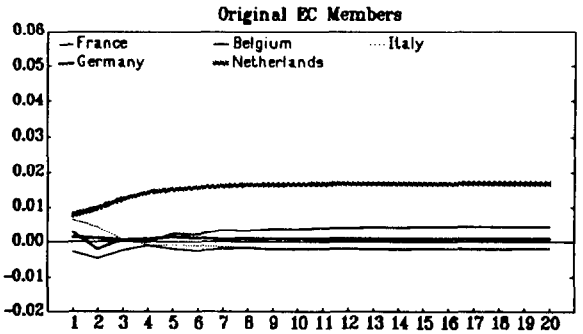


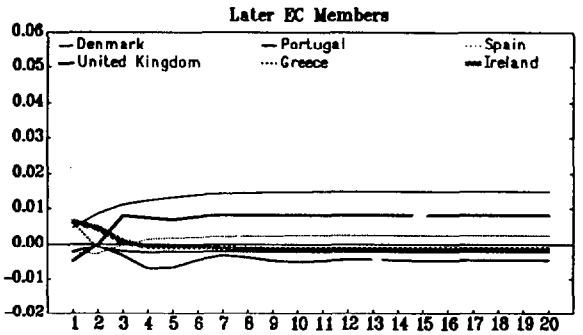


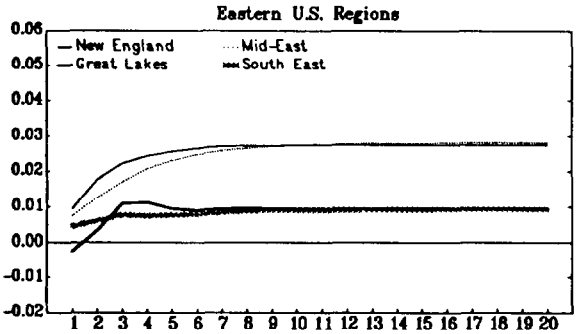




Output Response







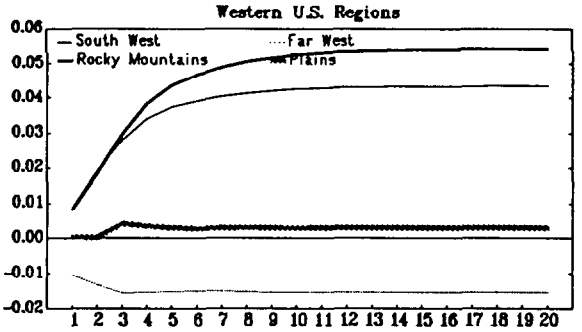


Table 2. Decomposition of Variance in Relative Prices

	Standard Deviation of Change In Relative Prices	Standard Deviation of Change in National Prices	Standard Deviation of Change in Nominal Exchange Rates	Correlation Between Changes in National Prices and Nominal Exchange Rate
		Original EU Members		
Belgium	0.043	0.022	0.032	0.24
France	0.037	0.013	0.039	-0.33
Germany	0.049	0.023	0.043	0.00
Italy	0.039	0.027	0.047	-0.56
The Netherlands	0.038	0.019	0.028	0.26
		Later EU Entrants		
Denmark	0.039	0.014	0.031	0.38
Greece	0.066	0.036	0.064	-0.20
Ireland	0.038	0.037	0.042	-0.55
Portugal	0.059	0.042	0.083	-0.74
Spain	0.056	0.032	0.065	-0.49
United Kingdom	0.086	0.045	0.075	-0.03

members. Much more striking, however, is the much smaller relative price movements across U.S. regions. This is even true for the raw material producing regions (the South West and Rocky Mountains), which have the largest relative price responses amongst the U.S. regions.

Chart 2(a) also shows the response of output to supply shocks. The long-run response of output in the EU is between 0.005 and 0.04 (since the data are in logarithms this implies responses of between 1/2 and 4 percent), with the responses for the newer EU entrants being generally larger than for the original members. The magnitude of the long-run responses of U.S. regions are similar to those of EU countries, although the speed of adjustment is slower. The two U.S. regions which are most specialized in raw material production, the South West and Rocky Mountains, again have relatively large responses.

