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## ABSTRACT

# Currency Unions, Economic Fluctuations and Adjustment: Some Empirical Evidence*

This paper compares sources of disturbances to output and labour market adjustment in the US currency union compared to a set of EU countries. Comparable datasets comprising 1-digit sectoral data for 8 US regions and 8 European countries are constructed and used to study the relative importance of industry-specific, region-specific, and aggregate shocks to output growth. Both areas are subject to similar overall disturbances although a disaggregated perspective reveals some differences. The major difference, however, is in labour market adjustment. Inter-regional labour mobility appears to be a much more important adjustment mechanism in the United States, which has a more integrated labour market than the EU.

JEL Classification: E32, F33, J61
Keywords: currency unions, economic fluctuations, labour market adjustment

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## NON-TECHNICAL SUMMARY

Proposals for a European currency union have generated an upsurge in interest in behaviour across regions within the United States. If European countries do relinquish their own currencies, they will face many of the same constraints faced by US regions. By analysing regional behaviour in the United States, a large economy with a single currency, researchers hope to shed light on the potential effects of a single currency in Europe. This paper extends this line of research. Parallel data sets are constructed for the United States and 8 European countries since the early 1970s containing data on real output, employment, and productivity, differentiated by both region (or country) and by 1-digit industrial sector. Although the two datasets are similar in many respects, the crucial difference is the fact the US regions are part of a currency union while the European countries are not. These datasets are used to analyse the role of sectoral, regional, and aggregate shocks in economic fluctuations and labour market adjustment to such disturbances.

This work draws from a number of earlier lines of enquiry. Earlier comparisons between the EU and United States have arrived at different conclusions about EMU. Work using data on aggregate output by region and country to investigate the correlations between underlying disturbances within the United States and EU have tended to find that disturbances within the EU as a whole are less correlated than those within the United States, implying significant costs to monetary union. Others, however, who have used disaggregated data on output within the manufacturing sector to differentiate among different types of underlying disturbances, have found that industry-specific shocks account for the majority of the explained variance in output in both the United States and Europe. As the exchange rate is not a potent instrument for dealing with industry-specific disturbances, this implies that the exchange rate is not a particularly useful adjustment mechanism in Europe. Using disaggregated data on total output is one way of investigating the reasons for these divergent results.

Another related literature considers the sources of business cycle shocks. Several authors have used data disaggregated by both region and industry to look at the relative importance of aggregate, industry-specific, and region-specific shocks for fluctuations in output. Generally, these studies find a significant role for regional and (where calculated) aggregate shocks in economic fluctuations, suggesting that it may be inadequate to model output fluctuations as being attributable to technology shocks alone. Finally, there has

been considerable work on the role of labour markets in adjustment to economic disturbances, particularly in the United States. This work has generally concluded that labour mobility is an important factor in such adjustment in the United States, but that it is less important in Europe.

This paper differs from this earlier work in two ways. Unlike most earlier studies, we use data on the whole economy, not just manufacturing or industrial production, which accounts for only about a quarter of total employment and output in the United States and the EU. Our results indicate significant differences between behaviour in manufacturing and transportation (which make up the bulk of industrial production) and other sectors of the economy. Studies which limit themselves to manufacturing or industrial production data may not, therefore, be a reliable guide to aggregate economic behaviour. We also extend the analysis to look at labour market adjustment to disturbances. Earlier studies using disaggregated data on output or employment have also focused almost exclusively on the nature of the disturbances. Since outcomes reflect the interaction between both disturbances and responses to those disturbances, characterizing responses would appear to be an equally important endeavour, however.

For the full sample, the relative importance of aggregate, industry-specific, and country- or region-specific shocks in explaining output growth fluctuations is roughly similar in Europe and the United States, with each of these types of shocks playing an important role. A more disaggregated analysis of the sources of disturbances at the sectoral level, however, indicates that region-specific disturbances in the United States are more important in non-traded goods sectors while in the EU country-specific disturbances are more prevalent in traded goods sectors.

The major difference between the United States and the EU is in the nature of labour market adjustment to shocks. Our results indicate that productivity trends are dominated by industry-specific factors in the United States and by country-specific factors in the EU. These results appear to confirm other evidence that the United States has a much more integrated labour market, either because of, or reflecting, the single currency, and that inter-regional flows of labour constitute an important adjustment mechanism in the US labour market. In Europe, while flows of labour across sectors within countries may be important, labour flows across countries do not seem to be an important adjustment mechanism. This implies that large wage differentials across European countries could remain after EMU. In addition, unless labour mobility across European countries is enhanced, wage differentials across countries

will have to remain flexible if significant disruptions from country-specific disturbances are to be avoided in EMU.

## 1. Introduction

Proposals for a European currency union have generated an upsurge in interest in behavior across regions within the United States. If European countries do relinquish their own currencies, they will face many of the same constraints faced by U.S. regions. By analyzing regional behavior in the United States, a large economy with a single currency, researchers hope to shed light on the potential effects of a single currency in Europe. This paper extends this line of research. Parallel data sets are constructed for the United States and eight European countries since the early 1970s containing data on real output, employment, and productivity, differentiated by both region (or country) and by 1-digit industrial sector. These datasets are used to analyze the role of sectoral, regional, and aggregate shocks in economic fluctuations and labor market adjustment to such disturbances.

This work draws from a number of earlier lines of enquiry.[1] Direct comparisons between the EU and United States include Bayoumi and Eichengreen (1993) and Bini Smaghi and Vori (1992), who come to very different conclusions about EMU. Bayoumi and Eichengreen use data on aggregate output by region and country to investigate the correlations between underlying disturbances within the United States and EU. They find that disturbances within the EU as a whole are less correlated than those within the United States, implying significant costs to monetary union. Bini Smaghi and Vori use data on output across 11 manufacturing industries to differentiate among different types of underlying disturbances. They find that industry-specific shocks account for the majority of the explained variance in output in both the United States and Europe. As the exchange rate is not a potent instrument for dealing with industry-specific disturbances, they conclude

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[1] More comprehensive surveys of the literature on EMU are contained in Eichengreen (1992) and Bean (1992).

that the exchange rate is not a particularly useful adjustment mechanism in Europe.[2] Using disaggregated data on total output is one way of investigating the reasons for these divergent results.

