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COMMON TRENDS AND COMMON CYCLES IN REGIONAL PER CAPITA INCOMES

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ABSTRACT

Cyclical dynamics at the regional level are investigated using newly developed time-series techniques that allow a decomposition of aggregate data into common trends and common cycles. We apply the common-trend/common-cycle representation to per capita personal income for the eight BEA regions using quarterly data for the 1948:1-93:4 period. Our analysis reveals considerable differences in the volatility of regional cycles. Controlling for differences in volatility, we find a great deal of comovement in the cyclical response of four regions (New England, Mideast, Great Lakes, and Southeast), which we call the core region, and the nation. We find some evidence of comovement of the Plains, Rocky Mountain, and Far West regions and the nation, but to a much less extent than the comovement among the core regions and the nation. Finally, the cyclical response of the Southwest region is strongly negatively correlated with that of all the other regions and the nation.

The nation is made up of diverse regions that are linked but that respond differently to changing economic circumstances. For example, the large declines in crude oil prices in the mid-1980s affected the energy-producing Southwest region very differently from the energy-consuming regions. There are other examples of regional differences. Hoskins (1991) points out that in the 1980s, the farming states, the energy states, and then manufacturing in the midwestern states all experienced downturns while the national economy was expanding. Indeed, the terms "rolling recovery" and "bi-coastal recession" have already entered the business vocabulary and suggest that the timing and perhaps the magnitude of ups and downs in economic activity vary across regions.

In this paper we investigate cyclical dynamics at the regional level using the common-trend, common-cycle methods recently developed in Vahid and Engle (1993), Engle and Kozicki (1993), and Engle and Issler (1995). In this framework, common trends arise from cointegration among a set of integrated variables, while common cycles arise from serial correlation of common features. Under the condition that the dimensions of the cointegration space and the cofeature space sum to the number of variables in the system, a clean decomposition of integrated series into trend and cycle components can be achieved without requiring the imposition of extraneous identifying assumptions.

We apply the common-trends/common-cycle representation to real per capita personal income for the Bureau of Economic Analysis (BEA) regions using quarterly data for the 1948:1-93:4 period. Our empirical analysis suggests that the eight regions share four common stochastic trends and four common cycles. We focus our attention largely on the cyclical components of the series and investigate the extent to which regional cycles are similar in amplitude, duration, and timing.

We find quite similar long-run trends across regions, but quite different cyclical behavior. Our analysis reveals considerable differences in the volatility of regional cycles. The cyclical component in the most volatile region (Great Lakes) is more than six times as great as in the least volatile region (Far West). Per capita income in the New England, Mideast, Great Lakes, Plains, and Rocky Mountain regions tends to be more volatile than the national average. Per capita income in the Southeast, Southwest, and Far West regions tends to be less volatile than the national average.

Controlling for differences in volatility, we find a great deal of comovement in the cyclical response of four regions (New England, Mideast, Great Lakes, and Southeast), which we refer to as the core region, and the nation. We find some evidence of comovement of the Plains, Rocky Mountain, and Far West regions and the nation, but to a much less extent than the comovement among the core regions and the nation. Finally, the cyclical response of the Southwest region is strongly negatively correlated with that of all the other regions and the nation. We think this has to do with the conflicting interest of the oil-producing region (the Southwest) and the other oil-consuming regions.

Sources of Business Cycle Differences Across Regions

There are a number of reason why business cycles might differ across regions and from national business cycles. Some regions may react more strongly than others to nationwide forces such as changes in consumer and business confidence and changes in monetary and fiscal policies and to technology shocks. For example, Carlino and DeFina (1996) show that regions respond quite differently to monetary policy shocks. Another avenue for differential responses is through regional specialization of production coupled with industry specific innovations. As Figure 1 shows, industry mix differs widely across regions. For example, manufacturing, which is a cycle-sensitive sector, accounted for 27 percent of real gross state product (GSP) in the Great Lakes region, on average, during the 1985-90 period, but less than 13 percent of the Rocky Mountain region's real GSP. The shares of real GSP attributable to other important sectors, such as trade, fire insurance and real estate (FIRE), services, and government, also varied across regions during this period, although to a lesser extent than in manufacturing. Compounding these differences are interregional input-output relationships, which can transmit localized responses differently across regions.

Regional differences in the proportion of large and small firms could also lead to different regional responses to shocks. For example, large firms often produce goods for a national or international market, whereas small firms tend to supply localized markets. Local shocks, such as blizzards, droughts, or earthquakes, would tend to have a larger impact on the affected region's small firms than on its large firms, which produce for geographically broader markets. To the extent that some regions have a relatively large share of small firms, these regions may be more responsive to localized innovations than regions containing a relatively large share of large firms. Moreover, the demand faced by larger firms that produce for both national and international markets may change less as a result of shocks that are common across regions than the demand for the products of smaller firms producing largely for the domestic marketplace.

As Figure 2 shows, the percentage of small firms (defined as regional firms with fewer than 500 employees) varies widely across regions. It ranges from a low of 66 to 67 percent in the New England, Mideast, and Great Lakes regions to a high of about 82 percent in the Rocky Mountain region.

These forces, when combined, will most likely lead to cyclical differences across regions. The magnitude of idiosyncratic shocks relative to shocks common across regions determines the extent to which regional patterns will be similar. This paper shows that diversity in regional cyclical patterns is fairly pervasive.

Literature Review[1]

Sherwood-Call (1988) and Cromwell (1992) have used VAR methods to analyze comovements among selected western regional states. The

[1]The review in this section is meant to be suggestive rather than exhaustive. The interested reader should consult the papers cited in this section for more complete lists of references.

goal of the Sherwood-Call and Cromwell papers is to explore the extent to which fluctuations in the growth of personal income (Sherwood-Call) and fluctuations in employment growth (Cromwell) in western states are driven by idiosyncratic elements or by comovement with California (the largest western state). They find that the economy of California has important spillover effects on other western states.

Carlino and DeFina (1995) extend the work of Sherwood-Call (1988) and Cromwell (1992) by developing a VAR analysis of the linkages in per capita income growth among all U.S. regions. Carlino and DeFina find a high degree of comovement among the U.S. regions and that the codependence tends to be geographically dispersed. While the papers by Sherwood-Call, Cromwell, and Carlino and DeFina are interesting, the analysis in these papers is not based on a trend-cycle decomposition. That is, the analysis in these papers looks at fluctuations in regional growth rather than to fluctuations of detrended levels.

A number of recent papers have looked at regional labor market dynamics [Blanchard and Katz (1992); Decressin and Fatas (1995), and Davis, Loungani and Mahidhara (1996)]. The papers by Blanchard and Katz (1992) and Decressin and Fatas (1995) analyze how regional labor markets adjust to shocks. Blanchard and Katz find that shocks permanently alter the level of employment, but not its growth rate. They also find that shocks to unemployment rates are temporary. Blanchard and Katz and Decressin and Fatas (for their U.S. sample) find that the adjustment mechanism is via labor mobility, rather than job migration or job creation.

Finally, a number of recent studies have looked at cyclical behavior at the sectoral level [Loungani and Rogerson (1989); Romer (1991); Engle and Issler (1995); and Petersen and Strongin (1996)]. Loungani and Rogerson find that the general outflow from goods-producing industries to services accelerates during recessions. Petersen and Strongin find that durable-goods industries are about three times more cyclical than nondurable goods industries. The sectoral study by Engle and Issler is most closely related to ours. They look at the degree of short-run and long-run comovement in U.S. sectoral output using a special trend-cycle decomposition. They find very different behavior for trends, but they find quite similar cyclical behavior among the one-digit industries during the postwar period.

The Empirical Model

In this section we discuss a method for analyzing common trends and common cycles in a multivariate time series system. Common trends are identified using cointegration analysis. As in Engle and Kozicki (1993), common cycles are identified as serial correlation common features. Under certain circumstances, there is a unique decomposition of a vector time series into trend and cycle components using the cointegration and cofeature bases. This decomposition is discussed fully in Vahid and Engle (1993). A brief summary of their method is provided in this section.

Let y_t denote an Nx1 vector of I(1) variables whose first differences Δy_t follow an autoregressive process. The elements of y_t are cointegrated if there exists a linear combination of them that is I(0). There can exist $r<N$ independent cointegrating combinations. The elements of Δy_t have a serial correlation common feature if there exists a linear combination of them that is an innovation with respect to the information set available at time t. In other words, if there exists a linear combination of the Δy_t's that is serially uncorrelated, then a serial correlation common feature is present. There can exist $s<N$ linearly independent cofeature vectors.

Assuming that Δy_t is I(0), we have the Wold moving average representation:

$$\Delta y_t = \mu + C(L)\varepsilon_t.$$

The multivariate Beveridge-Nelson decomposition of y_t into a permanent and transitory component is given by:

$$y_t = C(1)\ \textstyle\sum_{s=0}^{\infty}\varepsilon_{t-s} + C^*(L)\varepsilon_t$$

where $C^*_i = -\sum_{j>i}C_j$. If we stack the cointegrating vectors into an Nxr matrix α, then $\alpha' y_t = \alpha' C^*(L)\varepsilon_t$, a stationary vector. Consider the existence of an Nxs matrix $\tilde{\alpha}$ that eliminates the cyclical component of y_t. It would have to be the case that $\tilde{\alpha}' C^*_i = 0$ for all $i\geq 0$. But from the definition of C^*_i, this implies that $\tilde{\alpha}$ is orthogonal to all the C_i's apart from the identity matrix C_0. Thus, the matrix $\tilde{\alpha}$ eliminates all serial correlation in the vector Δy_t, that is $\tilde{\alpha}'\Delta y_t = \tilde{\alpha}\mu + \tilde{\alpha}'\varepsilon_t$. The matrix $\tilde{\alpha}$ then is a matrix of cofeature vectors.