The overidentifying restriction implied by the model is that the short-run effect on relative prices should be the opposite of that on real output. This response, which is not imposed on the estimation, is satisfied for all of the EU countries. The results for the U.S. regions are less uniform. While most regions show a fall in relative prices there are three exceptions; the Plains, the Far West, and the Great Lakes. However, in all three cases the responses are small compared to those of the other U.S. regions. Overall, combining the results for the EU and United States, the relative price response is correct in 16 of 19 cases. 1/

Impulse response functions for demand disturbances are shown in Chart 2(b). The EU countries show relative price responses of between 0.02 and 0.07 (between 2 and 7 percent), with no clear difference between the behavior of the original EU members and newer entrants, although the original members do show some evidence of slower adjustment. As in the case of the supply disturbances, there is a big difference between the relative price responses in the EU and in the United States, with the U.S. responses being much smaller than the EU ones. Within the U.S. regions, the largest relative price responses are again associated with the regions which specialize in raw material production.

In contrast to the relative price responses, the output responses to demand disturbances in the EU are generally small, particularly for the original EU members, while the responses for the U.S. regions are significantly larger. The overidentifying restriction of the model is that the output response should have the same sign as the relative price response. Seven of the 11 EU country estimates have the anticipated response, while 4 responses are perverse. However, as with the U.S. regional results for supply disturbances discussed above, these perverse responses are all relatively small. The responses of the U.S. regions to

---

1/ The probability of getting 16 or more correct responses if the responses were random is $1160/2^{19}$, or about 0.2 percent. Hence, there is considerable evidence that the overidentifying restriction is satisfied.

demand shocks conform to the predictions of the model rather more closely than those for the EU countries, with only one region (the Far West) having a perverse response. Aggregating over both the EU and United States, the responses conform to the predictions of the underlying framework in 14 out of 19 cases. 1/

Overall, the results paint a fairly consistent picture. The EU is characterized by large relative price responses to both types of disturbance, with particularly large responses to demand disturbances. The output responses to demand disturbances are relatively small, indicating that most of the adjustment to demand disturbances occurs through relative prices, and not through output adjustment. Within the United States the relative price responses are both relatively small and relatively slow, presumably reflecting the highly integrated nature of the goods and factor markets and the limitations to relative price adjustment brought about by having a common currency.

2. Comparing aggregate responses

An alternative method of analyzing the impulse response functions is to look at the responses in relative price-output space. Recall from Chart 1 that a positive shift in the demand curve entails a movement up the supply curve. Similarly, a positive shift in the supply curve involves a short-run movement down the demand curve, followed by a movement back along the supply curve as the demand curve shifts outwards over time. Hence, a scatter plot of the impulse response functions with respect to output against the impulse response functions with respect to relative prices should trace out the underlying demand and supply curves.

The results from such a scatter plot are shown in Chart 3. To compare the behavior of a typical EU country with that of a typical region in the United States, the graph uses the average responses across the EU countries and the average responses across the U.S. regions rather than showing the results for any specific country or region. 2/

The two curves in the upper right-hand quadrant of the chart trace out the supply curve for the typical EU country and for the typical region of the United States. In the case of the EU the supply curve is close to vertical, with almost all of the adjustment coming through movements in

---

1/ The probability of this occurring randomly is $16664/2^{19}$, or 3.2 percent.

2/ There is a problem in aggregating countries or regions with responses which are perverse, since it is not clear which "incorrect" sign should be used. Fortunately, when the normalizations shown in Figure 2 are used the perverse responses are generally very small, and hence the incorrect values make very little difference to the results. The one exception is the output response to a demand shock in the Far West region of the United States. Hence, for the demand responses the Far West region was excluded from the U.S. data.

relative prices and virtually no output response. By contrast, the supply curve for the typical region in the United States has more of the adjustment coming through output than through prices. In addition, there is a distinct flattening of the estimated curve over time. As discussed in Appendix I, this is consistent with labor migration in response to disturbances. Both results plausibly reflect the higher level of integration of factor markets within the United States. 1/

The length of the estimated curves indicates the average size of the underlying disturbances, while the tick-marks represent adjustment in each year. In the EU adjustment is relatively rapid, being virtually complete within two years. By contrast, in the United States less than half of the long-run adjustment occurs within two years. Hence, despite its significantly smaller size, relative price adjustment is considerably slower in the United States.

