# Regional employment growth and the business cycle

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## Introduction and summary

The purpose of this article is to study the sources of regional employment fluctuations in the U.S. and to shed light on the interactions of these regional fluctuations with the aggregate economy. Many studies of regional employment growth have analyzed the effect of regional differences in a number of underlying factors, such as local government expenditures and tax policy, while controlling for aggregate economic activity. My analysis focuses alternatively on the role of regional fluctuations in determining aggregate economic activity.

Macroeconomists have tended to concentrate on the impact of changes in aggregate factors in determining the business cycle.[1] Such aggregate factors have included, for example, fiscal and monetary policy, the role of consumer confidence, aggregate supply and demand, and productivity. Yet there is a growing literature that suggests that aggregate disturbances are the result of a variety of influences.[2] In the work introduced here, I explicitly consider the role of regional employment fluctuations in determining the business cycle. I do not specifically identify the sources of such regional shocks. They could be the result of changing federal governmental policies, for example, immigration or defense spending, that impinge upon certain areas of the country more than others. They could also reflect changes in local welfare programs or shifts in local fiscal and tax policy.

The analysis is complicated by the fact that while regional fluctuations may have aggregate repercussions, aggregate factors influence regional growth as well. For example, general productivity shocks are likely to have broad consequences across a variety of industries and geographical areas that are reflected in regional employment growth. Ascertaining what movements in employment growth are common across regions and what are region-specific would be helpful for policymakers. If, for example, regional employment growth is largely unrelated to employment growth in other regions, a more regional policy focus might be appropriate. Examples of more localized policy would include differential taxation and spending programs that are coordinated within a region or a more geographically targeted approach to federal government spending. If, however, most regional employment growth is common across regions, a more centralized policy process is warranted.

The business cycle has been conceptualized as "expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle."[3] Thus, the business cycle is characterized by comovements among a variety of economic variables and is observable only indirectly. Only by monitoring the behavior of many economic variables simultaneously can one quantify the business cycle. For example, recessions are typically associated with declining output and employment across broadly defined industries. It is this notion of comovement that has supplied the foundation for measuring cyclical activity. This is the practice behind the widely publicized National Bureau of Economic Research's (NBER) dating of business cycles and Stock and Watson's (1988) index of coincident economic indicators.

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While most analyses of the business cycle focus on the notion of comovement in employment or output across industries, a great deal of comovement exists across geographical regions as well. Yet, until recently this regional cyclicality has gone largely unexplored, with a few notable exceptions such as Altonji and Ham (1990), Blanchard and Katz (1992), Clark (1998), and Clark and Shin (1999). The reason for the lack of interest in the regional cycle has largely been the belief that whatever cyclicality a geographical region experiences is due in large part to its industrial mix and to common aggregate shocks. In fact, regional shocks are typically not considered in assessing the business cycle.

Altonji and Ham (1990) investigate the effect of U.S., Canadian national, and sectoral shocks on Canadian employment fluctuations at the national, industrial, and provincial level. They find that sectoral shocks account for only one-tenth of aggregate variation, with two-thirds of the variation attributable to U.S. disturbances and one-quarter to Canadian shocks. The relatively small importance of sectoral fluctuations in describing aggregate variation in Canadian data suggests that regional shocks have little effect on the business cycle. The conclusion holds true for Canada but the study does not necessarily apply to the U.S. economy, in which external shocks presumably play less of a role.

In a model similar to Altonji and Ham (1990), Clark (1998) attempts to quantify the roles of national, regional, and industry-specific shocks on regional employment growth for U.S. data. Contrary to the traditional view that regional fluctuations are unimportant in determining the aggregate and the results of Altonji and Ham (1990) for Canada, Clark finds that "roughly 40 percent of the variance of the cyclical innovation in any region's employment growth rate is particular to that region."[4] He goes on to show that these regional shocks tend to propagate across regions. Clark's conclusion is that heterogeneous regional fluctuations have possibly important implications for business cycle study. Although valuable, the methodology he employs does not permit the construction of actual estimates of regional disturbances, which hampers his ability to clarify the underlying causes of the regional shocks.

In this article, I develop and estimate a model of regional employment growth aimed at understanding the role of the aggregate economy. Each region's employment growth is assumed to depend upon a common factor, thought of here as the business cycle.[5] This common factor is not directly observable, but is inferred through the comovements of employment growth across a number of regions simultaneously. This does not mean that each region responds in the same manner to cyclical fluctuations. Some regions will be more cyclically sensitive while others are less. Accordingly, the methodology permits the cycle to have a differential impact on regional employment growth.

The methodology I employ is similar to that in Rissman (1997) and utilizes a statistical technique known as the *Kalman filter*. The research here is akin to Clark's in that it is an attempt to isolate the effects of the business cycle and regional disturbances on regional employment growth. However, I expressly model the business cycle as a common factor affecting all regions and some more than others. A measure of the business cycle develops naturally from the estimation of the model and is based solely upon the comovements in employment growth across census regions. In addition, I estimate regional employment shocks, which are useful for elucidating the reasons behind regional differences in economic growth.

In summary, while aggregate fluctuations are an important force behind regional employment growth, local disturbances contribute significantly as well. The role of such local shocks is not uniform across regions. My estimates indicate that almost 60 percent of the steady state variance in employment growth in the West South Central region is attributable to local fluctuations. This compares with only about 10 percent in East South Central, where aggregate conditions are the driving force.