Vahid and Engle (1993) show that if there are s linearly independent cofeature vectors, there exists a full column rank Nx(N-s) matrix F such that $C^*(L)\varepsilon_t = F\tilde{c}_t$ so that the N-element cycle $C^*(L)\varepsilon_t$ can be expressed as a linear combination of the N-s element cycle $\tilde{c}_t$. This is the sense in which the vector series y_t is said to have common cycles. These results are summarized in proposition 2 of Vahid and Engle:

> **Proposition 2 (Vahid and Engle (1993)):** *If there exist s linearly independent linear combinations of the elements of a set of N I(1) variables which are random walks, then those variables must share N-s common cycles.*

Another important result for the purposes of this paper is theorem 1 in Vahid and Engle:

> **Theorem 1 (Vahid and Engle (1993)):** *If y_t is an N-vector of I(1) variables with r linearly independent cointegrating vectors (r<N), then if elements of y_t have common cycles, there can, at most, exist N-r linearly independent cofeature vectors that eliminate the common cycles. Moreover, these linear combinations must be linearly independent of the cointegration vectors.*

A special case occurs when there exists r linearly independent cointegrating vectors and N-r linearly independent cofeature vectors. Theorem 1 indicates that the two sets of vectors are independent and thus span the space $\mathbf{R}^n$ so that the trend and cycle components of y_t can be recovered:

$$\alpha' y_t = \alpha' F\tilde{c}_t \equiv z_t$$
$$\tilde{\alpha}' y_t = \tilde{\alpha}' C(1) \textstyle\sum_{s=0}^{\infty}\varepsilon_{t-s} \equiv w_t .$$

Defining the NxN matrix $\mathbf{A} = [\tilde{\alpha}' \; \alpha]'$, $\mathbf{A}$ will have full rank in this special case, and will thus have an inverse $\mathbf{A}^{-1} = [\tilde{\alpha}^{-} \mid \alpha^{-}]$. The trend-cycle decomposition of y_t follows from:

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\begin{aligned}
y_t = \mathbf{A}^{-1}\mathbf{A}y_t &= \tilde{\alpha}^{-}w_t + \alpha^{-}z_t \\
&= \tilde{\alpha}^{-}\tilde{\alpha}'y_t + \alpha^{-}\alpha'y_t \\
&= \text{trend} + \text{cycle}
\end{aligned}
$$

To decompose the data into trend and cycle components we proceed in two steps. First, we estimate the cointegrating rank of the eight-region system using the method of Johansen (1988, 1991). Once the cointegrating rank is determined, an error-correction (EC) model is formed with the number of EC terms restricted to equal the cointegrating rank. Write the generic form of the VECM model as:

$$\Delta y_t = ß\alpha' y_{t-1} + A(L)\Delta y_{t-1} + \varepsilon_t$$

where y_t is an Nx1 vector, and $\alpha' y_t$ are the cointegrating relationships. Following Engle and Issler (1995), the rank of the cofeature matrix is estimated using canonical correlation analysis. Since the vector $z_t = \{\alpha' y_{t-1}, \Delta y_{t-1}, \ldots \Delta y_{t-k}\}$ represents the relevant past, we search for linear combinations of the elements of Δy_t that are uncorrelated with z_t. Thus, we compute canonical correlations between Δy_t and z_t. The statistically zero canonical correlations represent linear combinations of the elements of Δy_t that are uncorrelated with all linear combinations of z_t. The cofeature rank, denoted s, is the number of canonical correlations that are statistically different from zero and the number of common cycles is N-s. Note also that if the cointegration rank is given by r, then s ≤ N-r.

Data. Our study uses quarterly data on real per capita personal income (logs) by major BEA region for the 1948:1 to 1993:4 period (sse Appendix A for regional definitions).[2] As Figure 3 shows, while real regional personal incomes are trending upward through time, they do not drift too far apart. This suggests that the regional income data may share a common long-run trend and thus may be cointegrated.

The average annualized quarterly growth rates of real per capita personal income are reported in Figure 4, along with the minimum and maximum quarterly growth rates for each region. Real per capita income growth varied widely across regions, ranging from a low of 1.7 percent in the Great Lakes region to a high of about 2.6 percent in the Southeast regions. Despite the seeming differences, the 95 percent confidence intervals for the estimated means are overlapping, suggesting that the average growth rates are probably not statistically different.[3] The standard deviation of real per capita income growth by region, reported in the last

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[2]Real incomes are calculated by deflating each region's nominal income with the national Consumer Price Index. Ideally, regional incomes should be deflated using regional price deflators. However, such deflators are not available. Consumer price indexes do exist for many of the metropolitan areas in the various regions. We found a high degree of correlation in consumer price inflation across these metropolitan areas during the 1958:1 to 1986:4 period.

[3]Our conclusion that the long-run growth rates of regional per capita incomes are equalized across regions is consistent with the findings of conditional convergence of U.S. regional per capita incomes reported by Barro and Sala-i-Martin (1992) and Carlino and Mills (1993). Conditional convergence is consistent with the data shown in Figure 3 of this paper.

column of Figure 4, reveal significant cross-regional differences. Real per capita income growth variance in the most volatile region (Plains) is 75 percent greater than in the least volatile regions (New England and Mideast). Indeed, the 95 percent confidence interval for the Plains does not overlap with the confidence intervals from any of the other regions. Finally, Figure 5 shows that real per capita income growth is highly correlated among regions.[4]

Unit root tests. The variables used in the estimation must be stationary so that standard statistical theory applies. We use an augmented Dickey Fuller (ADF) test to check for stationarity in the level [equation (1a)] and growth rate of regional real per capita income [equation (1b)]. Allowing for a constant and deterministic trend in the level and a constant in growth of real per capita income, the ADF equations to be estimated are:

$$\Delta z_t = a + bt + \alpha z_{t-1} + \sum_{i=1}^{k} \beta_i \Delta z_{t-1} + \varepsilon_t \qquad (1a)$$

where z_t refers to the level of regional real per capita income; and,

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[4]Alternative variables for measuring regional economic activity are labor market variables such as employment and unemployment rates and output measures such as Gross State Product (GSP). A consistent series on employment and unemployment rates at the regional level is available only from 1958, and GSP data are available only from 1963. In contrast, quarterly personal income data at the regional level are available beginning in 1948, spanning nine business cycles compared with only six business cycles in the employment series and five cycles in the GSP data. In addition, real GSP data are published only on an annual basis and, as such, are not well suited to analysis of regional business cycles.

$$\Delta y_t = a + \alpha y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-1} + \varepsilon_t \tag{1b}$$

where y_t refers to the growth rate of regional real per capita income.[5] Since y_t is calculated as a log difference (and, thus, as a growth rate), estimating equation (1b) amounts to regressing the second difference of regional real per capita income on a constant, the lagged first difference of regional real per capita income, and the k-lags of the difference of regional real per capita income. We found that k = 6 employs enough lags to remove serial correlation from both equations.

Estimating (1a) or (1b) and testing α=0 are the ADF test for the unit root in the data series of interest. If α=0, then the series tested contains a unit root and, hence, is nonstationary. Figure 6 presents the estimated τ-statistics for each region's α coefficient. A τ-statistic of at least -3.50 is needed to reject the unit root null at the 5 percent level of significance and a τ-statistic of at least -4.15 is needed to reject at the 1 percent level (Fuller, 1976). Figure 6 also includes the estimated τ-statistics for the Phillips-Perron (PP) unit root tests.

As Figure 6 shows, the unit root null cannot be rejected for the level of regional real per capita income using either the ADF or PP tests, although stationarity is achieved by first-differencing. Thus, the VARs to be estimated include the

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[5] We also conducted the ADF test dropping the trend and then dropping both the constant and the trend terms. These alternative specifications do not alter any conclusions concerning stationarity.

stationary first differences of regional real per capita income.[6]

<u>Test for cointegration and common features</u>. The maximum likelihood method developed by Johansen (1988, 1991) and Johansen and Juselius (1990) is used to test for cointegration and to estimate the error correction model. Figures 7a and 7b report the test for cointegrated relations among regional real per capita income variables. We test for the number of cointegration vectors when a time trend is excluded (Figure 7a) and when a time trend is included (Figure 7b) in the vector error correction model (VECM). In addition, the VECM are run with and without the relative price of energy entered as an exogenous variable (oil). A constant term is included in all versions to account for the possibility of a deterministic trend in the series. Two tests are used to evaluate the rank of the cointegration space for the eight-region system. The first test is the Johansen likelihood ratio trace test:

$$\begin{aligned}\text{Likelihood ratio trace} &= -2\ln Q(H_1(r)\,|\,H_1(p)) \\ &= -T\textstyle\sum_{i=r+1}^{p}\ln(1 - \hat{\lambda}_i).\end{aligned}$$

where p is the number of variables in the system, r is the largest number of cointegrating vectors under the null hypothesis, and the $\hat{\lambda}_i$ are the p - r smallest eigenvalues. The null hypothesis is that there are at most r cointegrating relations present in the system, implying at least p - r unit roots.

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[6]Figure 6 also reports the findings of the ADF and PP unit-root tests for a relative price energy variable, since it will be used in subsequent analysis. Both tests suggest that this variable must be first-differenced to achieve stationarity.

The second test we use is the λmax statistic, which is based on the comparison of $H_1(r)$ given $H_1(r+1)$:[7]

$$\lambda max = -2\ln Q(H_1(r)|H_1(r+1)) = -T\ln(1 - \hat{\lambda}_{r+1})$$

The values in each column of Figures 7a and 7b pertain to the null hypothesis that the number of cointegrating vectors is $r \leq k$, against the alternative hypothesis that $r > k$. The results in Figure 7a indicate four cointegrating relationships and hence four common trends among the eight regions using the λmax statistic without a time trend. The estimated rank of the cointegration space is the same whether or not the relative price of energy variable is included in the VECM. The trace statistic results (Figure 7b) indicate that the rank of the cointegration space is between four and five. To avoid the risk of falsely rejecting the null, we opted for identifying the rank of the cointegration space as four, consistent with the λ_{max} statistic results and suggesting that the eight BEA regions share four common stochastic trends. The presence of common long-run trends in the regional data could arise from factors such as national economic policy or perhaps common productivity shocks.