The initial segment of the lines in the bottom right-hand quadrant traces out the demand curves within the EU and the U.S. The demand curve for the typical EU country has a negative slope which is about 35 degrees below the horizontal, indicating that both output and relative prices respond significantly to supply disturbances. By contrast, the short-run demand curve for the typical region in the United States is very flat, with almost all of the adjustment coming through movements in real output and very little through movements in output prices. Regional goods are very close substitutes in the United States, while there is more differentiation of goods within the EU. Both estimated demand curves are appreciably flatter than the estimated supply curves, indicating that goods markets are more integrated than factor markets.

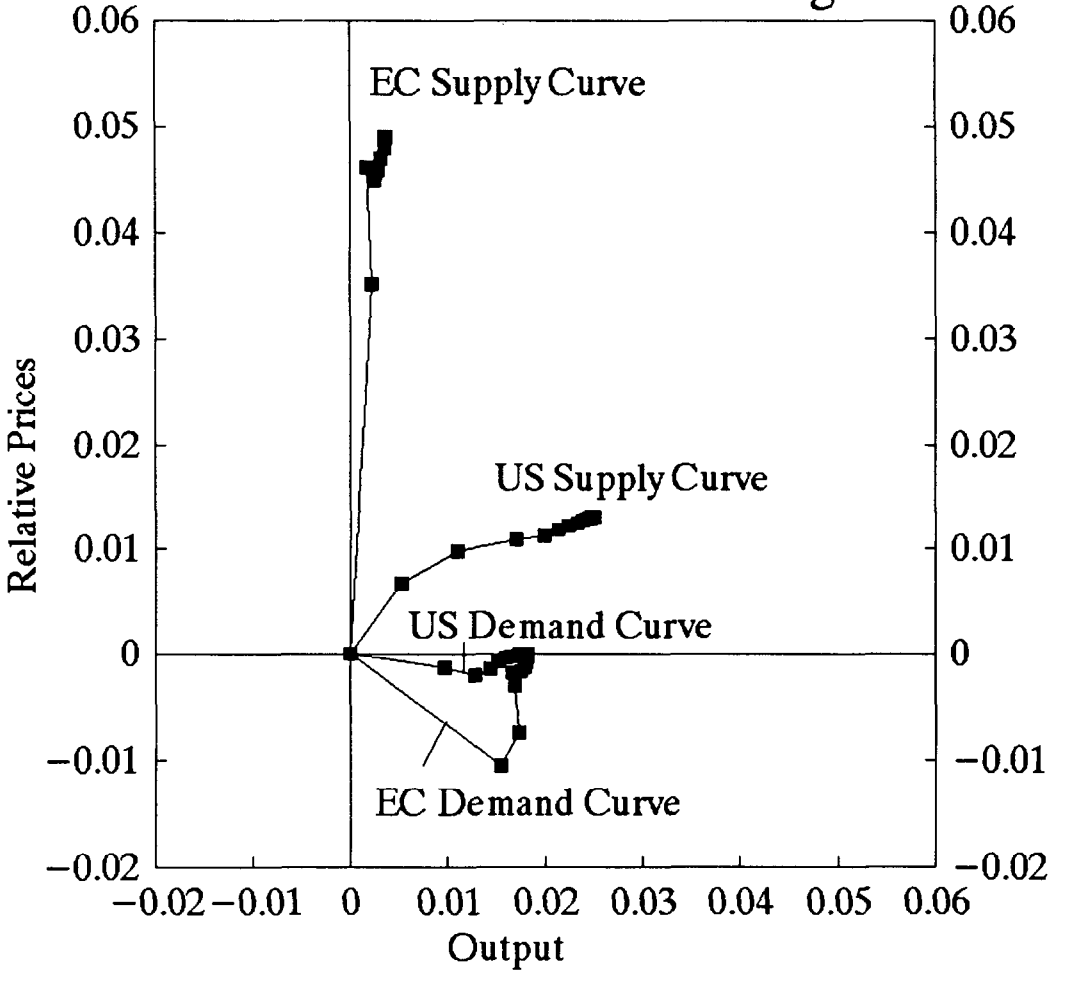
The magnitude of the initial disturbance to output is somewhat larger in the EU than in the United States, which may reflect a wider diversity of technologies in Europe. Correspondingly, the adjustment in the United States is significantly slower than in the EU that presumably indicates the greater importance of movements of factors of production (in particular labor) in the adjustment to supply disturbances within the United States.