My results suggest that regional employment growth can be described remarkably well by a simple model in which a common business cycle has a differential impact upon the various regions. Measures of the business cycle from this approach are quite consistent across models and agree quite well with more typical measures of the business cycle. The main difference between this measure and other such measures is that this one relies upon regional employment data alone, while other measures may take into consideration a wide variety of other factors, such as productivity.

Interestingly, errors made in forecasting employment growth in the West South Central region appear to have some predictive content for forecasting employment growth in most other regions. This suggests that there is something unique about this region's economy that is not currently captured by the model but that does have aggregate repercussions. This might be due to the region's reliance on the oil industry. My analysis implies that regional policies may be an important tool in managing the economy. However, more research on the nature of the spillovers across regions would be required to support economic policy targeting specific regions.

## Data

In formulating a model of regional employment growth, a necessary first step is to observe the patterns in the data. The Bureau of Labor Statistics (BLS) collects regional employment statistics from its *Employment Survey* for the following nine census regions: New England, Mid-Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific.[6] Figure 1 shows annualized quarterly employment growth for each of the nine census regions from 1961:Q1 to 1998:Q2. (The construction is explained in box 1.) It is clear from the figure that some regions consistently exhibit high employment growth (for example, South Atlantic, East South Central, West South Central, Mountain, and Pacific), while other regions consistently exhibit below-average employment growth (New England, Mid-Atlantic, East North Central, and West North Central).[7]

In addition to differences in mean employment growth, regional employment growth exhibits an apparent cyclical pattern. Typically, employment growth declines during a recession (shaded areas in figure 1) and increases in an expansion.[8] This cyclical pattern shows up quite clearly in all regions but is less pronounced in some. Specifically, the Pacific and Mountain states appear to be less affected by the business cycle than a more typical Rust Belt region such as East North Central. This is not to say that employment growth does not decline here as well, but in these regions contractions are associated with smaller declines.

Closer inspection of figure 1 shows that regional employment growth appears to have a random component in addition to a cyclical one. For example, the West South Central region experienced a marked decline in employment growth in the mid-1980s. This decline was echoed in a few other regions, but was nowhere as pronounced as in West South Central. In fact, regions such as the Mid-Atlantic, East North Central, South Atlantic, and Pacific experienced relatively little negative impact at that time.

In modeling the effect of the business cycle on regional employment growth it is useful to know how the business cycle affects the regional economy through other less-direct avenues. For example, the cycle may affect the distribution of employment across regions. Figure 2 exhibits regional employment growth net of aggregate employment growth. A negative number for a region indicates that that region's employment share of the aggregate is shrinking. Conversely, a positive number shows that that region's employment is growing relative to the aggregate. The figure shows that trends in employment growth seem to persist for long periods. For example, the Rust Belt New England region experienced below national average employment growth for most of the earlier part of the data period. This decline was temporarily reversed in the 1980s—the much-vaunted "Massachusetts miracle." However, the New England recovery was short-lived, as shown by the subsequent pronounced decline in New England's employment share. The Mid-Atlantic states lost ground as well over most of the period. In contrast, employment growth in the Mountain states was above the national average, with the exception of a brief period in the mid-1960s and again in the mid-1980s.

The employment shares in figure 2 do not appear, at least by casual observation, to behave cyclically. It is *not* the case that a given region's relative importance in the composition of aggregate employment is affected systematically by the business cycle. This is in direct contrast to the evidence on industries, where the composition of total employment shifts away from goods-producing and toward service-producing industries during contractions. Although regions show periods of expansion and contraction, at first blush the timing of these "regional cycles" is unlike the timing of the familiar business cycle. If a business cycle is described by comovements in a number of series, it is difficult to describe what these comovements might be from looking at net regional employment growth alone.

At times, statistical relationships can be difficult to ascertain by casual observation of the data at hand. To investigate a more complex model of the cyclicality of net regional employment growth, I perform a

**BOX 1**

**Annual employment growth and net annual employment growth**

Employment growth in region $i$ at time $t$, $y_{it}$, is calculated as:

$$y_{it} \equiv \log(e_{it} / e_{it-4}) \times 100,$$

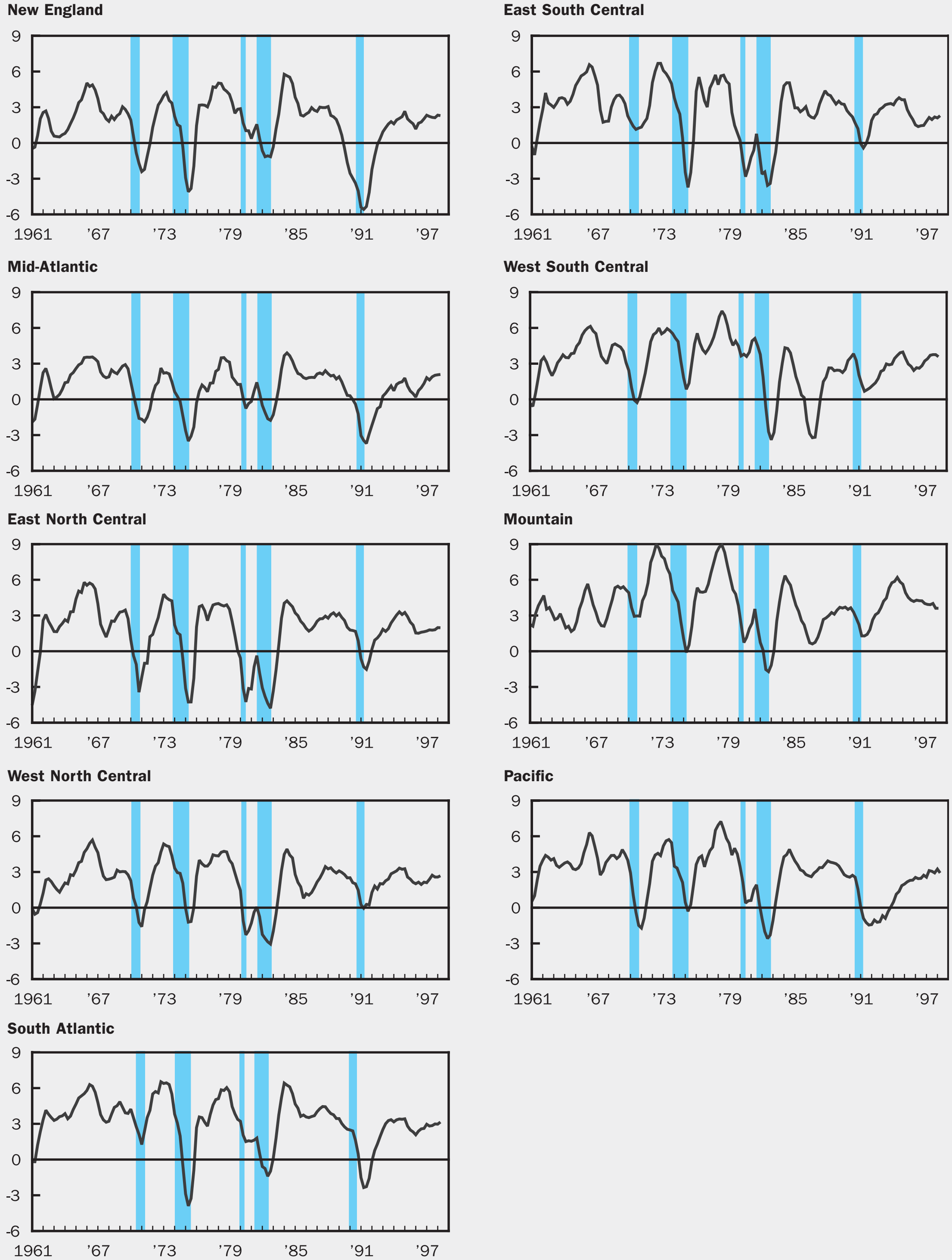
where $e_{it}$ is employment in region $i$ at time $t$. Define net employment growth $n_{it}$ as the difference between regional employment growth and aggregate employment growth. Specifically,

$$n_{it} \equiv y_{it} - y_t$$
$$n_{it} = [\log(e_{it} / e_{it-4}) - \log(e_t / e_{t-4})],$$

where $e_t$ is defined as aggregate employment at time $t$ and $y_t$ is aggregate employment growth.

FIGURE 1

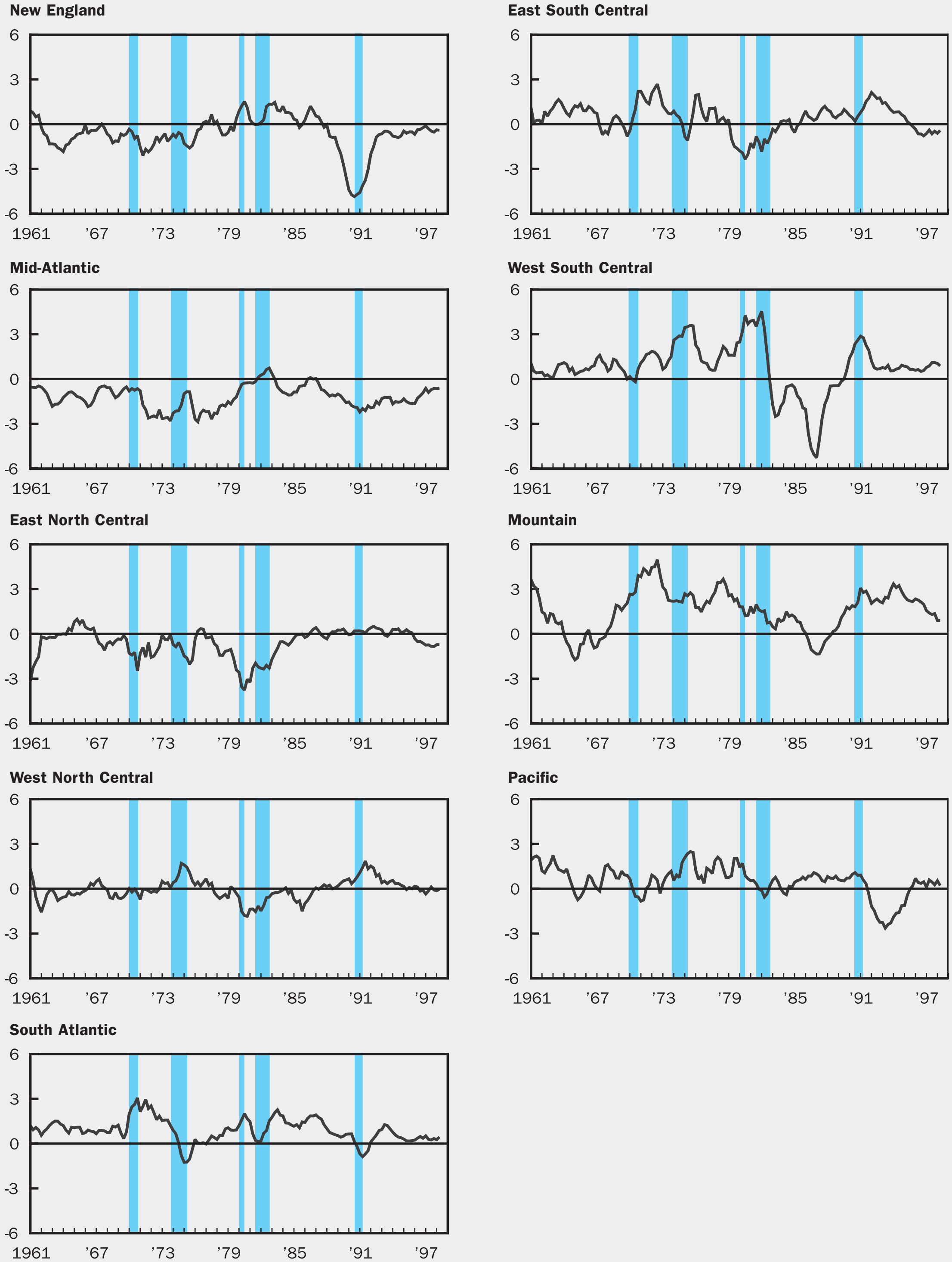
**Regional employment growth, 1961:Q1–98:Q2**
(percent)