Another related literature considers the sources of business cycle shocks. Norrbin and Schlagenhauf (1988) decompose the sources of fluctuations in quarterly U.S. employment growth disaggregated by region and 1-digit industry into aggregate, industry-specific, and region-specific shocks. All three factors are significant, with the aggregate factor being the most important, followed by industry-specific shocks, and then region-specific shocks.[3] In a similar vein, Altonji and Ham (1990) use an error components methodology to assess the impact of external, national, sectoral, and provincial shocks on growth in Canadian employment using data disaggregated by industry and province. They find the dominant influences to be U.S. and, to a lesser extent, aggregate Canadian shocks. Finally, Stockman (1988) performs a similar decomposition using two-digit industries within industrial production in the United States and seven European countries. He finds that both industry-specific and country-specific shocks are empirically important, suggesting that it may be inadequate to model output fluctuations as being attributable to technology shocks alone.

This paper differs from this earlier work in two ways. Unlike most earlier studies, we use data on the whole economy, not just manufacturing or industrial production, which accounts for only about a quarter of total employment and output in the United States and EU. Our results indicate significant differences between behavior in manufacturing and transportation (which make up the bulk of industrial production) and other sectors of the

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[2] This argument has been repeated by a number of other authors. See, for example, Melitz (1993).

[3] The importance of industry-specific shocks is interpreted by these authors as providing indirect support for technology-shock models of the business cycle.

economy. Studies which limit themselves to manufacturing or industrial production data may not, therefore, be a reliable guide to aggregate economic behavior. We also extend the analysis to look at labor market adjustment to disturbances. Earlier studies have focused almost exclusively on the nature of the disturbances. However, since outcomes reflect the interaction between both disturbances and responses to those disturbances, characterizing responses would appear to be an equally important endeavor.[4]

The next section provides further motivation by reviewing recent work on regional adjustment, particularly in the United States. Section 3 describes the data and section 4 the econometric methodology. The results from our analysis of disturbances are reported in section 5, while section 6 presents the results on labor market adjustment. Section 7 concludes.

## 2. Regional Adjustment in the United States

Recent work on regional adjustment in the United States contains a number of strands other than those discussed in the introduction. Long-term trends in personal income and output per capita were examined by Barro and Sala-i-Martin (1992), who conclude that they are converging across states over time. This convergence is interpreted in terms of the Solow growth model. Income inequalities, caused by differences in the capital-labor ratio between regions, are steadily reduced as the investment opportunities caused by differences in initial endowments cause the capital-labor ratios to converge. The implication of this argument is a currency union could enhance market mechanisms that tend to reduce regional inequalities in the long run.

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[4] A point made in Bayoumi and Eichengreen (1993).

A second issue is labor market adjustment to disturbances. Blanchard and Katz (1992) conclude that it is employment which bears the brunt of regional adjustment in the U.S using data on employment, wages, and unemployment by state.[5] A negative disturbance that lowers employment in a given state produces relatively little real wage response. Rather, the labor market regains equilibrium as the excess labor moves to a new location within the United States. The implication is that in the United States inter-regional labor mobility is the major equilibrating force in the economy.[6]

Regional diversification of industries has also been examined. By comparing industrial diversification in the United States with that in the EU, possible effects of EMU on European economic geography can be inferred. Krugman (1991) concludes that the greater regional specialization exhibited by industries in the U.S. manufacturing sector relative to those in European countries is a function of the common currency and, hence, that over time EMU may imply significant regional dislocation in the EU.[7]

This paper is mainly concerned with the nature of, and adjustment to, underlying disturbances in the United States and EU, although some issues concerning specialization and long-term growth are also addressed. Before discussing our approach, a number of limitations in any comparison of the United States with the EU as a guide to the impact of EMU should be recognized. The institutional structures in the two regions are different. The United States has a much more important federal fiscal system, a single language, a

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[5] An earlier study by Eichengreen (1990), which looks at the behavior of unemployment across U.S. regions, comes to similar conclusions.

[6] This is not incompatible with the results for long-term growth discussed above due to the different time perspectives considered in these papers.

[7] A number of authors have also investigated mechanisms which cushion the effects of economic disturbances within the United States, including federal fiscal policy (Sala-i-Martin and Sachs (1992), von Hagen (1992), and Bayoumi and Masson (1994)) and private capital markets (Atkeson and Bayoumi (1992)).

unified cultural heritage, lower taxes, fewer state enterprises, and a weaker tradition of government intervention in the economy than most EU countries. In addition, the United States has operated with a common currency for over 200 years, so that the analysis will have little to say about the speed or difficulty of the economic transition implied by moving from separate monies to a currency union. Finally, the level of regional inequalities within the United States is somewhat lower than across EU countries.

At the same time, the similarities of the underlying economic structures in the United States and EU (outside the monetary field) should also be recognized. Both are continent-wide economies, with similar levels of development, population, and per capita income. Both are characterized by mature market-based economies and democratic political institutions. When aggregated into a single economy, the EU is, like the United States, relatively closed to international trade.[8] Hence, while not being the only factor at work, it is probably not unreasonable to attribute a significant portion of the observed differences in behavior to the existence of a unified currency in the United States and separate national currencies in the EU.

## 3. Data

Parallel data sets were constructed for the 8 standard U.S. regions defined by the Bureau of Economic Analysis (BEA) and for 7 EU countries plus Austria, which, although not in the EU during our sample period, has close economic ties to Germany and has

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[8] This is particularly true if the EFTA countries are included in the European aggregate (Bayoumi and Sterne (1993)).

recently joined the Union.[9] The dataset consists of three variables--real output (value added), employment, and output per employee--and covers 8 industrial classifications: primary industries (or mining, where data on agriculture were not available); construction; manufacturing; transportation; trade; finance; services; and government. The U.S. data come from the BEA regional data bank. The European data come from the OECD National Accounts, and the real output data were converted into U.S. dollars using 1985 purchasing power parities, also obtained from the OECD. The data are annual and generally cover the period 1970-89 for the United States and 1970-87 for the EU. However, some of the employment (and, hence, productivity) series were only available for a shorter time period.

The United States and the OECD use somewhat different industrial classification systems, and it was necessary to amalgamate some series to produce industrial sectors which were more closely aligned. Table 1 shows the aggregation that was used, based on the major industrial classifications in each data set. Although some differences in classification still remain,[10] the result is a pair of data sets whose classifications are, we believe, compatible enough to be used for comparative work.