Overall, the most striking differences between the two areas are the very different underlying supply curves and slower rate of adjustment in the United States. These results can be interpreted as saying that the lower integration of goods and (particularly) factor markets in the EU implies the need for a significant degree of relative price flexibility in Europe in order to adjust to underlying disturbances. As discussed earlier, much of this flexibility is currently provided by adjustable nominal exchange rates. Such relative price flexibility is less important in the United States since more of the adjustment occurs through real output via integrated goods and factor markets. This allows the United States to operate a common currency

---

1/ Blanchard and Katz (1992) discuss the operation of regional labor markets in the U.S. in detail.

Chart 3
Adjustment to Disturbances: EC Countries and U.S. Regions



without significant economic disruption, although the importance of movements of labor and capital does mean that adjustment is relatively slow.

The implication is that, without higher factor mobility, introduction of a common currency in the EU could cause significant economic disruption by limiting the flexibility of relative prices. There is, however, an alternative interpretation of Chart 3 which is rather more favorable to a single European currency. Instead of being an equilibrating response to underlying disturbances, the large movements in relative prices observed in the demand response of the EU could reflect excess volatility in nominal exchange rate markets. On this view, the introduction of a common currency would simply lower the observed volatility in relative prices. While there may well be some truth to this view, there are at least two reasons for thinking that it is not the whole story. While smaller than those across EU countries, estimated long-run relative price movements across U.S. regions are not inconsiderable. 1/ Also, as will be discussed below, the long-run relative price response of EU countries which were members of the snake and the ERM (arrangements designed to limit nominal exchange rate fluctuations) are similar to those countries which were not involved in these arrangements, but their relative prices adjust at a slower rate. Hence, these mechanisms appear to have slowed the speed of response of relative prices without having reduced the size of underlying adjustment.

It is also of interest to look at the size of the underlying disturbances over time. Economic integration in the EU could have led to a significant fall in the size of the underlying disturbances over time, implying smaller required movements in relative prices and output across countries. To investigate this possibility, Table 3 reports the average size of the underlying disturbances for the EU and U.S. for 3 period, 1963-72 (1966-72 for the U.S.), 1973-80, and 1981-89, where the aggregate values are measured by calculating the variation in the disturbances for each country or region separately and averaging them. 2/ Since each shock is normalized in the estimation to have a standard deviation of 1 over the estimation period, any deviation from unity indicates disturbances which were larger or smaller compared to the entire period. The results indicate a fall in the variability of both demand and supply disturbances in the EU in 1980s compared with the 1972-80 period, but very little change compared with the 1960s. This is very similar to the path evident in the U.S. data, indicating that the higher variability of the disturbances in the 1970s probably reflects the economic turbulence caused by the two oil shocks.

1/ As will be discussed below, the long-run real exchange rate adjustment in the raw material producing regions of the U.S. is about half that estimated for EU countries, despite the existence of a common currency and large associated movements in regional output.

2/ One reason for averaging them was that the individual results indicated the existence of a considerable amount of noise.

Table 3. Variability of the Underlying Disturbance Over Time

	1963-72	1973-80	1981-89
EU Demand	0.99	1.07	0.91
EU Supply	0.85	1.26	0.95
U.S. Demand	0.96	1.14	0.91
U.S. Supply	0.81	1.15	0.89

Notes: The table reports the average of the standard deviations of the underlying demand or supply disturbances for each individual EU country or U.S. region over the relevant period.