Notes: See box 1 for details of calculations. Shaded areas indicate recessions, as defined by the National Bureau of Economic Research.
Source: U.S. Department of Labor, Bureau of Labor Statistics, 1960–98, employment database available at ftp://ftp.bls.gov/pub/time.series and author's calculations.

**FIGURE 2**

**Employment growth, regional less aggregate, 1961:Q1–98:Q2**
(percent)




Notes: Regional employment growth less total employment growth, quarterly from previous year. Growth rates measured as four-quarter log differences. See box 1 for details. Shaded areas indicate recessions, as defined by the National Bureau of Economic Research.

Source: U.S. Department of Labor, Bureau of Labor Statistics, 1960–98, employment database available at ftp://ftp.bls.gov/pub/time.series and author's calculations.

regression exercise in which net regional employment growth is assumed to depend upon lags of net regional employment growth and whether the economy is in a contraction as defined by the NBER. (The form of the regression is shown in box 2.) Table 1 shows the results of these simple ordinary least squares (OLS) regressions. A significant negative or positive number in the *CONTRACT* column indicates that, even after accounting for dynamics through lags of own-region net employment growth, the state of the aggregate economy has an additional impact upon net employment growth. In the case of a negative number, the region's employment share shrinks during a contraction. Conversely, a positive number suggests that the region's employment share expands during a contraction.

From table 1, clearly business cycle contractions as defined by the NBER are not particularly good at explaining regional net employment growth after accounting for serial correlation in the dependent variable. Most of the estimates are not significantly different from zero. The exceptions are Mid-Atlantic, East North Central, and Mountain. In the East North Central region, comprising Ohio, Indiana, Michigan, Wisconsin, and Illinois, employment shares typically decline in a recession. Furthermore, the estimated effect for East North Central is quite large compared with the other regions. In the Mid-Atlantic and Mountain regions, employment shares tend to rise during a contraction. The $\bar{R}^2$ statistic is a measure of the *fit* of the regression. The closer this number is to unity, the better the data fit the estimated equation. The high values of $\bar{R}^2$ suggest that most of the variation in net regional employment growth is accounted for by lags in the dependent variable.

## Industry effects

To summarize, the data on regional employment growth suggest that the business cycle affects regional employment growth directly and to a far lesser extent through its effect on the distribution of employment across regions. It has long been observed that the business cycle systematically affects the distribution of employment across industries.[9] One possible explanation for the cyclicality of regional employment growth is that certain regions are dominated by specific industries. To the extent that this is true, then the regional cycles found in employment growth merely mirror the effects of the business cycle on the regional industry mix and, thus, there is relatively little role for regional fluctuations or shocks to explain the patterns in the data. Box 3 shows how state industry employment data can be used to evaluate this issue.

Changes in state employment are dominated by two effects. First, there is the effect of shifting industry employment on employment within the state, holding the contribution of the state in employment within the industry constant. The second effect measures the importance of shifting the state's contribution to each industry, holding aggregate industry employment

**BOX 2**

### OLS regression testing effect of contractions on net employment growth

Let *CONTRACT* be a dummy variable taking on the value 1 during an NBER contraction and 0 elsewhere. The OLS regression equation is of the form:

$$n_{it} = c + a(L)n_{it-1} + b*CONTRACT + \varepsilon_{it}.$$

Four lags of the dependent variable have been included and are generally enough to ensure that the error term is serially uncorrelated.