The VECM was re-estimated, imposing the restriction that there are four cointegration terms in the system. A canonical correlation analysis was then conducted between the vector Δy_t and the vector $w_t = \{\beta' y_t, \Delta y_{t-1}, \ldots, \Delta y_{t-6}\}$. As mentioned above, the

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[7]A full discussion of the two test statistics is given in Johansen and Juselius (1990).

canonical correlations that are statistically different from zero represent linear combinations of Δy_t that are uncorrelated with the past information set. The squared canonical correlations and the associated values of the F-test for the dimension of the cofeature space are given in Figure 8.[8] We test the cofeature rank when a time trend is excluded from, and when a time trend is included in, the VECM model. In addition, the analysis was conducted with and without the relative price of energy included in the VECM. At the 5 percent level of significance, we find that the rank of the cofeature space is 4 regardless of the version of the analysis chosen. These findings indicate that the eight regions share four serial correlation common features, which suggests that the eight regions share four common cycles.[9] Given the relatively high number of common cycles, we expect to find somewhat different cyclical patterns across the eight BEA regions.

Trend-cycle decompositions Figure 9 presents the trend-cycle estimate for each of the BEA regions. The upper panels in Figure 9 show plots of the actual level of regional per capita incomes (dashed curves) and the estimated trends (solid curves). The cyclical estimates of regional per capita incomes are plotted in the lower panels of Figure 9. All panels include the NBER recession bars for reference.

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[8]The canonical correlation analysis was conducted using the CANCORR procedure available in SAS.

[9]Following Engle and Issler (1995), we use F-tests because they provide better small sample results than the usual χ^2 approximation discussed in Vahid and Engle (1993).

The percent change in the actual levels of regional per capita incomes for each of the nine postwar recessions is reported in Figure 10, which also reports the trend-cycle decompositions for each of the recessions. The 1957-58 recession is an example where both the cyclical components and trend components generally declined for all regions. For example, the 3.7 percent decline in real per capita income in the Mideast region during the 1957-58 recession consists of a 2.5 percent drop in the cyclical term and a 1.2 percent decline in the trend component. Note that in some downturns, such as the 1948-49 recession, the trend components rose, which served to lessen the magnitude of the negative cyclical movement in real per capita incomes.

The 1973-75 recession is of interest for several reasons. First, this was the most severe recession of the postwar period. With the exception of the Far West region, declines in real per capita income were larger in the 1973-75 recession than those of any other postwar recession. At the national level, real per capita income fell 6 percent during the 1973-75 recession, two-thirds greater than the 3.6 percent drop registered in the 1957-58 recession, the second largest downturn of the postwar period. Second, a comparison of the trend and cyclical components reported in Figure 10 indicates that the effects of the 1973-75 recession led to permanent declines in trend growth for all regions. This can also be seen from extrapolating the trend lines shown in Figure 9 between 1948 and 1973 out to 1993. Per capita personal incomes at the regional level never return to the earlier trends following the 1973-75 recession.

Since the focus of this paper is on regional cycles, we will focus attention on the graphs presented in the lower panels of Figure 9. These graphs reveal broad differences across regions in terms of timing, duration, and amplitude of the cyclical components. While it is difficult to make comparisons across the various graphs, the standard deviation of the cyclical components is a convenient way to summarize the volatility across regions. The first column of Figure 11 reports the standard deviation of the regional cyclical components for our entire sample period. The data reveal considerable cross-regional differences in the deviation of the cyclical components. The cyclical component in the most volatile region (Great Lakes) is more than six times as great as in the least volatile region (Far West). Per capita income in the New England, Mideast, Great Lakes, Plains, and Rocky Mountain regions tends to be more volatile than the national average. Per capita income in the Southeast, Southwest, and Far West regions tends to be less volatile than the national average.

Figure 11 reports the standard deviations for two subperiods, 1948-72 and 1973-93. With the exception of the Rocky Mountain and Far West regions, the volatility of regional per capita income dramatically increased after 1972. Specifically, volatility increased at least 50 percent in the New England, Great Lakes, Southeast, and Southwest regions.[10] The increase in volatility

[10]Real per capita income volatility fell in the Rocky Mountain regions and was unchanged in the Far West after 1972.

after 1973 may be related to the adverse oil price shock of 1979 and the back-to-back recessions of 1980-81 and 1981-82. In general, the largest cyclical declines in regional real per capita incomes occurred during this period. This can be seen by the large declines in the cyclical components in Figure 9, and by the numbers reported in the last rows of Figure 10 for the 1979-82 period. The Great Lakes region was hardest hit during this period, with its cyclical component falling 13 percent. In addition, the cyclical component for the New England, Mideast, Plains, and Southeast regions fell more than 4 percent. Increases in the trend component in the New England, Mideast, Great Lakes, and Southeast regions, however, partially offset the large cyclical declines, resulting in smaller declines in the level of real per capita incomes in these regions. While the cyclical component declined less than 2 percent in the Rocky Mountain and Far West regions, larger declines were recorded for the level of per capita personal incomes because the trend component also declined in these regions. Finally, the Southwest (an energy-producing region) was the only region to experience a cyclical expansion during the 1979-82 period.

The cyclical components of the 1990-91 recession were substantially smaller than those of the two prior recessions. With the exception of the Southwest and Rocky Mountain regions, the remaining six regions experienced permanent declines in real per capita incomes during the 1990-91 recession. In addition, four of these six regions (Mideast, Great Lakes, Southeast, and Far West) also experienced declines in their cyclical components. Only the

Rocky Mountain region experienced increases in both its trend and cycle components during the last recession.

The differences in amplitude and timing of each region's cycle and those of the national cycle are shown in the graphs in Figure 12. Figure 12 presents the cyclical component of each region relative to the national cycle (difference of logs). If the amplitude of the regional cycles is similar to that of national cycles, the plots should lie close to zero. The graphs, however, show a good deal of divergence in the cyclical patterns. This divergence supports the view that to a large extent localized events either accentuate or dampen the effect of national events on regional economies.

In spite of the differences in amplitude of regional cycles, we find a high degree of correlation of the cycle components for many regions. Figure 13 reports the simple correlation coefficients among the regional and national cyclical components. Four of the eight regions (New England, Mideast, Great Lakes, and Southeast) have correlation coefficients that in every instance are greater than .80. Moreover, the cyclical components in these four regions are highly correlated with the national cyclical component. The correlation coefficient increases from .88 and .90 for the Great Lakes and Southeast regions, respectively, to about .94 for both the New England and Mideast regions.

There is a moderate amount of correlation between the Plains and Rocky Mountain regions (correlation coefficient of .64). These regions also share a moderate correlation with national cycles.

While there is a moderate correlation between the Far West region and the nation (correlation coefficient of .69), there is essentially no correlation of the Far West region with the Plains or Rocky Mountain regions.

The data also reveal a negative correlation between the Southwest region and the nation as well as all other regions. The negative correlation is probably related to Hamilton's (1983) finding that all but one of the previous eight national recessions have been preceded by an oil price shock and that the fortunes of the Southwest region, an energy producing region, are opposite those of the energy-consuming regions.

Finally, to standardize the regional cyclical components, we divided each series by their respective standard deviations. This should approximately control for differences in amplitude of the cycles and provide an understanding of the commonality of timing and duration of regional cycles. Figure 14 presents the standardized cyclical component of the regions in three graphs. The standardized cyclical component for the nation has been included in each graph. The graph in the northwest quadrant shows the regions found to have highly codependent cycles. We refer to this grouping as the core region. Not surprisingly, this grouping consists of the same four regions (New England, Mideast, Great Lakes, and Southeast) that were found to share high correlation coefficients. While some differences in the amplitude of the regions that make up the core region remain, these regions appear to be similar with respect to turning points and the duration of their cycles.

The graph in the northeast quadrant presents the standardized cyclical component for the Plains, Rocky Mountain, and Far West regions. There is considerably less codependence of the cycles among these regions as compared to the core grouping. In addition, the timing of cycles also appears to differ for these regions relative to one another and relative to the nation. The graph in the southwest quadrant shows the standardized cyclical component for the Southwest region. Cycles in this region are mostly the mirror image of national cycles. Per capita income in the Southwest appears to be countercyclical.

Conclusion

The national economy is a composite of diverse regional sub-economies. Similarly, national business cycles are amalgams of regional cycles. The cyclical pattern provided by such aggregates as GDP, national income, employment, industrial production, and the like can mask a large amount of detail about regional cycles. This loss of regional detail may be unimportant if the divergence of regional cycles from national cycles is small. However, we find evidence of considerable divergence of regional business cycles from national cycles. The findings from the cofeature analysis indicate that the eight regions share four common cycles. This suggests we should observe somewhat different cyclical patterns across the eight BEA regions. Engle and Issler (1995) found only two idiosyncratic serially correlated common cycles in their study of the one-digit U.S. industries. This indicates quite similar cyclical patterns across industries. Juxtaposing our finding with those of Engle and Issler (1995) suggests that the divergent regional cycles that we report are due to more than just industry mix differences across regions.

Our analysis reveals considerable differences in the volatility of regional cycles. The cyclical component in the most volatile region (Great Lakes) is more than six times as great as in the least volatile region (Far West). Controlling for differences in volatility, we find a great deal of comovement in the cyclical response of four regions (New England, Mideast, Great Lakes, and Southeast) and the nation, which we refer to as the core region. We find some evidence of comovement of the Plains, Rocky Mountain, and Far West regions and the nation, but to a much less extent than the comovement among the core regions. Finally, the cyclical response of the Southwest region is strongly negatively correlated with that of all the other regions and the nation.