Table 2 reports some comparative statistics across the two data sets. It shows the average share of total output produced by each industry within the region or country, as well as the mean and the coefficient of variation of these industry output shares. The mean

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[9] State-level data were aggregated into the 8 standard BEA regions in order to make the U.S. data more comparable to the EU data in terms of the number of regions and their economic size. The eight U.S. regions are: New England, Mid-East, Great Lakes, Plains, South-East, South-West, Rocky Mountains, and Far-West. The eight European countries are Austria, Belgium, Denmark, Germany, Greece, Italy, Netherlands, and the United Kingdom. Constraints on data availability led us to exclude other important European countries such as France.

[10] For instance, hotels are classified in the service sector in the regional U.S. data and in the trade sector in the European data.

values illustrate the composition of output across different industries. Many industries have relatively similar mean ratios across the two data sets. However, the service sector is significantly more important in the United States than in Europe, while manufacturing is more important in Europe. Manufacturing has the largest share of output in both data sets.

The coefficient of variation is a measure of the degree of regional specialization of an industry. The larger the variation in the composition of output across regions, the larger the coefficient of variation. Primary industries and manufacturing in the United States are highly concentrated in particular regions, presumably reflecting the concentration of agriculture and mining in the Plains, South-Western, and Rocky Mountain regions and of manufacturing in the Great Lakes region. The European countries in our sample show less specialization in these two industries. In all other industries, however, the coefficient of variation is higher in the EU than in the United States.[11]

Based on an examination of manufacturing sector data, Krugman (1991) concluded that the United States is a significantly more specialized economy than Europe. He therefore argued that the introduction of a single currency in Europe would create an impetus towards greater specialization and, consequently, lead to significant reallocation of labor and other factors following EMU. The results in Table 2 do not support this argument. Our measure of specialization indicates that, in all industries except manufacturing and primary goods, the EU is more diverse than the United States, at least at the 1-digit SITC level. Manufacturing may, therefore, not necessarily provide an adequate basis for comparing the structure of the United States and EU economies.

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[11] The results in the text are based on data for the full sample period. To examine whether factors such as increasing European integration could affect our conclusions, we also constructed our measures of specialization for the first and last five years of the sample for both datasets. There were no important differences relative to the results for the full sample.

Some of the diversity observed within the EU may reflect problems in making industrial classifications consistent across countries. However, it is more likely to result from the wide diversity of regulations and practices across EU countries, which could mean that similar tasks are often carried out by different industrial sectors. Outside of manufacturing, the pertinent concern for EMU may not be Krugman's argument that greater specialization will create changes in industrial structure. To the contrary, the greater homogeneity in industrial structure engendered by EMU could well be a more potent factor.

## 4. Econometric Methodology

This section presents the econometric methodology that we employ to identify the sources of disturbances: those that affect all industries within a given region or country (regional shocks); those that affect industries across all regions or countries (industrial shocks); and those that affect all regions or countries and all industries simultaneously (aggregate shocks). Such a decomposition allows us to analyze the nature of the disturbances affecting the United States and the EU, and how these two economic areas adjust to these disturbances.

Our datasets contain observations on output, employment, and productivity over time disaggregated by U.S. region or EU country and by 1-digit industry. Since there are 8 industries and 8 regions or countries in each data set, this implies a panel with a maximum of 64 observations per time period, each identified by industry, location, and date. The sources of the underlying disturbances are measured using the following specification:

$$\Delta \ln(y_{i,j,t}) = \alpha_{i,t} + \beta_{j,t} + \Psi_t + \epsilon_{i,j,t}, \qquad (1)$$

where $\Delta \ln(y_{i,j,t})$ is the change in the logarithm of output in industry i, region/country j, and period t; $\alpha_{i,t}$, $\beta_{j,t}$ and $\Psi_t$ are the coefficients associated with dummy variables that are equal to 1 for industry i in period t, for region/country j in period t, and for all industries and regions in period t, respectively (and 0 otherwise), and $\epsilon_{i,j,t}$ is an error term.[12]

If the $\alpha_{i,t}$ coefficients were calculated for all industries i, then a linear combination of these coefficients would be equal to the time-specific dummy variable $\Psi_t$. The same is true of the region/country dummies $\beta_{j,t}$, if summed over all j. Accordingly, one industry and one region need to be eliminated from the set of dummy variables to identify the model. The choice of the omitted industry and region/country does not affect tests of the significance and explanatory power of the industrial or regional effects. An F-test of the joint significance of the remaining $\alpha_{i,t}$ coefficients represents a valid test of the importance of industry-specific shocks in the regression, as does a similar test of the joint significance of the $\beta_{j,t}$ coefficients.

Since the industry-specific and region-specific dummy variables are orthogonal by construction, the explanatory power of these variables can also be calculated from the reduction in the $R^2$ statistic caused by excluding them from the original regression. Any

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[12] $\Delta \ln(y_{i,j,t})$ is measured as the deviation from the mean growth rate of the series as a whole in industry i, country/region j at time t. The specification assumes that region- or country-specific disturbances have the same effect on the growth rate of output in all industries. To control for differences in cyclical sensitivities across industries within each region/country, output growth rates for each industry i in each region/country j were divided by the sample standard deviation of output growth for that series. The decomposition is similar to that used by Stockman (1988), except that we include time-specific dummies $\Psi_t$. Hence, in our setup, $\alpha_{i,t}$ and $\beta_{j,t}$ can be directly interpreted as the orthogonal components of the industry-specific and region- or country-specific shocks, respectively.

variation that is explained by the regression but that is not specifically attributable to either set of dummy variables can be attributed to the aggregate disturbance.[13]

The exclusion of one of each of the $\alpha_{i,t}$ and $\beta_{j,t}$ coefficients is of more importance when the estimated coefficients are used to construct a series which represents the underlying disturbances of industry i or region/country j. As estimated, the series $\alpha_i$ (made up of $\alpha_{i,1}$, $\alpha_{i,2}$,...,$\alpha_{i,T}$) represents the shock to industry i relative to the shock to the industry which was excluded from the estimation. Similarly, the series $\beta_j$ represents the shock to region/country j relative to the excluded region/country, while the series $\Psi$ represents the sum of the aggregate disturbance plus the shocks to the excluded industry and excluded region/country. To distinguish the aggregate disturbance from that experienced by the excluded industry and region a further restriction is necessary. The restriction employed here is that the sum of all of the $\alpha_{i,t}$ disturbances (including the region excluded from the estimation) is equal to zero in each period t; a similar restriction was imposed on the sum of the $\beta_{j,t}$ disturbances. The rationale is that the industrial and regional shocks represent deviations from an underlying aggregate disturbance and the aggregate impact of these deviations should then sum to zero. The aggregate disturbance itself was then calculated as the value $\Psi$ minus the implied shocks to the industry and region excluded from the estimated set of dummy variables.