**TABLE 1**

### Effect of timing of NBER contractions on regional employment growth less aggregate employment growth, OLS

| Region | *CONTRACT* | $\bar{R}^2$ |
|---|---|---|
| New England | 0.1170 | 0.9281 |
| Mid-Atlantic | 0.1345** | 0.8851 |
| East North Central | –0.3581*** | 0.8541 |
| West North Central | 0.0272 | 0.8207 |
| South Atlantic | 0.0540 | 0.8686 |
| East South Central | –0.0458 | 0.8393 |
| West South Central | 0.1444 | 0.9394 |
| Mountain | 0.1561* | 0.9267 |
| Pacific | –0.0308 | 0.8436 |

Notes: The regression equation estimated by OLS is:

$$n_{it} = c + a(L)n_{it-1} + b*CONTRACT + \varepsilon_{it},$$

where *CONTRACT* takes on the value of 1 during an NBER contraction and is 0 otherwise; $a(L)$ is a polynomial in the lag operator with a maximum lag length of four. ***Indicates significance at the 1 percent level; **indicates significance at the 5 percent level; and *indicates significance at the 10 percent level.

Source: Author's calculations based on data from the U.S. Department of Labor, Bureau of Labor Statistics, database at ftp://ftp.bls.gov/pub/time.series and the National Bureau of Economic Research database available on the Internet at www.nber.org.

constant. The first effect can be thought of as an industry effect while the second can be thought of as a state effect. If state effects are not important, then an analysis of employment growth by geographical region is unlikely to yield any insight into business cycles. If, however, a significant portion of the change in employment within a state is state-specific, a regional analysis is likely to provide further information.

Table 2 shows the relative importance of each of these two factors for all states except Hawaii. Specifically, the table shows the portion of the normalized change between 1985:Q1 and 1998:Q2 in employment in state $s$ attributable to changing industry employment and changing employment shares, respectively.[10] The industry categories are mining, construction, manufacturing, trade, services, transportation and public utilities, government, and finance, insurance, and real estate. The goal is to analyze how important state and industry effects are in explaining state employment changes. A full set of data on all states with the exception of Hawaii is available from 1982:Q1 forward. To avoid evaluating employment over two

**BOX 3**

### Effect of industry composition on state employment

Define $e_i^s(t)$ as employment in industry $i$ in state $s$ at time $t$. Define

$$k_i^s(t) \equiv \frac{e_i^s(t)}{e_i(t)}$$

as the share of industry $i$'s employment in state $s$. These numbers sum to unity over all states. The larger the share in a given state, the more important that state is in the employment of that particular industry. Employment in state $s$ at time $t$, $e^s(t)$, can be calculated as:

$$e^s(t) = \sum_i k_i^s(t) e_i(t),$$

which says that total state employment is the sum of employment in each industry within that state.

Now define the difference operator $\Delta^\tau$ as:

$$\Delta^\tau x(t) \equiv x(t) - x(t-\tau).$$

Applying the difference operator to the expression for state employment yields:

$$\Delta^\tau e^s(t) = \sum_i \Delta^\tau e_i(t) k_i^s(t) + \sum_i \Delta^\tau k_i^s(t) e_i(t) - \sum_i \Delta^\tau k_i^s(t) \Delta^\tau e_i(t).$$

From this expression, the change in state employment between periods $t–\tau$ and $t$ can be separated into three different effects. The first term to the right of the equal sign reflects the effect of changing industry employment while keeping the share of industry $i$'s employment in state $s$ constant. An example will help clarify this construct. Suppose aggregate manufacturing employment declines, this effect calculates the effect of declining aggregate manufacturing employment on employment within a given state, holding the share of that state's contribution to total manufacturing employment constant. No secondary effects are permitted whereby the distribution of manufacturing across states has been altered.

The second term captures the effect of changing employment shares in industry $i$ in state $s$ while keeping total industry employment constant. Suppose that employment remains constant over time but that the importance of a given state in its contribution to the total changes. This second term calculates the effect of this shift on employment within that state. Finally, the third term is an interaction term that permits both state industry employment shares and industry employment to vary together. Because it is calculated by multiplying together two changes, it is smaller in magnitude than the first two effects and will be dominated by the first two terms in the expression.

Rearranging terms,

$$\Delta^\tau e^s(t) + \sum_i \Delta^\tau k_i^s(t) \Delta^\tau e_i(t) = \sum_i \Delta^\tau e_i(t) k_i^s(t) + \sum_i \Delta^\tau k_i^s(t) e_i(t)$$

or

$$1 = \frac{\sum_i \Delta^\tau e_i(t) k_i^s(t) + \sum_i \Delta^\tau k_i^s(t) e_i(t)}{\Delta^\tau e^s(t) + \sum_i \Delta^\tau k_i^s(t) \Delta^\tau e_i(t)}.$$

This expression says that the normalized sum of the two effects should be unity.