There does not appear to have been an independent downward trend in demand and supply shocks within the EU over time. 1/

3. Behavior within the regions

Thus far the comparisons have been between the typical behavior of an EU country and the typical behavior of a region in the United States. However, as noted earlier, countries who were original members of the EU appear to behave somewhat differently from those who entered the EU at a later date. Similarly, within the United States the behavior of regions which are heavily concentrated in producing raw materials appear somewhat different from the remainder.

Chart 4 shows the responses for these groups separately. The results for the EU show both interesting differences and some striking similarities between the two sets of countries. Consider first the supply curves traced out in the upper right-hand quadrant of the graph. Both curves are very steep and have almost identical lengths. However, while the later EU entrants reach the new equilibrium almost immediately (relative prices move by almost 4 percent in the first year) the speed of adjustment for the original EU members is significantly slower. This slower rate of adjustment plausibly reflects the greater commitment to inter-European exchange rate stability of the original EU members, through mechanisms such the ERM in the 1980s and the snake in the 1970s, as reflected in their lower observed relative price volatility (Table 1). 2/

Turning to the lower right hand quadrant, the results indicate that the slope of the short-run demand curve is relatively similar across the two groups of countries, implying a similar level of goods market integration. However, there does appear to be a significant difference in the size of the underlying disturbances. While an average disturbance changes real output in the original EU countries by 1 percent, it increases output for newer entrants by over 2 percent. The smaller underlying supply disturbances within the original EU members may reflect their greater homogeneity in

---

1/ The disturbances were also divided between long-term members of the EU and more recent entrants. Except for the relatively low level of demand disturbances for long-term EU members in the 1970s, there were no large differences in behavior between the groups.

2/ Table 1 indicates that Denmark and Ireland, who are later EC entrants, also had relatively low real exchange rate volatility. When Denmark and Ireland were included with the original EC members and excluded from the EC entrants, the results are similar. In a similar vein, results for a smaller group of core EU countries, consisting of Germany, the Netherlands, and Belgium, showed very similar results to that for all long-term members of the EU.

technology and industrial structure. 1/ In both cases the adjustment occurs very quickly, essentially within a year.

The top right-hand quadrant of the graph for the U.S. regions indicates that the slopes of the supply curves for the raw material producers and for the more industrial regions are very similar. However, the underlying demand disturbances, which are traced out by these lines, are much larger for the raw material producing regions than for the industrial regions, although the speed of adjustment is not dissimilar. The basic pattern of similarly sloped curves but larger disturbances for the raw material producing regions also holds in the lower right hand panel of the graph. Both sets of regions have relatively flat demand curves. However, the size of the supply disturbances for raw material producing regions is double that for industrial regions.

These results indicate that the slopes of the estimated demand and supply curves are relatively stable within both the EU and the United States. Hence, while differences in adjustment between the EU and United States largely reflect the lower level of market integration in the EU compared to the U.S., differences in behavior within the U.S. and EU reflect variations in the size of the underlying disturbances.

4. Conclusions and implications for EMU

This paper has used structural vector autoregressions of the type proposed by Blanchard and Quah (1989) to look at the response of output and relative prices to supply and demand shocks within the EU and within the United States. The results indicate that, at least during the 1960s, 1970s, and 1980s, the United States had significantly more integrated goods and factor markets than the EU. As a result, relative prices were more important for adjustment within the EU than within the United States, even though the estimated underlying disturbances were similarly sized. Adjustment occurred more quickly within the EU, presumably reflecting the flexibility in relative prices implied by adjustable nominal rates of exchange.