In addition to decomposing short-term fluctuations in output between industrial, regional, and aggregate disturbances, we also consider how the economy adjusts to these disturbances over time. Average rates of growth of output, employment, and output per

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[13] These dummy variables are exactly orthogonal only when all data points are available. In other cases, there is a small residual value which is unattributable across the three types of disturbance.

worker over several years are used to calculate the relative importance of regional and industrial factors in adjustment using the following cross-sectional regression:

$$\Delta \ln(y^*_{i,j}) = \alpha_i + \beta_j + \epsilon_{i,j}, \tag{2}$$

where $\Delta \ln(y^*_{i,j})$ is the average change in output for industry i in region j. Since there is no time dimension, it is not possible to identify an aggregate disturbance. The analysis is therefore limited to the relative importance of regional and industrial factors in medium-term adjustment. In this part of the analysis, the growth in output is further divided into the growth in employment and the growth in output per employee.

## 5. Sources of Disturbances

The U.S. data cover the period 1972-89, implying that there are 1152 observations (8 industries times 8 regions times 18 data points). The European data cover the period 1971-87, and contain 1088 observations.

### 5.1 United States Results

Table 3 reports the overall explanatory power of equation (1) and the importance of industry-specific, region-specific, and aggregate disturbances in this total.[14] Equation (1) explains 73 percent of the variation in disaggregated U.S. output growth. The aggregate disturbance is the most important factor, explaining 29 percentage points of the variance, while the industrial and regional dummy variables explain a further 25 and 19

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[14] As discussed earlier, to avoid collinearity dummies for one industry (government) and one region (far-west region) were excluded in the U.S. regressions. Similarly, dummies for one industry (services) and one country (Italy) were excluded from the EU regressions. All of our results were quite robust to the choice of excluded industry and country/region.

percentage points of the variance, respectively. F-tests of the significance of the dummy variables (not reported) indicate that all of the elements of the model (the industry, region, and time dummies) are highly significant. In short, the model as a whole explains three-quarters of the variance of output growth and all three types of disturbances are significant, with the aggregate disturbance explaining the largest fraction, industrial factors being almost as important, and regional factors accounting for a smaller share.

Table 3 also reports the overall $R^2$ and the decomposition between the different factors for each industry, calculated using the estimated coefficients from the full regression but limiting each calculation to only those observations which involve that industry. Regional disturbances turn out be relatively unimportant for the manufacturing industry; indeed, using this approach, the impact on the $R^2$ is negligible.[15] This suggests that sectoral factors are more important than regional factors in explaining variation in the growth of output in manufacturing. Thus, our aggregate results for U.S. manufacturing are consistent with the more disaggregated results, using 2-digit industry classifications, obtained by Bini Smaghi and Vori (1992).[16] A similar result is obtained for transportation. By contrast, regional disturbances explain a significant part of the variance in construction, finance, services, and government, four industries which make up almost half of total output in the United States. Finally, the trade and primary sectors are an intermediate case, with results between these two extremes. These differences appear relatively intuitive. Manufacturing and transportation, which produce goods that are easily

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[15] Since we are looking at a subset of the original data set, it is possible for the independent variables to lower the variance of the dependent variable (of course, this is not possible for the full data set). In rare instances, this resulted in a small negative contribution for a factor. We set these R-squared contributions to zero.

[16] Other approaches, such as regressing the estimated disturbances discussed below on the manufacturing data, produced a similar qualitative conclusion.

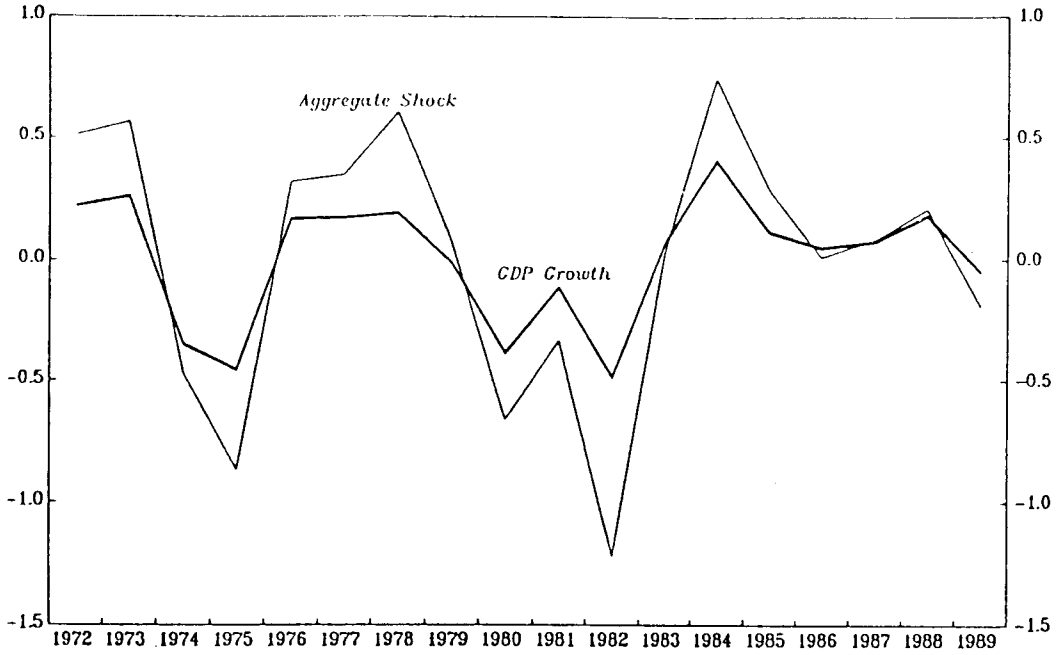
traded across regions, are dominated by non-regionally differentiated shocks. Industries whose products are less easily traded geographically, such as construction, finance, services, and government, are more prone to regional disturbances

The same decomposition can be carried out across regions. The results (lower panel of Table 3) indicate that the relative importance of the three types of disturbances also vary by region. Regional disturbances are most important in the South-West and Rocky mountain regions, presumably reflecting the importance of raw material production in the local economies. The Mid-East and New England, which are relatively specialized in finance and other service industries, also have relatively large regional disturbances. By contrast, regional disturbances are the least important factors in the Great Lakes and Plains regions, which are among the most specialized in manufacturing.