**TABLE 2**

**Changes in employment in state *s*, 1985:Q1–98:Q2**

| | Industry effect | State effect |
|---|---|---|
| Alabama | 0.80 | 0.20 |
| Alaska | 1.20 | –0.20 |
| Arizona | 0.58 | 0.42 |
| Arkansas | 0.63 | 0.37 |
| California | 1.20 | –0.20 |
| Colorado | 0.76 | 0.24 |
| Connecticut | 7.74 | –6.74 |
| Delaware | 0.74 | 0.26 |
| Florida | 0.73 | 0.27 |
| Georgia | 0.65 | 0.35 |
| Hawaii | n.a. | n.a. |
| Idaho | 0.57 | 0.43 |
| Illinois | 1.31 | –0.31 |
| Indiana | 0.76 | 0.24 |
| Iowa | 0.84 | 0.16 |
| Kansas | 0.82 | 0.18 |
| Kentucky | 0.67 | 0.33 |
| Louisiana | 1.78 | –0.78 |
| Maine | 1.07 | –0.07 |
| Maryland | 1.48 | –0.48 |
| Massachusetts | 3.85 | –2.85 |
| Michigan | 0.91 | 0.09 |
| Minnesota | 0.80 | 0.20 |
| Mississippi | 0.73 | 0.27 |
| Missouri | 0.99 | 0.01 |
| Montana | 0.91 | 0.09 |
| Nebraska | 0.89 | 0.11 |
| Nevada | 0.48 | 0.52 |
| New Hampshire | 1.06 | –0.06 |
| New Jersey | 2.54 | –1.54 |
| New Mexico | 0.81 | 0.19 |
| New York | 36.32 | –35.33 |
| North Carolina | 0.63 | 0.36 |
| North Dakota | 1.15 | –0.15 |
| Ohio | 1.03 | –0.03 |
| Oklahoma | 1.34 | –0.34 |
| Oregon | 0.60 | 0.40 |
| Pennsylvania | 1.87 | –0.87 |
| Rhode Island | 4.89 | –3.89 |
| South Carolina | 0.67 | 0.33 |
| South Dakota | 0.70 | 0.30 |
| Tennessee | 0.67 | 0.33 |
| Texas | 0.89 | 0.11 |
| Utah | 0.53 | 0.47 |
| Vermont | 1.15 | –0.15 |
| Virginia | 0.82 | 0.18 |
| Washington | 0.61 | 0.39 |
| West Virginia | 1.11 | –0.11 |
| Wisconsin | 0.73 | 0.27 |
| Wyoming | 1.76 | –0.75 |

Notes: See box 3 for the exact calculations. n.a. indicates not available.
Source: Author's calculations based on data from the U.S. Department of Labor, Bureau of Labor Statistics, database at ftp://ftp.bls.gov/pub/time.series.

different phases of the business cycle, I analyze changes in state employment between 1985:Q1 and 1998:Q2.

The evidence provided in table 2 supports Clark's (1998) contention that location-specific shocks are important. For example, about 58 percent of the increase in employment in Arizona is attributable to within-industry employment growth. However, the remaining 42 percent of the increase is the result of a shifting industrial mix within the state. Although the effect of changing aggregate industrial employment dominates, the importance of the changing industrial composition within the state is not insignificant in most instances, most often leading to increases in state employment.

Some states, notably Alaska, California, Connecticut, Illinois, Louisiana, Maryland, Massachusetts, New Jersey, New York, North Dakota, Oklahoma, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wyoming, would have experienced an even larger increase in employment between 1985:Q1 and 1998:Q2 except that employment shares shifted adversely. New York appears to be somewhat of an outlier with employment gains being offset to a large extent by shifts in employment shares: Manufacturing employment as a share of total state employment fell precipitously, while employment in finance, insurance, and real estate grew quickly.

The state industry employment data suggest that employment growth is only partly explained by industry effects and that a good portion of state employment changes results from location-specific factors. It follows that changes in local employment do not simply reflect the local industrial mix, but also have a significant location-specific component. This adds another dimension to our understanding of regional employment growth.

## The model

The evidence above indicates that regional employment growth is driven in large part by a common business cycle. Furthermore, regional shocks are important even after accounting for changing aggregate industrial composition. Let annual employment growth in region $i$, $y_{it}$, have the following specification:

$$y_{it} = \alpha_i + \beta_0{}^i C_t + \beta_1{}^i C_{t-1} + \beta_2{}^i C_{t-2} + \gamma_i y_{it-1} + \varepsilon_{it}\ ,$$

where $\alpha_i$ is a constant, $C_t$ is a variable meant to capture the business cycle, $\beta_0^i$, $\beta_1^i$, $\beta_2^i$ are coefficients measuring the effect on $y_{it}$ of current and lagged values of the business cycle (that is, $\beta^i(L)C_t = \beta_0^i\, C_t + \beta_1^i\, C_{t-1} + \ldots + \beta_p^i\, C_{t-p}$, where $p = 2$), $\gamma_i$ is a coefficient on lagged own-region employment growth, and $\varepsilon_{it}$ is an independent and identically distributed random variable with mean 0 and variance $\sigma_i^2$, $i = 1, ..., I$.

The business cycle is assumed to affect each region differently in terms of both timing and magnitude. This differing effect is captured parsimoniously by the coefficients $\beta_0^i$, $\beta_1^i$, $\beta_2^i$. Those regions that are less cyclical have values of the $\beta_j^i$ parameters that are closer to 0. Those regions that lag the cycle have estimates of $\beta_j^i$ that are insignificantly different from 0 for small $j$.