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Figure 1: Percent of Regional Gross State Product Accounted for by Major Industry (1985-90)[a]

Region	Agri	Mining	Const	Mfg	T&PU[b]	Trade	FIRE	Service	Govt	Pop (%ofUS)
NE	0.97	0.10	5.17	21.0	6.86	16.9	20.4	19.3	9.3	5.44
ME	0.75	0.27	4.69	16.8	9.0	16.0	21.0	19.9	11.7	18.6
GL	1.58	0.64	3.94	27.0	8.91	16.4	16.4	15.6	9.51	18.4
PL	4.80	0.88	4.07	19.6	10.0	17.3	16.7	15.3	11.3	7.57
SE	2.04	2.44	4.91	19.9	9.53	17.2	15.6	15.2	13.2	23.3
SW	1.77	7.02	4.73	15.2	10.4	17.0	16.2	15.6	12.1	9.42
RM	2.94	5.50	4.66	12.6	11.0	16.2	17.0	16.2	12.7	2.90
FW	2.33	1.62	4.88	15.8	8.1	16.7	19.3	19.1	12.2	14.4
US	1.88	1.85	4.63	19.2	9.06	16.7	17.9	17.2	11.7	-

NE = New England, ME = Mideast, GL = Great Lakes, PL = Plains, SE = Southeast, SW = Southwest, RM = Rocky Mountain, FW = Far West

[a]The percent by industry averaged over the 1985-90 period.

[b]Transportation and Public Utilities.

Source: Compiled from BEA data.

Figure 2: The Share of Total Region Employment Accounted for by a Region's Small Firms[a]

	Percent Small Firms
New England	66.2
Mideast	67.0
Great Lakes	66.5
Plains	77.1
Southeast	73.3
Southwest	76.9
Rocky Mountain	82.4
Far West	77.9

[a]Small firms are those with fewer than 500 employees in 1981.

Source: Compiled from County Business Patterns.

Figure 3: Real Per Capita Personal Income

By Region--1948:I to 1993:IV

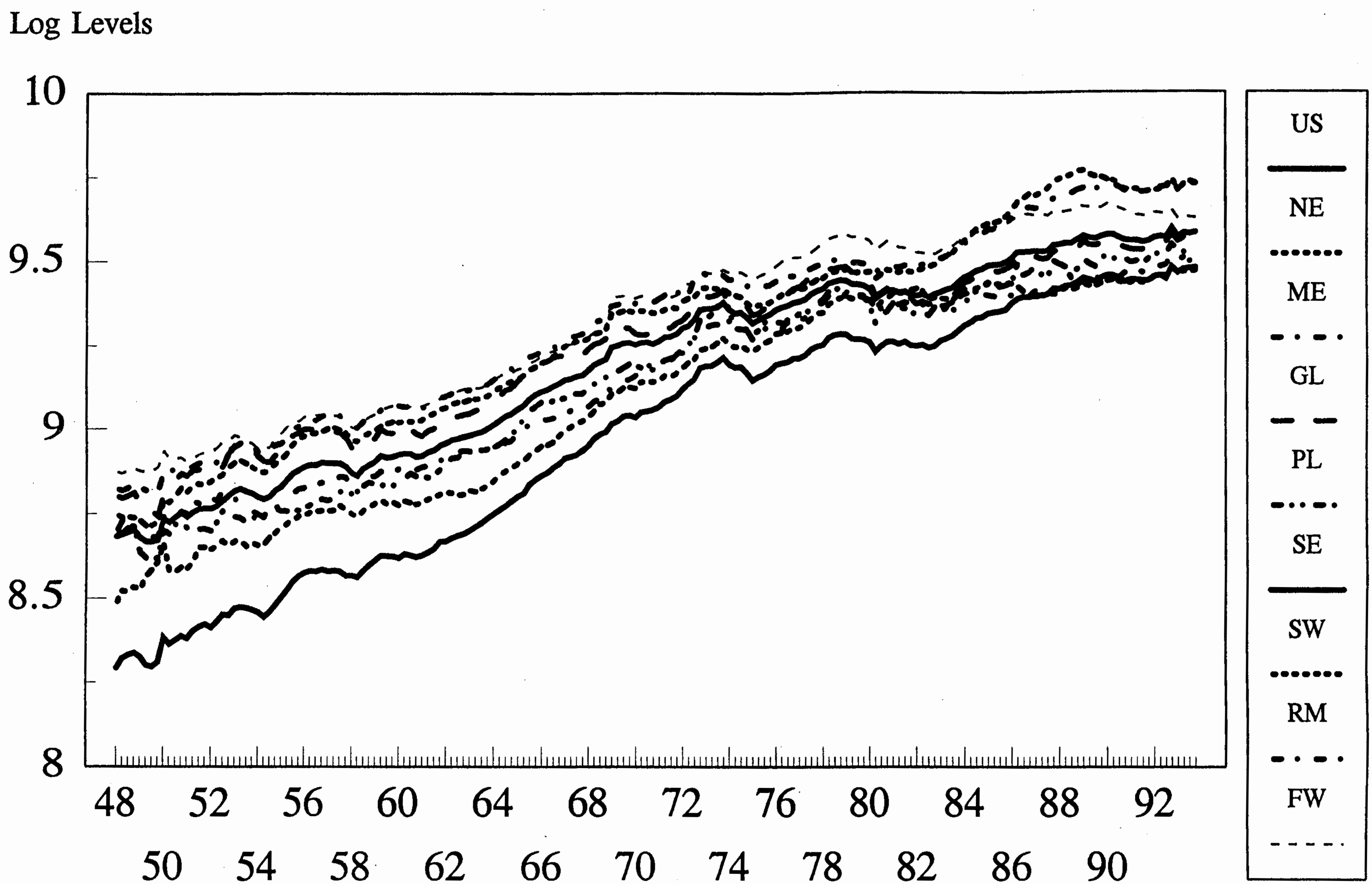


Figure 4: Summary Statistics of
Real Regional Per Capita Personal Income, 1948:1-93:4
(Average Annual Growth Rates)

REGION	Minimum	Maximum	Mean	Std Dev
United States	-11.68	25.24	1.97	4.16
New England	-13.80	24.0	2.14	4.40
Mideast	-14.80	24.40	1.98	4.36
Great Lakes	-15.30	25.44	1.69	5.36
Plains	-29.72	31.60	1.83	7.64
Southeast	-11.16	28.88	2.59	4.72
Southwest	-31.40	21.60	2.16	5.20
Rocky Mountain	-17.64	23.84	1.81	5.36
Far West	-11.80	34.88	1.65	4.64

Figure 5: Simple Correlations of Real Regional Per Capita Personal Income Growth, 1948:1-93:4

	US	NE	ME	GL	PL	SE	SW	RM
NE	0.8631							
ME	0.8601	0.8094						
GL	0.8922	0.7514	0.7365					
PL	0.6669	0.4095	0.3962	0.5766				
SE	0.9054	0.7775	0.6979	0.7393	0.5996			
SW	0.6384	0.4439	0.4196	0.3862	0.4801	0.6722		
RM	0.7488	0.5788	0.5345	0.6191	0.6336	0.6798	0.6102	
FW	0.8376	0.7794	0.6942	0.6565	0.4152	0.7382	0.5937	0.6196

NE = New England, ME = Mideast, GL = Great Lakes, PL = Plains, SE = Southeast, SW = Southwest, RM = Rocky Mountain, and FW = Far West

Figure 6: Unit Root Tests on Levels and First Differences of Regional Per Capita Personal Income, 1948:1-93:4

REGION	ADF[a]	PP[b]	ADF[a]	PP[b]
	Level		Growth Rate	
New England	-1.504	-2.008	-5.601**	-4.729**
Mideast	-2.011	-1.826	-5.589**	-4.719**
Great Lakes	-1.538	-1.816	-5.615**	-4.734**
Plains	-1.174	-2.803	-5.653**	-4.743**
Southeast	-0.891	-1.517	- 5.600**	-4.710**
Southwest	-0.936	-0.540	-5.570**	-4.683**
Rocky Mountain	-1.382	-1.460	-5.608**	-4.722**
Far West	-1.485	-1.101	-5.590**	-4.724**
Relative Price of Oil	-2.041	-1.4282	-4.336**	-4.3642**

[a]ADF represents the Augmented Dickey-Fuller test statistic for a unit root.
[b]PP represents the Phillips-Perron test statistic for a unit root.
**indicates significance at the 1% level [critical values of -3.50 (5%) and -4.15 (1%) are taken from Fuller (1976)].

Figure 7a: Cointegrating Results, No Trend						
λ_{max} Statistic		Trace Statistic		Critical Value at 90%		Null Hyp.
W/O Oil	With oil	W/O oil	With oil	λ_{max}	Trace	
0.02*	0.23*	0.02*	0.23*	2.71	2.71	r≤7
4.53*	3.61*	4.55*	3.85*	10.60	13.31	r≤6
9.68*	9.19*	14.23*	13.03*	13.34	26.70	r≤5
13.88*	14.14*	28.11*	27.18*	17.15	43.84	r≤4
33.44	30.87	61.55*	58.05*	20.90	64.74	r≤3
41.17	41.23	102.72	99.28	24.63	89.37	r≤2
56.99	56.68	159.71	155.96	28.36	117.73	r≤1
72.74	73.83	232.46	229.79	32.26	149.99	r≤0

*denotes significance at the 90% level.

Figure 7b: Cointegrating Results, With Trend						
λ_{max} Staticti c		Trace Statistic		Critical Value at 90%		Null Hyp.
W/O oil	With oil	W/O oil	With oil	λ_{max}	Trace	
4.32*	3.02*	4.32*	3.02*	10.56	10.56	r≤7
7.45*	7.24*	11.77*	10.26*	12.39	22.95	r≤6
10.49*	10.29*	22.27*	20.55*	16.13	39.08	r≤5
15.54*	15.68*	37.80*	36.23*	19.88	58.96	r≤4
33.57	31.12	71.37*	67.34*	23.72	82.68	r≤3
53.73	59.93	125.11	121.27	27.32	110.00	r≤2
58.95	58.38	184.06	179.66	31.31	141.31	r≤1
73.49	74.65	257.55	254.31	34.82	176.13	r≤0

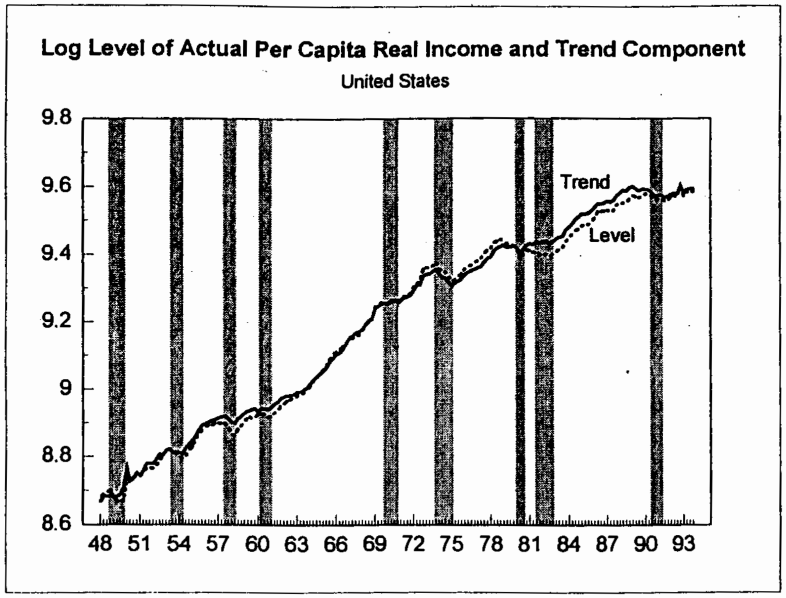
*denotes significance at the 90% level.