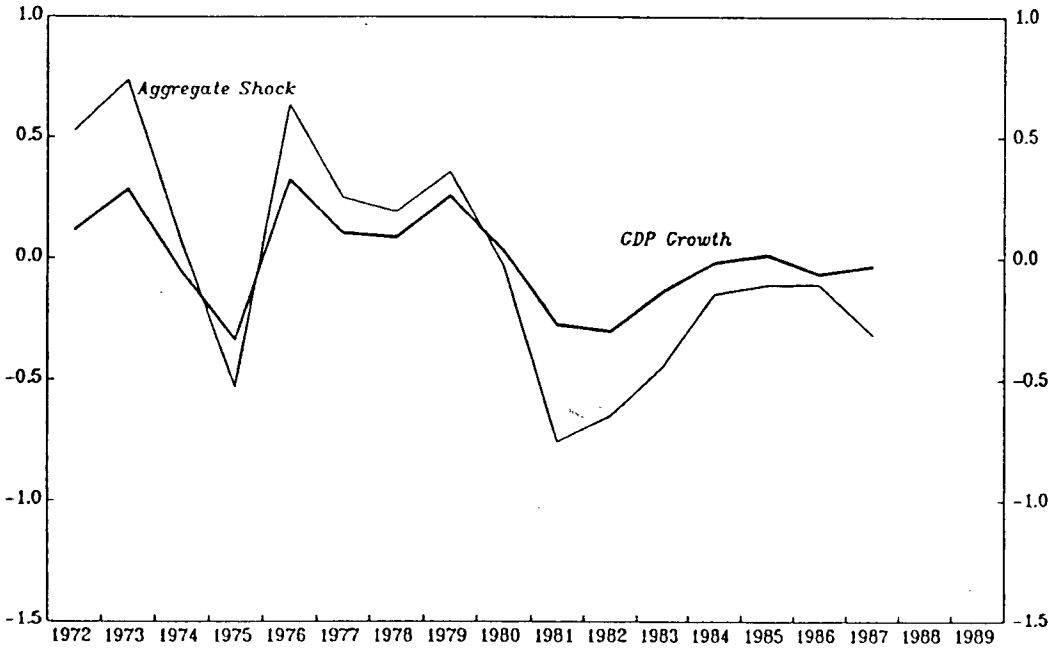
As discussed earlier, it is also possible (by putting the relevant $\alpha_{i,t}$ and $\beta_{i,t}$ coefficients into a time series) to derive individual series for the underlying disturbances to the 8 regions, the 8 industries, and the aggregate disturbance. The upper panel of Chart 1 plots the growth in total output and the aggregate disturbance for the United States. The two series are clearly highly correlated, indicating that our methodology has yielded a reasonable measure of the aggregate shock. The aggregate disturbance is negative after the oil price hikes in the 1970s and positive through much of the late 1980s. Visual inspection indicated that the other disturbances also appear sensible. For example, the disturbance for primary industries showed a positive impact from the oil price hikes and a negative pattern in the late 1980s, while the disturbance for New England vividly illustrated the rise and fall of the "Massachusetts miracle". The results for the EU also appear reasonable, as illustrated by the lower panel of Chart 1, which plots the aggregate disturbance and total output growth for this area.

Figure 1.

United States: Aggregate Shock and Total GDP Growth 1972-1989




European Union: Aggregate Shock and Total GDP Growth 1972-1987




Note: To make the series compatible, the rate of growth of total output in each economic area was divided by 10, and its mean was subtracted.

Next, we use these disturbances to examine two issues. First, the contemporaneous correlations among the disturbances are used to better understand the relation between different aspects of economic fluctuations. Such correlations could be important, for instance, in understanding which shocks magnify or dampen the effects of aggregate shocks. Next, we use time series properties and Granger-causality tests to see whether there are important dynamic influences among the disturbances. Such dynamic effects, which would not be captured by our methodology, could be important in understanding the nature of business cycle propagation.

Table 4a shows the correlation between the aggregate disturbance and the disturbances for individual industries, with statistically significant correlations marked with an asterisk. The disturbances for manufacturing and finance are significantly positively correlated with the aggregate disturbance, indicating that the cyclical effects of aggregate shocks are amplified in these two industries. By contrast, the disturbances associated with services and primary goods are negatively correlated with the aggregate. In the case of services, this presumably reflects the fact that aggregate fluctuations are dampened by this industry. For primary industries, it appears more likely that it illustrates the opposite impact of commodity price changes (particularly in oil prices) on the fortunes of the industry and of the economy as a whole. Inter-industry correlations (not reported) reinforce these results. In particular, disturbances between manufacturing and both services and primary goods are highly negatively correlated. An interesting aspect of these results is that the government sector disturbance (which primarily reflects wages and salaries) does not dampen the cycle, although other aspects of government activity such as the tax system or procurement may well have this effect on aggregate fluctuations.

The correlation coefficients between the regional disturbances and the aggregate (Table 4b) are generally smaller than those associated with industrial disturbances, and the

only significant correlation is the positive one between the South East and aggregate disturbances. Inter-regional correlations (not reported) indicate that New England and the Mid East face very similar disturbances, as do the South West and Rocky Mountains, but that disturbances between these two pairs are large and negative. The U.S. economy appears to be divided into three distinct regions: the North East, the raw material producing central states, and the remainder.[17]

Finally, we examined the dynamic properties of the estimated disturbances. In general, the shocks did not display significant persistence over time, with most of the first-order autocorrelation coefficients being small and insignificant. We also used bivariate Granger-causality tests (with two lags) to examine if there were important feedback effects among the various disturbances. We found that the null hypothesis of no Granger-causality could be rejected at the 5 percent significance level in only 7 percent (18/256) of the cases, indicating that our methodology adequately captures the dynamic properties of the data.

5.2 EU Results

A similar decomposition of output growth fluctuations was carried out for the 8 European economies. The second panel of Table 3 shows that equation (1) explains about half of the total variation in the growth of disaggregated output in the EU, with the aggregate, industry-specific, and country-specific disturbances accounting for 19 percent, 18 percent, and 16 percent, respectively. Comparing the results for the United States and the EU, the relative importance of the different disturbances is strikingly similar. In both cases, industry-specific shocks contribute about a third of the explained variance in output

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[17] Bayoumi and Eichengreen (1993) also find that the raw material producing regions face distinctly different underlying disturbances. However, they do not find the same dichotomy between the North-eastern regions and the rest of the economy.

growth, with aggregate shocks contributing slightly more and country/region shocks slightly less. At the same time, it should be noted that the relative contribution of country-specific shocks is slightly larger in Europe than in the United States (31 percent of the explained variance in the EU versus 26 percent in the United States).