Finally, I assume that one cannot observe the business cycle directly, but instead must infer it through its effects on regional employment growth across all regions simultaneously.[11] I assume that the cycle follows an AR(2) specification so that:

$$C_t = \phi_1 C_{t-1} + \phi_2 C_{t-2} + u_t.$$

The error term $u_t$ is assumed to be serially independent and identically distributed with mean 0 and variance of $\sigma_u^2$. The imposition of an AR(2) process for the business cycle provides a succinct way of allowing for a business cycle that is characterized by recessions followed by expansions.

To completely specify the model, it is necessary to assume something about the two types of shocks, $u_t$ and $\varepsilon_{it}$, where $u_t$ can be thought of as a business cycle shock and $\varepsilon_{it}$ is a regional disturbance. Specifically, I assume that the cyclical shock and the regional disturbances are mean 0, serially uncorrelated, and uncorrelated with each other. Box 4 provides a detailed discussion of the estimation.

## Results

As currently specified, the model is not identified without additional restrictions.[12] Neither the scale nor sign of the business cycle is defined. To see this, suppose that the common cycle $C_t$ is rescaled by multiplying it by some constant $b$, and define $C_t^* = bC_t$. Then $C_t^* = \phi_1 C_t^* + \phi_2 C_t^* + u_t^*$, where $u_t^* = bu_t$ and $\text{var}(u_t^*) = b^2\sigma_u^2$. I fix the scale by setting $\sigma_u^2$ to 1 and choose the sign so that $\beta_0$ is positive in the East North Central region. In fact, the parameter $\beta_0$ turns out to be positive in all regions. This is the natural normalization because we define a boom to be a state when economic activity is high.

Additional assumptions are required to pin down the timing of the cycle. Following Stock and Watson (1989), I normalize by restricting the business cycle to enter only contemporaneously in at least one region $j$, that is, $\beta_1^j = \beta_2^j = 0$. This region has been set arbitrarily as East North Central.[13]

The results reported in table 3 are for the model described above, in which two lags of $C_t$ are included (that is, $\beta^i(L)$ is second order). The estimation uses quarterly data from 1961:Q2 to 1998:Q3 for the nine census regions.[14]

According to the model, movements in the regional employment growth rate reflect macroeconomic conditions, local dynamics, and idiosyncratic fluctuations that are specific to the region. What kind of growth rates should the regions experience over the long term in the absence of cyclical fluctuations and regional shocks? The expected long-term regional growth rate depends upon both the constant $\alpha_i$ and the coefficient on the lagged dependent variable $\gamma_i$. Specifically,

$$E(y_i) = \frac{\alpha_i}{(1-\gamma_i)}.$$

From this computation, the West South Central, South Atlantic, and Mountain regions have had the highest growth rates on average, with mean growth over this period of 3.05 percent, 3.09 percent, and 3.74 percent, respectively. The Rust Belt regions of New England, Mid-Atlantic, and East North Central have had the lowest employment growth, recording annual percentage increases of 1.51 percent, 1.01 percent, and 1.98 percent, respectively.

The parameter $\beta_0^i$ reflects the contemporaneous effect of the business cycle on region $i$'s employment growth. These estimated coefficients (reported in column 2 of table 3) are positive and significant for all regions. The East North Central and East South Central regions are the most cyclically sensitive, exhibiting the largest estimated values for $\beta_0$. The West South Central region is by far the least cyclically sensitive contemporaneously with an estimated $\beta_0$ of only 0.8406, so that an increase in $C_t$ of one unit is associated with a less than 1 percent increase in regional employment growth contemporaneously.

Technically, the Kalman filter and maximum likelihood estimation provide a way to obtain estimates of the business cycle, $C_t$, conditional on information prior to time $t$. I apply a Kalman smoothing technique that uses all available information through the end of the sample period to generate smoothed estimates of $C_t$. These estimates of the cycle are also referred to as two-sided estimates since they reflect both past and future data.[15]

The process generating the business cycle is estimated as

$$C_t = \underset{(0.1029)}{0.6036}C_{t-1} + \underset{(0.0822)}{0.0123}C_{t-2} + u_t$$

## BOX 4

### Estimation details

The Kalman filter is a statistical technique that is useful in estimating the parameters of the model specified above. These parameters include $\alpha_i$, $\beta_k^i$, $\gamma_i$, $\phi_1$, $\phi_2$, $\sigma_u^2$, $\sigma_i^2$ for $i = 1, ..., I$ and for $k = 1, ..., p$. In addition, the Kalman filter enables the estimation of the processes $u_t$ and $\varepsilon_{it}$ and the construction of the unobserved cyclical variable $C_t$. The Kalman filter requires a state equation and a measurement equation. The state equation describes the evolution of the possibly unobserved variable(s) of interest, $z_t$, while the measurement equation relates observables $y_t$ to the state.

The vector $y_t$ is related to an $m \times 1$ state vector, $z_t$, via the measurement equation:

$$y_t = Cz_t + D\varepsilon_t + Hw_t,$$

where $t = 1, ..., T$; $C$ is an $N \times m$ matrix; $\varepsilon_t$ is an $N \times 1$ vector of serially uncorrelated disturbances with mean zero and covariance matrix $I_N$; and $w_t$ is a vector of exogenous, possibly predetermined variables with $H$ and $D$ being conformable matrices.