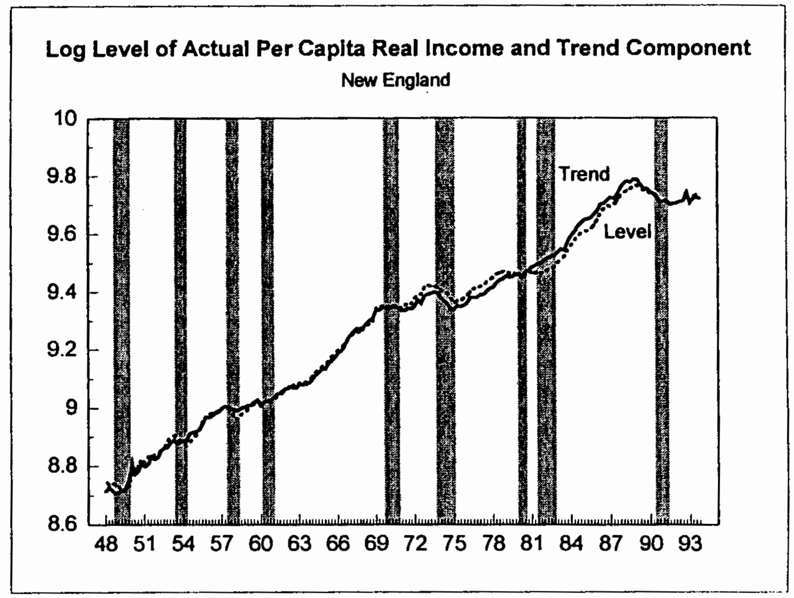
Figure 8: Canonical Correlation Analysis

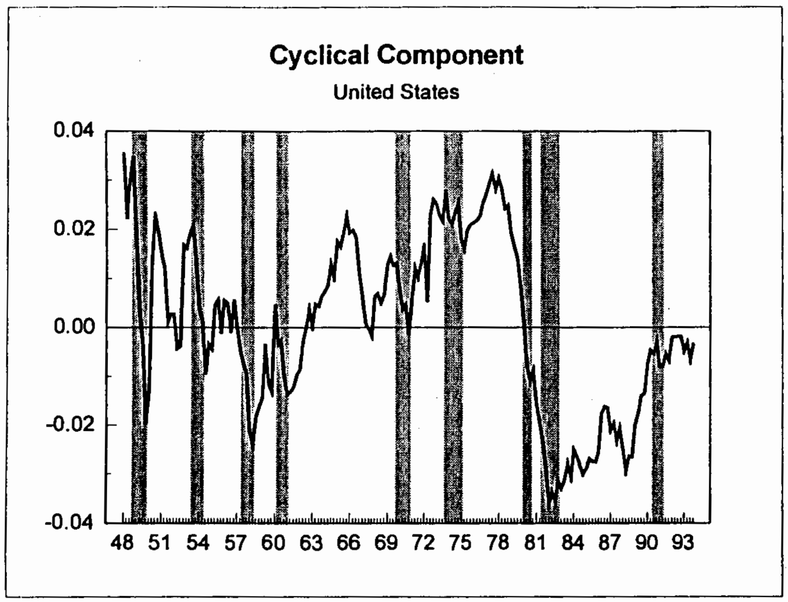
Squared Canonical Correlations (ρ_i^2)[a]								
No Trend				Trend				Null Hypothesis
W/O relative price of oil		With relative price of oil		W/O relative price of oil		With relative price of oil		
(ρ_i^2)	$P_r > F$	(ρ_i^2)	$P_r > F$	(ρ_i^2)	$P_r > F$	(ρ_i^2)	$P_r > F$	
0.6765	0.0001	0.6951	0.0001	0.6713	0.0001	0.6888	0.0001	Current (ρ_i^2) and all that follow are zero
0.5765	0.0001	0.5783	0.0001	0.5575	0.0001	0.5602	0.0001	Current (ρ_i^2) and all that follow are zero
0.5305	0.0001	0.5332	0.0001	0.5020	0.0001	0.5027	0.0001	Current (ρ_i^2) and all that follow are zero
0.4922	0.0044	0.4937	0.0012	0.4922	0.0092	0.4940	0.0026	Current (ρ_i^2) and all that follow are zero
0.3909	0.1820	0.4441	0.0698	0.3875	0.2805	0.4478	0.1182	Current (ρ_i^2) and all that follow are zero
0.3438	0.5479	0.3570	0.5333	0.3353	0.6856	0.3385	0.7005	Current (ρ_i^2) and all that follow are zero
0.2659	0.8575	0.2712	0.8738	0.2429	0.9214	0.2519	0.9218	Current (ρ_i^2) and all that follow are zero
0.2044	0.9068	0.2054	0.9230	0.2062	0.8997	0.2080	0.9139	Current (ρ_i^2) and all that follow are zero

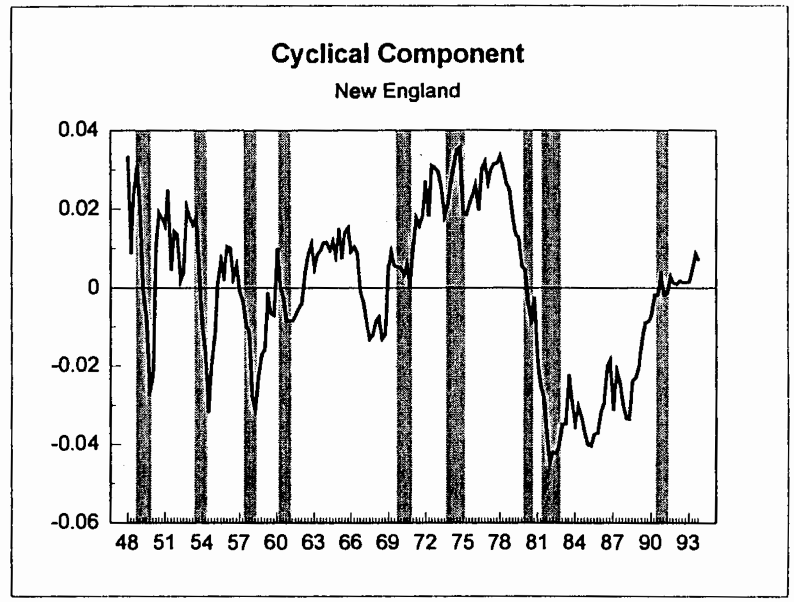
[a]The approximate F-statistics reported in the table are based on Rao's (1973) approximation to the distribution of the likelihood ratio.

Figure 9: Trend-Cycle Decomposition









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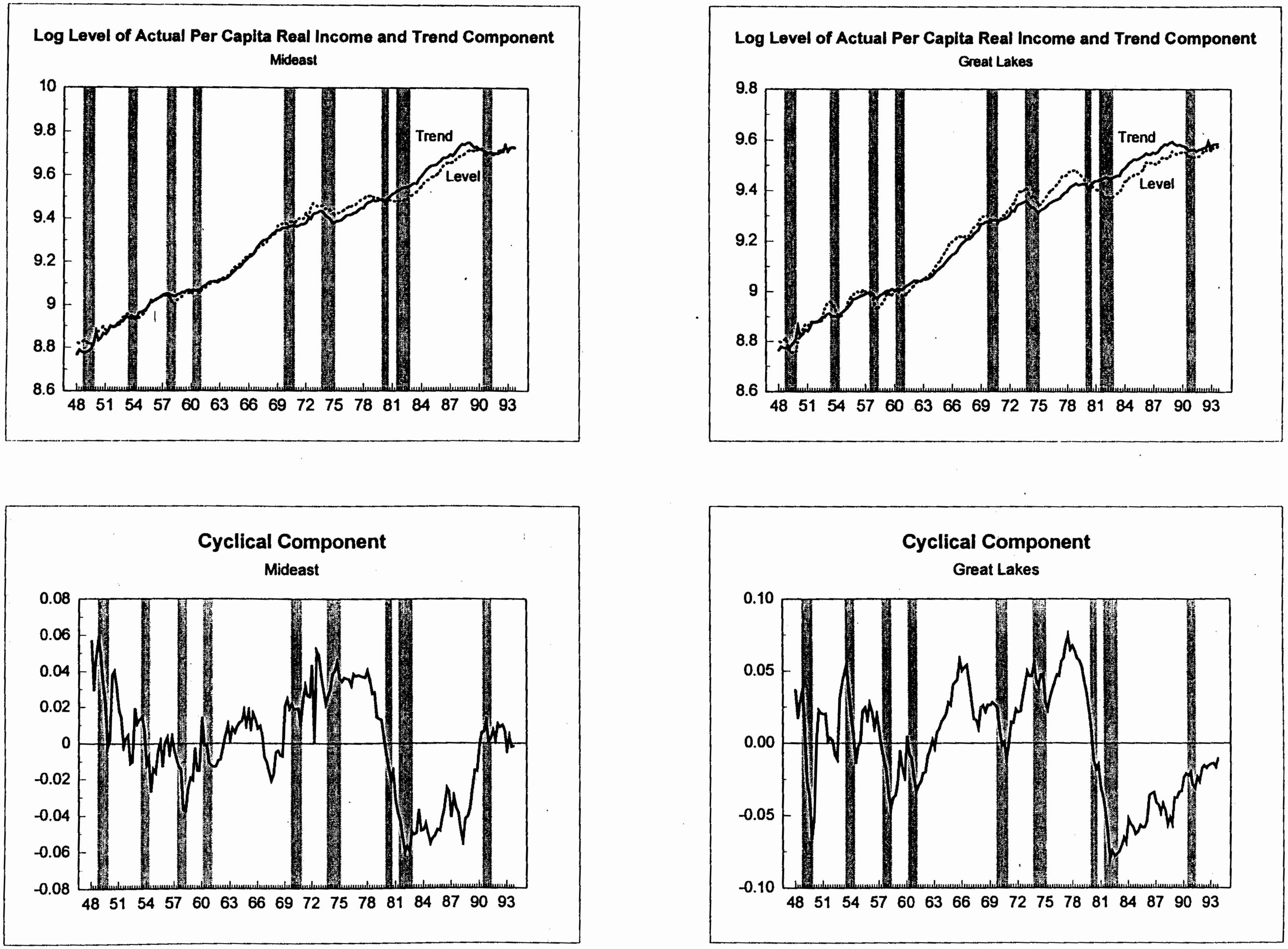