There are a number of differences from the United States results at the industry level. Country-specific factors account for more than a quarter of the 71 percent of variance explained for manufacturing.[18] Country-specific factors are also more important than industry-specific factors in transportation and trade, possibly reflecting the higher spatial concentration of these industries in the EU relative to the United States (see Table 2). In construction and services, two non-traded goods sectors, industry-specific factors have more explanatory power than country-specific factors in the EU, the reverse of the result for the United States.

When the decomposition is carried out for each country (lower panel of Table 3), large variations are seen in the relative importance of the three types of disturbances. Aggregate factors are most important in Germany, Greece, and Italy. Industry-specific factors are more important than country-specific factors in most countries, the exceptions being Greece and the United Kingdom. In the United Kingdom, country-specific factors appear to dominate output growth fluctuations, suggesting that aggregate factors that affect other European countries have little impact.

Table 4a reports the correlations between the aggregate disturbance and the disturbances for individual industries in the EU. As in the case of the United States, the

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[18] The relative importance of country-specific factors in manufacturing is similar to the findings of Stockman (1988), who uses 2-digit manufacturing data. However, the results are different from those obtained by Bini Smaghi and Vori (1992), who conclude that sectoral factors account for a substantial fraction of variation in this sector's output growth in the EU.

disturbances for manufacturing and finance amplify the aggregate shock, while the disturbances to the primary and service sectors have significant negative correlations. The correlation coefficients between the country-specific disturbances and the aggregate disturbance (Table 4b) are generally not statistically significant. The notable exception is Germany which has a strong positive correlation with the aggregate, presumably reflecting the importance of the German economy in the EU.

There are few significant correlations among the inter-industry disturbances (not reported here). Manufacturing is positively correlated with trade and finance and negatively correlated with services. Services and trade are negatively correlated as are the finance and primary sectors. Turning to the inter-country correlations, Belgium and Germany have a negative correlation with the United Kingdom. Other inter-country correlations are generally quite weak, indicating that country-specific disturbances in one country are generally not transmitted to other countries in the EU.

As in the case of the disturbances for the United States, the disturbances for the EU did not generally reveal significant persistence. Further, bivariate Granger causality tests again confirmed the absence of important dynamic effects across disturbances.

In summary, the results for the United States and the EU reveal a similar aggregate picture of the relative importance of various sources of disturbances. However, a disaggregated perspective reveals an interesting difference. In the United States, region-specific disturbances are most prevalent in non-traded goods sectors such as services and construction. By contrast, country-specific disturbances in the EU are important in traded

goods sectors. This suggests that external disturbances may be an important source of country-specific shocks in the EU.[19]

6. Labor Market Adjustment

Thus far, we have analyzed the nature of disturbances to disaggregated output growth. An equally important issue is how economies respond to such disturbances. In particular, we focus on the degree of integration and nature of adjustment of labor markets in the United States and the EU by considering the determinants of long-term trends in output, employment, and productivity. These trends are decomposed into sectoral and regional components. If labor markets are highly integrated across regions, implying an absence of wage differentials, the levels of productivity should be independent of regional effects (assuming, as seems reasonable, that the same technology is used in a given industry across all regions). Hence, if trends in productivity primarily reflect the fortunes of particular industries, this would imply relatively more integrated labor markets. By contrast, if such underlying productivity trends are primarily regional, this would imply a low level of labor market integration.

The relative importance of regional and industrial disturbances in employment trends, on the other hand, indicates the degree to which labor markets equilibrate through firms moving to regions of excess labor supply (region-specific effects) or labor moving to expanding industries (industry-specific effects). Hence, the productivity regressions measure the integration of labor markets, while the employment regressions measure how the labor market adjustment that does occur is achieved.

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[19] Although this issue is beyond the scope of this paper, we ran some simple regressions of the disturbances on various measures of real exchange rate changes. Our preliminary results indicate no clear evidence of any relation between exchange rate changes and the estimated disturbances.

The underlying econometric approach is similar to that used to examine disturbances, except that the time dimension is excluded. The sample averages for each of the relevant variables (level of productivity and rates of growth of output, employment, and productivity) were calculated for each region and sector.[20] For each of these variables, equation (2) was then estimated over the full sample (1972-89 for the United States and 1971-87 for the EU) and then over two sub-samples: the 1970s and the 1980s.

Table 5 reports the results from the full sample. In the United States, the full regression explains over 80 percent of the variation in average rates of output growth over the 1972-89 period. Four-fifths of the explanatory power comes from the industrial dummies and one-fifth from the regional dummies. The performance of an industry within a region appears much more closely related to the overall performance of that industry rather than the performance of that region. In short, industrial structure can go a long way in explaining relative performance across regions.

The results for both levels and changes in productivity indicate that the contribution of the regional dummies to the overall regression is very small and, hence, that U.S. labor markets are highly integrated, at least over long time spans. Of the 97 percent of variation explained by the regression for productivity levels, the industrial dummy variables account for 94 percentage points, regional dummy variables a mere 2 percentage points, with the remaining 1 percentage point being unallocatable.[21] Despite the low level of

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[20] Levels of productivity were measured as the average of the logarithm of output per worker.

[21] Because there are some missing values, the two sets of dummy variables are not exactly orthogonal. Hence, some of the variance can be explained by either. The reported values are the marginal contributions of each set of dummy variables to the overall explanatory power, measured as the increase in the R-squared that occurs when these variables are included in a regression already containing the other explanatory variables.

explanatory power, an F-test indicates that the regional dummies are jointly significant at conventional levels.

The regressions for productivity growth show a similar pattern. Of the total explanatory power of 89 percentage points, the contributions of the industrial and regional dummy variables are 83 percentage points and 1 percentage point, respectively. Unlike the productivity levels regressions, however, the regional dummy variables are not jointly significant in this case.

The regressions using employment growth indicate a larger, although still subsidiary, role for regional factors. Slightly over one quarter of the total explanatory power in the regression comes from the regional dummy variables, with almost all of the remainder being attributable to their sectoral counterparts. The implication is that the majority of economic adjustment occurs through movements of labor to regions with expanding industries, rather than movements of expanding industries to regions with excess labor. In short, regional labor market migrations of the type emphasized by Blanchard and Katz (1992) do appear to be the predominant form of regional adjustment in the United States.