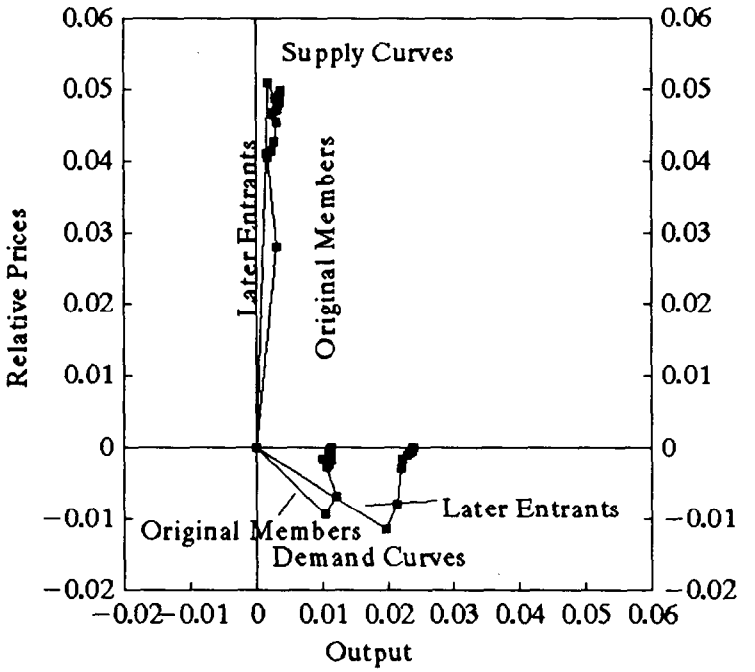
What are the implications for EMU? By adopting a single currency the EU is likely to reduce the short-run flexibility of relative prices, making it more difficult and costly to adjust to underlying disturbances. Given the very steep estimated supply curve, this will be particularly important in response to demand disturbances. Indeed, the exchange rate turmoil in 1992 and 1993 can be seen as an example of this, with the Exchange Rate Mechanism of the European Monetary System making it difficult for relative

---

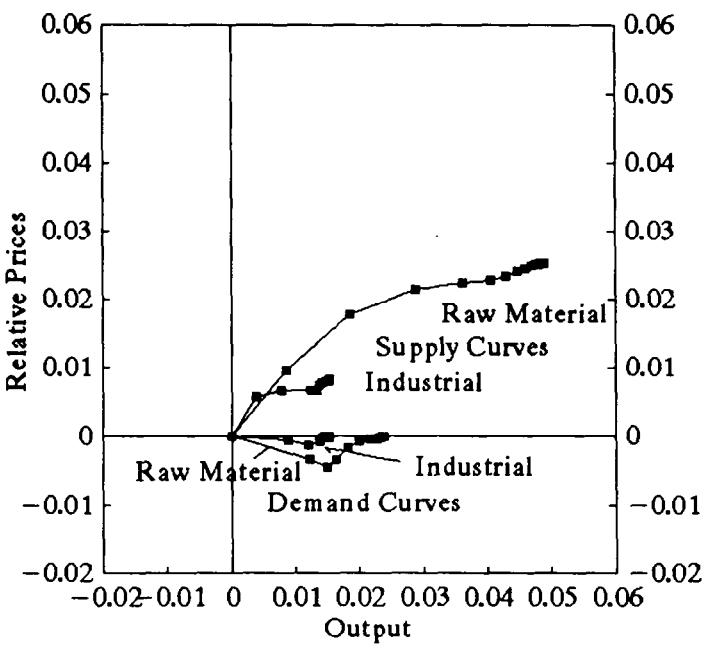
1/ Bayoumi and Eichengreen (1993) find a similar result, namely that aggregate supply disturbances are more highly correlated for Germany and her immediate neighbors than for the rest of the EU. The implication being that relative disturbances (which are measured in this paper) will be smaller for core members than for the rest.

Chart 4. Adjustment Within the EC and U.S.:

Original EC Members and Recent Entrants



U.S. Industrial and Material Producing Regions



prices in the EU to respond sufficiently quickly to the rise in demand for west German products caused by German unification.

In the longer term increasing integration of EU goods and factor markets should reduce the need for large movements in relative prices. Institutional changes, such as the recent completion of the single market in the EU, are important in promoting this integration. In addition, EMU itself will probably promote greater flexibility than has been seen in the past. With the exchange rate instrument no longer available, the incentive for greater flexibility in domestic prices and factor markets is clearly greater, while a single monetary policy may allow larger inflation differentials than those deemed acceptable by national central banks.