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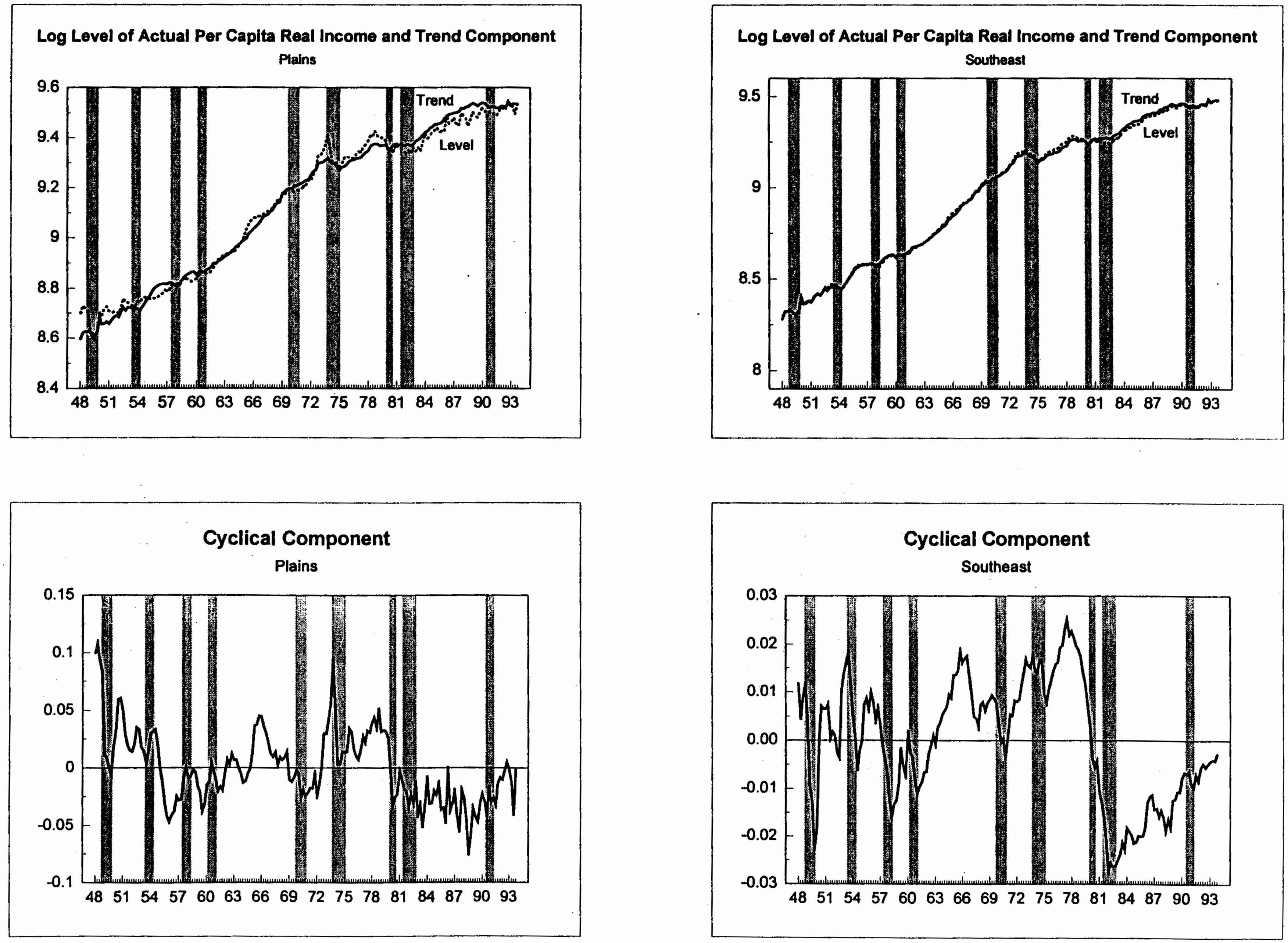

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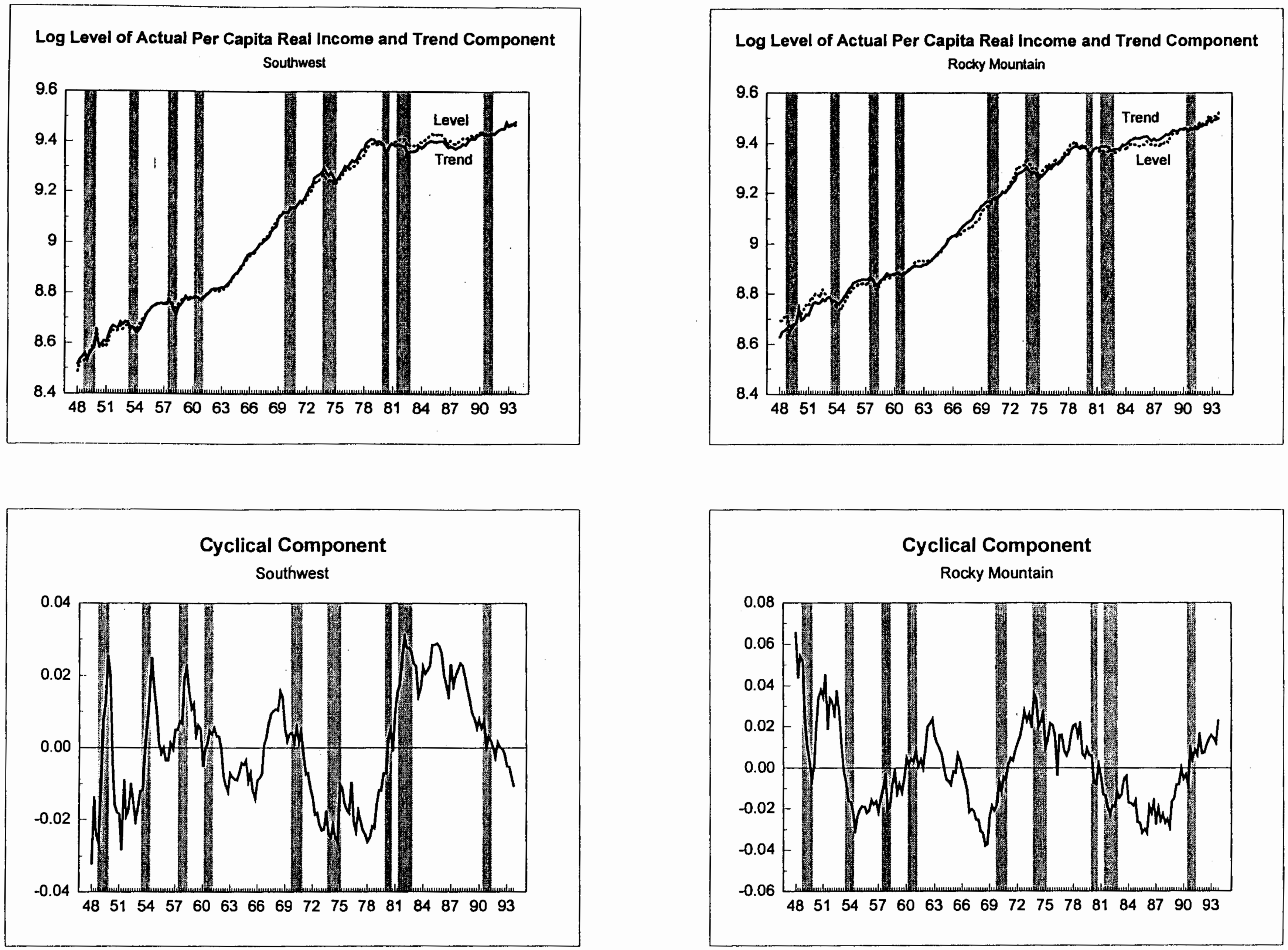

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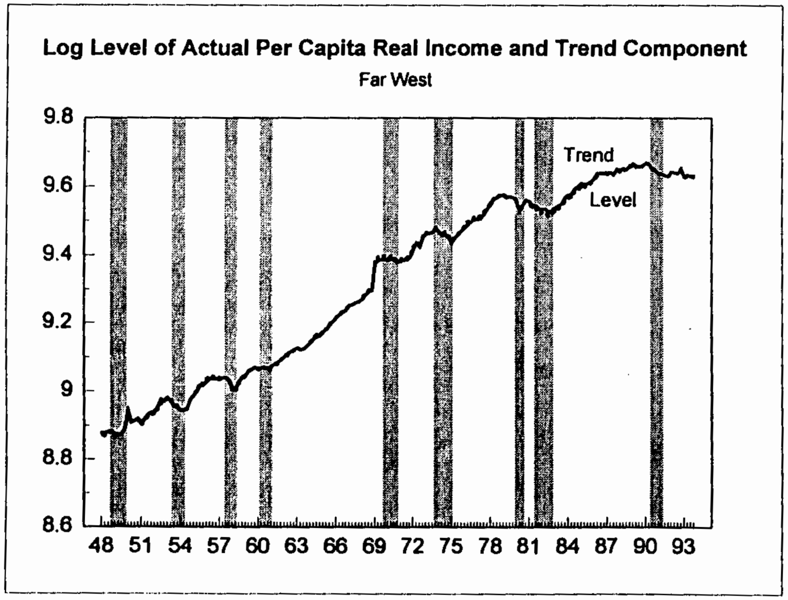