The results from the regressions for output and productivity growth for the EU are strikingly different. Although the regression for average output growth has about the same explanatory power as in the case of the United States, the relative contribution of country-specific factors is about four times that of the industry dummies, the reverse of the result for the United States. In the EU, the correlation of average output growth is much higher across industries within a given country than across countries for a particular industry.

The productivity regressions suggest that labor markets are far less integrated in the EU than in the United States. The regression using productivity levels shows that country-specific factors have a far more important role in this regression than in its U.S. counterpart. In the regression using the growth in productivity, more than three-quarters of

the total explanatory power of the regression is attributable to country-specific dummies. Unlike in the United States, long-term trends in productivity in the EU appear to be overwhelmingly determined by national performance, rather than industrial factors.

The employment regression shows that country-specific factors play a very small role in explaining differences in long-term employment growth. As in the case of the United States, this implies that long-term trends in employment are primarily determined by industrial factors. However, as the productivity growth regressions indicate that labor markets in the EU are not highly integrated across national borders, the interpretation of these results is different. Unlike in the United States, this inter-sectoral reallocation of labor appears to operate only within, not across, EU countries.

Finally, we examine whether the patterns that exist over the full 1972-89 period can also be identified over somewhat shorter periods by repeating the analysis for two sub-periods, 1972-79 and 1980-89.[22] The results are reported in Table 6. In the United States, the regressions over shorter time periods confirm the lack of importance of regional factors in explaining either levels or changes in productivity. On the other hand, regional factors are generally more important in explaining changes in output and employment over these sub-periods than over the full time period. This may well reflect the slow pace of labor market adjustment. If labor market adjustment is a gradual process, then the importance of regional factors would decline over time. For the EU, the sub-sample results were very similar to the full sample results, suggesting that, from 1970 to 1987, there were no significant structural changes that affected the degree of integration of labor markets.

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[22] Other sub-periods, not reported, showed broadly similar results. For the EU, data availability limited the analysis in the second sub-period to 1980-87.

## 7. Conclusions

This paper has analyzed the effects of a currency union on the relative importance of different types of shocks to output growth and also the labor market mechanisms by which economies adjust to these shocks. We constructed two comparable datasets for United States regions and eight European countries with data on output, employment, and productivity at the 1-digit sectoral level. Although the two datasets are similar in many respects, the crucial difference is the fact the U.S. regions are part of a currency union while the European countries are not.

For the full sample, the relative importance of aggregate, industry-specific, and country- or region-specific shocks in explaining output growth fluctuations is roughly similar in Europe and the United States, with each of these types of shocks playing an important role.[23] A more disaggregated analysis of the sources of disturbances at the sectoral level, however, indicates that region-specific disturbances in the United States are more important in non-traded goods sectors while in the EU country-specific disturbances are more prevalent in traded goods sectors.

The major difference between the United States and the EU is in the nature of labor market adjustment to shocks. Our results indicate that productivity trends are dominated by industry-specific factors in the United States and by country-specific factors in the EU. These results appear to confirm other evidence that the United States has a much more integrated labor market, either because of, or reflecting, the single currency.

Our regressions for long-term employment growth in the United States produced results consistent with the findings of Blanchard and Katz (1992) that inter-regional flows of labor constitute an important adjustment mechanism in the U.S. labor market. In

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[23] The importance of regional disturbances even in the U.S. implies that the exchange rate could continue to be a potentially important tool in reducing disturbances.

Europe, while flows of labor across sectors within countries may be important, labor flows across countries do not seem to be an important adjustment mechanism. This implies that large wage differentials across European countries could remain after EMU. In addition, unless labor mobility across European countries is enhanced, wage differentials across countries will have to remain flexible if significant disruptions from country-specific disturbances are to be avoided in EMU.

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Table 1. Comparison of the Industrial Classifications

| Classification | United States Regions | European Countries |
|---|---|---|
| Primary | Agriculture, Forestry and Fisheries plus Mining | Agriculture, Hunting, Forestry and Fishing plus Mining and Quarrying |
| Construction | Construction | Construction |
| Manufacturing | Manufacturing | Manufacturing |
| Transportation | Transportation and Public Utilities | Transport, Storage and Communication plus Electricity, Gas and Water |
| Trade | Wholesale Trade plus Retail Trade | Wholesale and Retail Trade, Restaurants and Hotels |
| Finance | Finance, Insurance and Real Estate | Finance, Insurance, Real Estate and Business Services |
| Services | Services | Community, Social and Personal Services |
| Government | Government | Government Services |

Table 2. Output Shares

| U.S. Regions | Industry | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | PRM | CTN | MFR | TSP | TRD | FIN | SVC | GVT | |
| New England | .01 | .05 | .26 | .08 | .16 | .17 | .17 | .11 | .06 |
| Mid East | .01 | .05 | .21 | .10 | .16 | .17 | .17 | .13 | .20 |
| Great Lakes | .03 | .04 | .31 | .09 | .16 | .14 | .13 | .09 | .18 |
| Plains | .10 | .05 | .21 | .10 | .17 | .15 | .13 | .10 | .07 |
| South East | .09 | .06 | .21 | .09 | .16 | .13 | .12 | .13 | .20 |
| South West | .22 | .06 | .15 | .09 | .14 | .12 | .11 | .10 | .11 |
| Rocky Mts. | .15 | .07 | .13 | .11 | .15 | .14 | .13 | .13 | .03 |
| Far West | .05 | .05 | .19 | .08 | .17 | .16 | .17 | .13 | .15 |
| Mean | .08 | .05 | .21 | .09 | .16 | .15 | .14 | .12 | |
| Coeff. var. | .87 | .15 | .28 | .11 | .06 | .12 | .17 | .14 | |

| EU Country | Industry | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | PRM | CTN | MFR | TSP | TRD | FIN | SVC | GVT | |
| Austria | .04 | .09 | .29 | .09 | .17 | .15 | .04 | .15 | .04 |
| Belgium | .03 | .07 | .23 | .11 | .19 | .07 | .16 | .14 | .05 |
| Denmark | .08 | .07 | .19 | .09 | .16 | .17 | .05 | .20 | .03 |
| Germany | .03 | .07 | .35 | .08 | .11 | .12 | .12 | .12 | .36 |
| Greece | .16 | .05 | .20 | .13 | .13 | .08 | .13 | .12 | .03 |
| Italy | .05 | .08 | .24 | .11 | .19 | .12 | .09 | .13 | .24 |
| Netherlands | .13 | .06 | .20 | .08 | .13 | .16 | .11 | .13 | .08 |
| U.K. | .07 | .06 | .26 | .10 | .13 | .19 | .05 | .15 | .18 |
| Mean | .06 | .07 | .28 | .09 | .14 | .14 | .09 | .13 | |
| Coeff. var. | .67 | .19 | .22 | .17 | .21 | .32 | .48 | .20 | |

Notes: The totals in the last column indicate the average share of each region (or country) in total U.S. (or EU) output. The means and the coefficients of variation for industry output shares are reported in the last two rows of each panel.