Having said this, it does not appear likely that the EU will achieve anything like the levels of integration of U.S. regions in the immediate future. In the shorter-run, disruptive relative price adjustments can probably be best avoided by reducing the size of underlying disturbances in demand for regional products. Coordination of domestic aggregate demand policies across EU countries, such as the fiscal restraints incorporated in the Maastricht treaty, can be seen as one method of moderating the teething problems likely to be associated with EMU.

A Simple Macroeconomic Model

Consider a world made up of a large number of regions with identical economic structures. Output in region i is produced using a Cobb-Douglas production function:

$$y_i = \phi_i + \alpha l_i + (1-\alpha) k_i \tag{A1}$$

where ϕ_i is the logarithm of a productivity disturbance, and y_i, l_i, and k_i are the logarithms of output, labor, and capital, respectively. Assuming that labor and capital responds to changes in relative prices in the following way, $l_i = \gamma w_i/(1+\gamma)$ and $k_i = \kappa r_i/(1+\kappa)$ then, for small changes in the underlying variables, the supply curve is:

$$y_i = (1 + \frac{\gamma\alpha}{(1-\alpha)(1+\gamma)} + \frac{\kappa(1-\alpha)}{\alpha(1+\kappa)})\phi_i + (\frac{\gamma\alpha}{(1-\alpha)(1+\gamma)} + \frac{\kappa(1-\alpha)}{\alpha(1+\kappa)})p_i \tag{A2}$$

The slope of the curve depends upon the degree to which factors move in response to differences in rates of return. If factors do not move at all between regions then the curve is vertical; by contrast, if both labor and capital are fully mobile, the coefficient on p_i is $(\alpha/(1-\alpha)+(1-\alpha)/\alpha)$.

Demand for local goods comes from workers, who receive wages, and capitalists, who earn income from the ownership of capital. It is assumed that workers consume only their locally produced good, y_i, while capitalists have consumption which is fully diversified across all regions. All capitalists have the same preferences, given by:

$$U^K = \sum_j (1-\sigma)(c_j - \epsilon_j) \tag{A3}$$

where U^K is the utility function of capitalists, and c_j and ϵ_j are the logarithms of consumption of good j and a shock to preferences, respectively. For small changes in variables, the logarithm of the demand curve for local goods is:

$$c_i = \alpha(w_i + l_i) + (1-\alpha)(\epsilon_i - \frac{p_i}{\sigma}) \tag{A4}$$

where w_i is the real wage of workers in terms of local goods. The first term shows the demand for local goods from workers; since they only consume local products it depends only on their real income. The second term, which represents demand from capitalists, depends only on local prices and not on incomes. (Since the demand of capitalists for local goods makes up only a small fraction of the total incomes of capitalists, changes in the rate of return on regional capital has no impact on demand.) The coefficients α and $(1-\alpha)$ reflect the weight of the two types of demand in total consumption.

It is assumed that both real wages and labor input are fixed in the short-run, so that all short-run changes in income accrue to capitalists. In this case, the short-run demand and supply curves for local products are:

$$s_i = y_i = (1+\lambda)\phi_i + \lambda p_i$$
$$d_i = y_i = (1-\alpha)(\epsilon_i - \frac{p_i}{\sigma}) \qquad \text{(A5)}$$

where $\lambda = \kappa(1-\alpha)/\alpha(1+\kappa)$. Demand and supply disturbances act exactly as in the usual demand and supply diagram. As the labor market adjusts, real wages and labor input both change. The resulting redistribution of income from capitalists to workers causes an endogenous change in demand for products. Assuming that labor remains immobile, 1/ the long-run demand and supply curves are:

$$s_i = y_i = (1+\lambda)\phi_i + \lambda p_i$$
$$d_i = y_i = \alpha y_i + (1-\alpha)(\epsilon_i - \frac{p_i}{\sigma}) \qquad \text{(A6)}$$

A positive demand or supply disturbance which raises output induces a subsequent expansion in demand equal to proportion α of the original change in output. This process will continue, causing demand to steadily expand over time.

1/ If labor is regionally mobile this will cause a flattening of the supply curve over time (see equation 2).