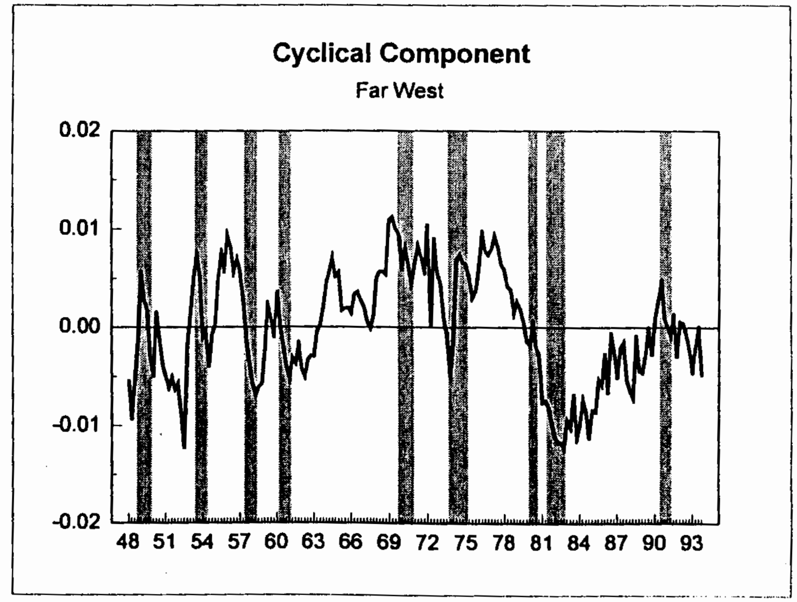


FIGURE 10: PERCENT CHANGE IN MEASURE OF PER CAPITA INCOME AND ITS TREND-CYCLE DECOMPOSITION FOR POST-WORLD WAR II RECESSIONS

RECESSIONS	NE	ME	GL	PL	SE	SW	RM	FW	US
MEASURED INCOME									
4Q48-4Q49	-0.013	-0.021	-0.069	-0.089	-0.027	0.075	-0.033	0.005	-0.029
3Q53-2Q54	-0.027	-0.020	-0.052	0.021	-0.026	0.005	-0.027	-0.018	-0.022
3Q57-2Q58	-0.033	-0.037	-0.060	-0.004	-0.018	-0.036	-0.044	-0.038	-0.036
2Q60-1Q61	0.005	-0.004	-0.022	0.007	-0.005	-0.006	0.000	0.000	-0.006
4Q69-4Q70	-0.005	-0.001	-0.031	-0.004	0.017	0.017	0.029	-0.015	-0.005
4Q73-1Q75	-0.057	-0.041	-0.072	-0.131	-0.067	-0.038	-0.071	-0.034	-0.060
1Q80-3Q80	-0.007	-0.009	-0.030	-0.028	-0.011	-0.008	-0.025	-0.016	-0.016
3Q81-4Q82	0.016	0.015	-0.024	0.004	-0.013	-0.019	-0.011	-0.018	-0.008
3Q90-2Q91	-0.017	-0.012	-0.014	0.010	-0.005	0.001	0.022	-0.019	-0.009
1Q79-4Q82	0.013	-0.000	-0.107	-0.045	-0.037	-0.005	-0.031	-0.060	-0.041
TREND COMPONENT									
4Q48-4Q49	0.045	0.041	0.034	0.000	0.008	0.023	0.026	0.007	0.025
3Q53-2Q54	0.008	0.003	-0.003	-0.006	-0.008	-0.021	-0.013	-0.010	-0.004
3Q57-2Q58	-0.012	-0.012	-0.026	-0.003	-0.006	-0.051	-0.034	-0.032	-0.021
2Q60-1Q61	0.014	0.007	0.003	0.006	0.004	-0.010	-0.006	0.005	0.004
4Q69-4Q70	-0.000	0.011	0.005	0.018	0.029	0.016	0.017	-0.010	0.009
4Q73-1Q75	-0.055	-0.050	-0.045	-0.048	-0.059	-0.052	-0.045	-0.045	-0.050
1Q80-3Q80	0.006	0.005	-0.004	-0.003	-0.003	-0.021	-0.011	-0.016	-0.005
3Q81-4Q82	0.029	0.021	0.005	-0.003	-0.003	-0.028	-0.014	-0.014	0.001
3Q90-2Q91	-0.017	-0.008	-0.006	-0.006	-0.002	0.007	0.005	-0.013	-0.007
1Q79-4Q82	0.072	0.063	0.023	-0.003	0.007	-0.048	-0.013	-0.045	0.010
CYCLICAL COMPONENT									
4Q48-4Q49	-0.058	-0.062	-0.104	-0.089	-0.035	0.052	-0.059	-0.002	-0.055
3Q53-2Q54	-0.034	-0.023	-0.049	0.027	-0.018	0.026	-0.013	-0.008	-0.019
3Q57-2Q58	-0.022	-0.025	-0.034	-0.001	-0.012	0.015	-0.010	-0.006	-0.017
2Q60-1Q61	-0.009	-0.011	-0.025	0.001	-0.008	0.004	0.006	-0.005	-0.010
4Q69-4Q70	-0.005	-0.012	-0.036	-0.022	-0.011	0.001	0.012	-0.005	-0.015
4Q73-1Q75	-0.002	0.009	-0.027	-0.083	-0.008	0.014	-0.026	0.012	-0.010
1Q80-3Q80	-0.013	-0.014	-0.026	-0.025	-0.009	0.012	-0.014	-0.000	-0.011
3Q81-4Q82	-0.012	-0.006	-0.029	0.007	-0.010	0.009	0.002	-0.004	-0.008
3Q90-2Q91	0.001	-0.004	-0.008	0.016	-0.003	-0.005	0.017	-0.006	-0.003
1Q79-4Q82	-0.058	-0.063	-0.130	-0.043	-0.044	0.043	-0.018	-0.015	-0.051

Figure 11: Standard Deviation of Regional Per Capita Income for Selected Periods.

REGION	1948-95	1948-72	1973-93
New England	2.0	1.4	2.5
Mideast	2.8	2.0	3.3
Great Lakes	3.8	2.6	4.6
Plains	3.1	2.9	3.2
Southeast	1.3	0.8	1.6
Southwest	1.5	1.2	1.8
Rocky Mountain	2.0	2.1	1.8
Far West	0.6	0.6	0.6
United States	1.8	1.2	2.1

Figure 12: Regional Cycles
Relative to National Cycles

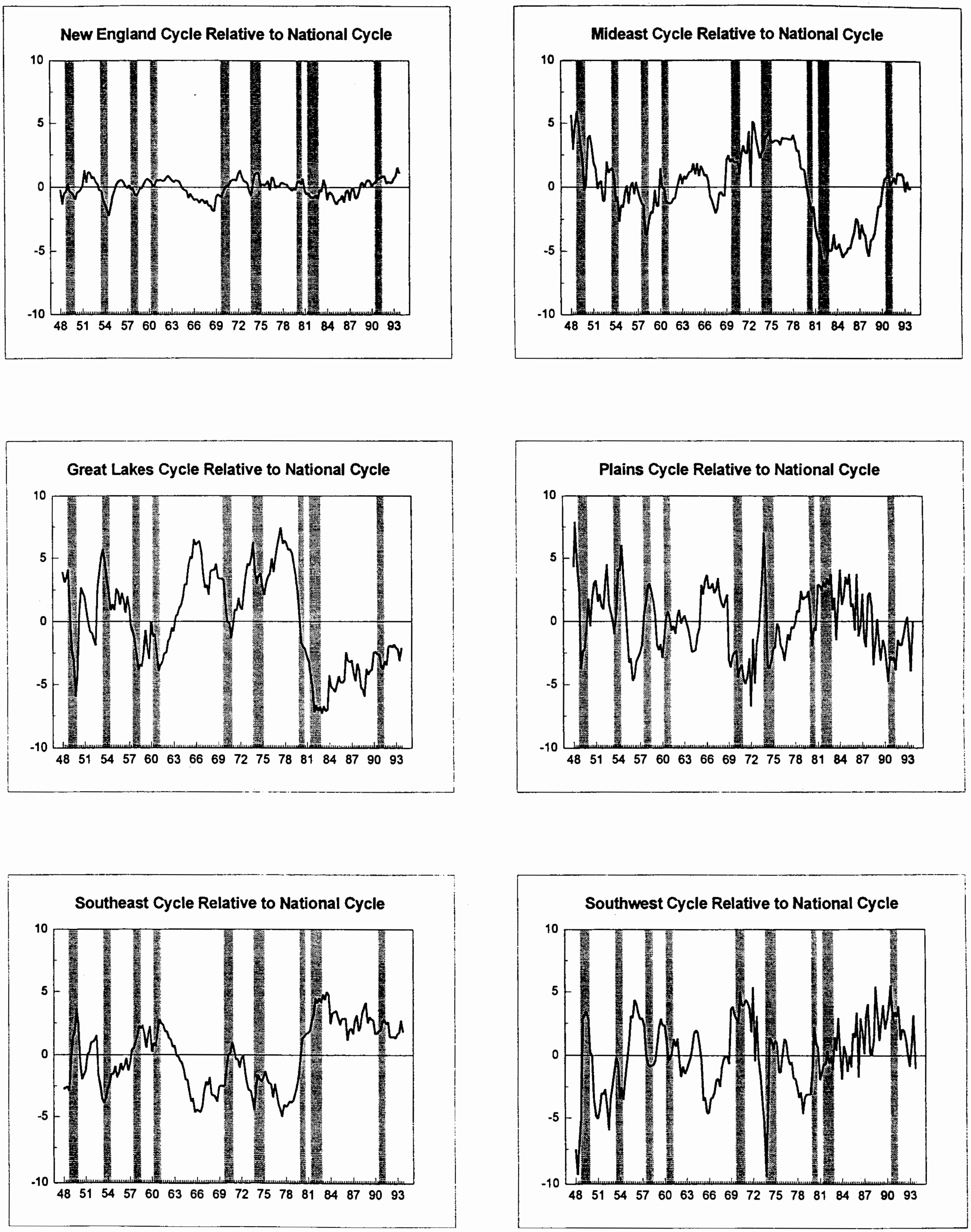
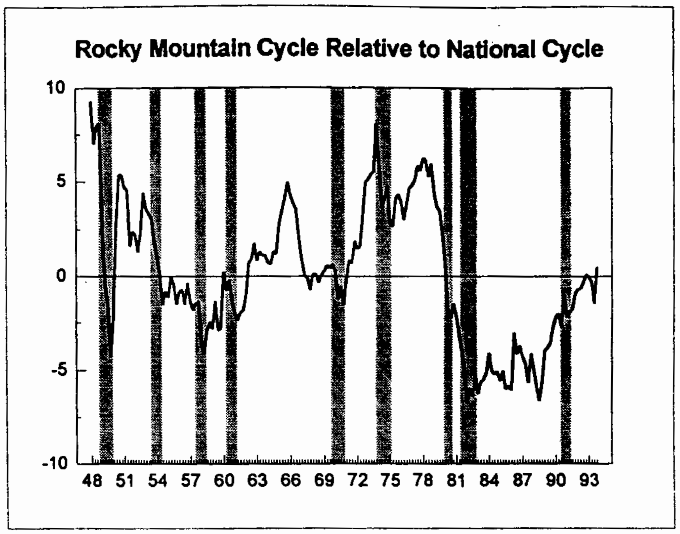