Table 3. Decomposition of Short-Term Fluctuations

Estimating Equation: $\Delta \ln(y_{i,j,t}) = \alpha_{i,t} + \beta_{j,t} + \Psi_t + \epsilon_{i,j,t}$

| | United States Regions | | | | | European Countries | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $R^2$ due to various shocks: | | | | | $R^2$ due to various shocks: | | | |
| | Total | Agg. | Ind. | Reg. | | Total | Agg. | Ind. | Cou. |
| All | **.73** | **.29** | **.25** | **.19** | | **.52** | **.19** | **.18** | **.16** |
| | | | | | | | | | |
| Primary | .43 | .00 | .39 | .17 | | .26 | .00 | .31 | .08 |
| Construct | .80 | .36 | .11 | .34 | | .51 | .17 | .19 | .16 |
| Manufact. | .83 | .67 | .24 | .00 | | .71 | .38 | .15 | .19 |
| Transport | .81 | .45 | .31 | .06 | | .69 | .28 | .13 | .28 |
| Trade | .94 | .41 | .37 | .16 | | .62 | .28 | .07 | .28 |
| Finance | .61 | .13 | .16 | .33 | | .56 | .34 | .07 | .15 |
| Services | .85 | .49 | .11 | .26 | | .27 | .00 | .20 | .09 |
| Gov'nment | .54 | .00 | .33 | .28 | | .55 | .21 | .32 | .02 |
| | | | | | | | | | |
| New Eng | .70 | .30 | .08 | .31 | Austria | .53 | .20 | .23 | .10 |
| Mid East | .75 | .26 | .22 | .27 | Belgum | .54 | .19 | .19 | .16 |
| Grt Lakes | .77 | .39 | .30 | .08 | Denmrk | .50 | .11 | .27 | .12 |
| Plains | .69 | .29 | .33 | .08 | Germny | .62 | .33 | .20 | .09 |
| South E | .80 | .43 | .32 | .04 | Greece | .57 | .27 | .11 | .19 |
| South W | .68 | .16 | .18 | .34 | Italy | .45 | .22 | .13 | .10 |
| Rocky Mts | .72 | .15 | .26 | .31 | Nthlnd | .49 | .21 | .22 | .07 |
| Far West | .73 | .33 | .32 | .08 | U.K. | .48 | .00 | .06 | .41 |

| Table 4a. Correlations with the Aggregate Disturbance (Correlation Coefficients) | | |
|---|---|---|
| Industry | U.S. | EU |
| | | |
| Primary | -0.62* | -0.66* |
| Construction | 0.20 | -0.07 |
| Manufacturing | 0.73* | 0.56* |
| Transportation | 0.18 | 0.30 |
| Trade | -0.38 | 0.39 |
| Finance | 0.59* | 0.65* |
| Services | -0.59* | -0.49* |
| Government | 0.27 | 0.04 |

| Table 4b. Correlations with the Aggregate Disturbance (Correlation Coefficients) | | | |
|---|---|---|---|
| U.S. Regions | | EU Countries | |
| New England | 0.02 | Austria | 0.05 |
| Mid East | -0.05 | Belgium | -0.02 |
| Great Lakes | 0.35 | Denmark | -0.27 |
| Plains | 0.00 | Germany | 0.53* |
| South East | 0.63* | Greece | 0.20 |
| South West | -0.21 | Italy | 0.12 |
| Rocky Mountains | -0.23 | Netherlands | 0.09 |
| Far West | 0.12 | United Kingdom | -0.34 |

Notes: An asterisk (*) indicates that the correlation coefficient is significant at the 5 percent level. Under the null hypothesis that the true correlation coefficient is zero, the approximate standard error of these coefficients is 0.24.

Table 5. Long-Term Adjustment: 1972-89

Estimating Equation: $\Delta \ln(z_{i,j}) = \alpha_i + \beta_j + \epsilon_{i,j}$

| | United States Regions | | | | European Countries | | |
|---|---|---|---|---|---|---|---|
| | $R^2$ due to: | | | | $R^2$ due to: | | |
| | Total | Ind. | Reg. | | Tot. | Ind. | Cou. |
| Output | .82 | .66 | .16 | | .77 | .15 | .61 |
| Output per Worker | .89 | .83 | .01 | | .83 | .19 | .64 |
| Level of Output per Worker | .97 | .94 | .02 | | .75 | .50 | .25 |
| Employment | .89 | .63 | .24 | | .69 | .61 | .08 |

Table 6. Long-Term Adjustment

Estimating Equation: $\Delta \ln(z_{i,j}) = \alpha_i + \beta_j + \epsilon_{i,j}$

| | United States Regions | | | | European Countries | | |
|---|---|---|---|---|---|---|---|
| | $R^2$ due to: | | | | $R^2$ due to: | | |
| | Total | Ind. | Reg. | | Tot. | Ind. | Cou. |
| | 1972-79 | | | | | | |
| Output | .80 | .43 | .37 | | .59 | .07 | .52 |
| Output per Worker | .90 | .88 | .01 | | .75 | .20 | .55 |
| Level of Output per Worker | .95 | .93 | .03 | | .78 | .38 | .40 |
| Employment | .85 | .23 | .52 | | .50 | .44 | .06 |
| | 1980-89 | | | | | | |
| Output | .62 | .34 | .28 | | .69 | .26 | .43 |
| Output per Worker | .82 | .74 | .05 | | .70 | .13 | .58 |
| Level of Output per Worker | .98 | .96 | .02 | | .72 | .62 | .10 |
| Employment | .79 | .70 | .09 | | .74 | .64 | .11 |

Note: For the European countries, the sample ends in 1987.