The Estimation Methodology

Consider a system where the 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:

$$\begin{aligned} X_t &= A_0\epsilon_t + A_1\epsilon_{t-1} + A_2\epsilon_{t-2} + A_3\epsilon_{t-3} \ldots . \\ &= \sum_{i=0}^{\infty} L^i A_i \epsilon_t \end{aligned} \tag{A7}$$

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 the change in relative prices and the change in output, and let ϵ_t be supply and demand shocks. Then the model becomes:

$$\begin{bmatrix} \Delta r_t \\ \Delta y_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \epsilon_{st} \\ \epsilon_{dt} \end{bmatrix} \tag{A8}$$

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

Demand and supply shocks are identified by assuming that, while demand shocks have permanent effects on relative price, supply shocks have only temporary effects. Since relative prices are measured as first differences, this implies that the cumulative effect of supply shocks on the change in relative prices (Δr_t) must be zero:

$$\sum_{i=0}^{\infty} a_{11i} = 0. \tag{A9}$$

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

$$\begin{aligned} X_t &= B_1 X_{t-1} + B_2 X_{t-2} + \ldots + B_n X_{t-n} + e_t \\ &= (I - B(L))^{-1} e_t \\ &= (I + B(L) + B(L)^2 + \ldots) e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots \end{aligned} \tag{A10}$$

where e_t represents the residuals from the equations in the VAR. In the case being considered, e_t is comprised of the residuals of a regression of lagged values of Δr_t and Δy_t on current values of each in turn; labeled e_{rt} and e_{yt}, 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 the 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_{st} and ϵ_{dt}. A third restriction comes from assuming that demand and supply shocks are orthogonal.

The final restriction, which uniquely defines the matrix C is that supply shocks have only temporary effects on relative prices. This implies:

$$\sum_{i=0}^{\infty}\begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix}\begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & . \\ . & . \end{bmatrix} \tag{A11}$$

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

References

Bayoumi, Tamim, and Barry Eichengreen, "Shocking Aspects of European Monetary Union," in Francesco Torres and Francesco Giavazzi (eds.), The Transition to Economic and Monetary Union in Europe (Cambridge: Cambridge University Press, 1993).

Bean, Charles, "The Economics of EMU," Journal of Economic Perspectives, Vol. 6 (Fall 1992), pp. 31-52.

Blanchard, Olivier, and Lawrence Katz, "Regional Evolutions," Brookings Papers on Economic Activity 1992, Vol. 1 (1992), pp. 1-75.

_____, and Daniel Quah, "The Dynamic Effects of Aggregate Demand and Supply Disturbances," American Economic Review, Vol. 79 (September 1989), pp. 655-673.

Cohen, Daniel, and Charles Wyplosz, "The European Monetary Union: An Agnostic Evaluation," in Ralph Bryant, David Currie, Jacob Frenkel, Paul Masson, and Richard Portes (eds.), Macroeconomic Policies in an Interdependent World (Washington: International Monetary Fund, 1989).

Eichengreen, Barry, "Is the Maastricht Treaty Worth Saving?" Princeton Essays in International Finance, No. 74, Princeton University (December 1992).

_____, "One Money for Europe? Lessons from the U.S. Currency and Customs Union," Economic Policy, Vol. 10 (1990), pp. 118-187.

Krugman, Paul, "Increasing Returns and Economic Geography," Journal of Political Economy, Vol. 99 (June 1991), pp. 483-99.

Masson, Paul, and Steven Symansky, "Evaluating the EMS and EMU Using Stochastic Simulations: Some Issues" (International Monetary Fund: Washington), Working Paper No. WP/93/28 (1993).

Minford, Patrick, "Do Floating Exchange Rates Insulate?" in R. MacDonald and M. Taylor (eds.), Exchange Rates and Open Economy Macroeconomics (Basil Blackwell, Oxford, 1989).

Mussa, Michael, "Exchange Rates in Theory and Reality," Princeton University Essays in International Finance, No. 179 (Princeton University, 1990).

Poloz, Stephen, "Real Exchange Rate Adjustment Between Regions in a Common Currency Area," unpublished manuscript, Bank of Canada (1990).

Sims, Christopher, "Macroeconomics and Reality," Econometrica, Vol. 48 (1980), pp. 1-48.

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