Figure 12: (Cont.)



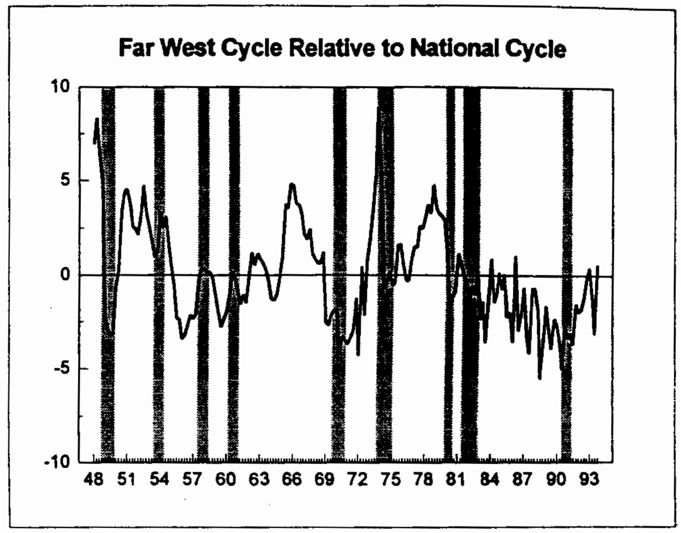
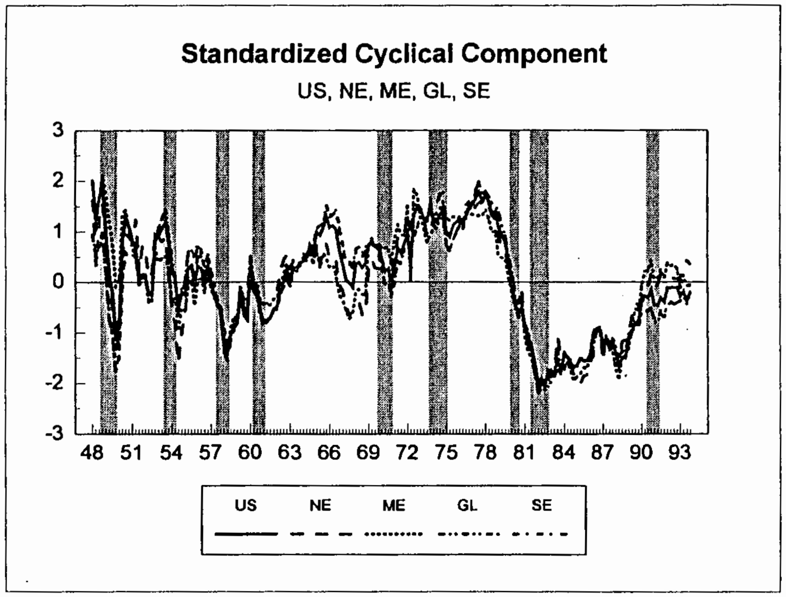


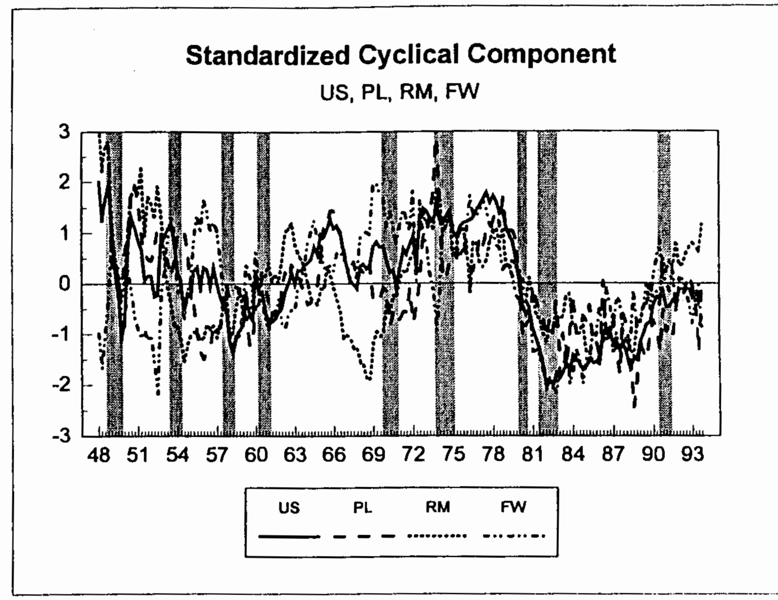
Figure 13: Simple Correlations Among the Regional Cyclical Components and Standard Deviation of a Region's Cyclical Component, 1948:1-93:4

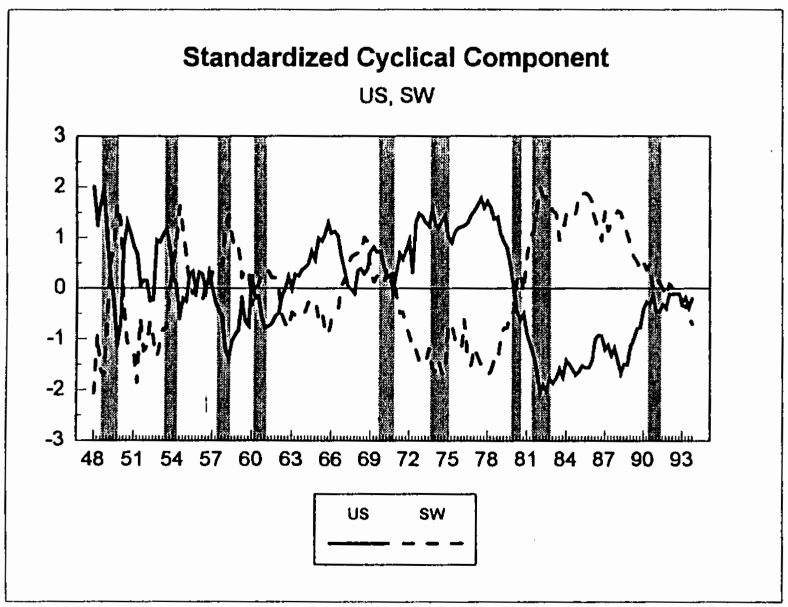
	US	NE	ME	GL	PL	SE	SW	RM
NE	0.9386							
ME	0.9333	0.9426						
GL	0.9606	0.8823	0.8183					
PL	0.7265	0.5679	0.6103	0.6529				
SE	0.9600	0.8952	0.8239	0.9991	0.6320			
SW	-0.8933	-0.9694	-0.8686	-0.8393	-0.6469	-0.8517		
RM	0.5950	0.7215	0.6898	0.4274	0.6428	0.4377	-0.8218	
FW	0.6877	0.6612	0.6935	0.7194	0.0639	0.7283	-0.4685	0.0011

US = U.S. average, NE = New England, ME = Mideast, GL = Great Lakes, PL = Plains, SE = Southeast, SW = Southwest, RM = Rocky Mountain, and FW = Far West. S.D. refers to a region's standard deviation.

Figure 14 Standardized Cyclical Component
(Regional Cycle Divided by its Standard Deviation)







APPENDIX A
DEFINITIONS OF REGIONS

<u>New England</u>
- Connecticut
- Maine
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont

<u>Mideast</u>
- Delaware
- District of Columbia
- Maryland
- New Jersey
- New York
- Pennsylvania

<u>Great Lakes</u>
- Illinois
- Indiana
- Michigan
- Ohio
- Wisconsin

<u>Plains</u>
- Iowa
- Kansas
- Minnesota
- Missouri
- Nebraska
- North Dakota
- South Dakota

<u>Southeast</u>
- Alabama
- Arkansas
- Florida
- Georgia
- Kentucky
- Louisiana
- Mississippi
- North Carolina
- South Carolina
- Tennessee
- Virginia
- West Virginia

<u>Southwest</u>
- Arizona
- New Mexico
- Oklahoma
- Texas

<u>Rocky Mountain</u>
- Colorado
- Idaho
- Montana
- Utah
- Wyoming

<u>Far West</u>
- California
- Nevada
- Oregon
- Washington