In general, the elements of $z_t$ are not observable. In fact, it is this very attribute that makes the Kalman filter so useful to economists. Although the $z_t$ elements are unknown, they are assumed to be generated by a first-order Markov process as follows:

$$z_t = Az_{t-1} + Bu_t + Gw_t$$

for $t = 1, ..., T$, where $A$ is an $m \times m$ matrix, $B$ is an $m \times g$ matrix, and $u_t$ is a $g \times 1$ vector of serially uncorrelated disturbances with mean zero and covariance matrix $I_g$. This equation is referred to as the transition equation.

The definition of the state vector $z_t$ for any particular model is determined by construction. In fact, the same model can have more than one state space representation. The elements of the state vector may or may not have a substantive interpretation. Technically, the aim of the state space formulation is to set up a vector $z_t$ in such a way that it contains all the relevant information about the system at time $t$ and that it does do by having as small a number of elements as possible. Furthermore, the state vector should be defined so as to have zero correlation between the disturbances of the measurement and transition equations, $u_t$ and $\varepsilon_t$.

The Kalman filter refers to a two-step recursive algorithm for optimally forecasting the state vector $z_t$ given information available through time $t$–1, conditional on known matrices $A$, $B$, $C$, $D$, $G$, and $H$. The first step is the prediction step and involves forecasting $z_t$ on the basis of $z_{t-1}$. The second step is the updating step and involves updating the estimate of the unobserved state vector $z_t$ on the basis of new information that becomes available in period $t$. The results from the Kalman filtering algorithm can then be used to obtain estimates of the parameters and the state vector $z_t$ employing traditional maximum likelihood techniques.[1]

The model of regional employment growth proposed above can be put into state space form defining the state vector $z_t = (C_t, C_{t-1}, C_{t-2})'$; $y_t = (y_{1t}, ..., y_{It})'$. The system matrices are given below:

$$A = \begin{bmatrix} \phi_1 & \phi_2 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \qquad C = \begin{bmatrix} \beta_0^1 & \beta_1^1 & \beta_2^1 \\ \beta_0^2 & \beta_1^2 & \beta_2^2 \\ \vdots & & \\ \beta_0^9 & \beta_1^9 & \beta_2^9 \end{bmatrix}$$

$$D = \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \sigma_2 & \cdots & 0 \\ & & \ddots & \\ 0 & \cdots & & \sigma_9 \end{bmatrix} \qquad B = \begin{bmatrix} \sigma_u \\ 0 \\ 0 \end{bmatrix}$$

$$H = \begin{bmatrix} \alpha_1 & \gamma_1 & 0 & \cdots & 0 \\ \alpha_2 & 0 & \gamma_2 & \cdots & 0 \\ \vdots & & & \ddots & \\ \alpha_9 & 0 & 0 & \cdots & \gamma_9 \end{bmatrix} \qquad G = 0$$

$$\varepsilon_t = (\varepsilon_{1t}\ \varepsilon_{2t} \cdots \varepsilon_{9t})' \qquad w_t = (1\ y_{1t-1}\ y_{2t-1} \cdots y_{9t-1})'.$$

The Kalman filter technique is a way to optimally infer information about the parameters of interest and, in particular, the state vector $z_t$, which in this case is simply the unobserved cycle, $C_t$, and its two lags. The cycle as constructed here represents that portion of regional employment growth that is common across the various regions, while allowing the cycle to differ in its impact on industry employment growth in terms of timing and magnitude through the parameters of $\beta^i(L)$. The model is very much in the spirit of Burns and Mitchell's (1946) idea of comovement but the estimation technique permits the data to determine which movements are common and which are idiosyncratic.[2]

[1]The interested reader may obtain further details in Harvey (1989) and Hamilton (1994).

[2]Stock and Watson (1989) is a recent illustration of the Kalman filtering technique for constructing the business cycle.

**TABLE 3**

**Regional employment growth model with lagged dependent variable**

| Region | Constant | Current cycle | Cycle 1 quarter ago | Cycle 2 quarters ago | Lagged regional employment growth | Standard deviation of regional shock |
|---|---|---|---|---|---|---|
| New England | 0.3711** | 1.1428*** | –0.1332 | –0.5495*** | 0.7535*** | 1.1183*** |
| | (0.1605) | (0.1207) | (0.1650) | (0.1218) | (0.0559) | (0.0710) |
| Mid-Atlantic | 0.3520** | 1.1286*** | –0.4275*** | –0.0985 | 0.6529*** | 0.9122*** |
| | (0.1668) | (0.1092) | (0.1528) | (0.0980) | (0.0719) | (0.0633) |
| East North Central | 1.2952*** | 1.8330*** | 0.0000 | 0.0000 | 0.3457*** | 1.1718*** |
| | (0.4102) | (0.1450) | — | — | (0.0822) | (0.0869) |
| West North Central | 1.8999*** | 1.0579*** | 0.5853*** | 0.0050 | 0.1164 | 0.8563*** |
| | (0.4076) | (0.1025) | (0.1570) | (0.0632) | (0.0948) | (0.0614) |
| South Atlantic | 1.8717*** | 1.2708*** | 0.0000 | 0.0000 | 0.3939*** | 0.9549*** |
| | (0.3251) | (0.1157) | — | — | (0.0514) | (0.0696) |
| East South Central | 2.2168*** | 1.7102*** | 0.4925** | –0.2914** | 0.1411 | 0.9026*** |
| | (0.5117) | (0.1359) | (0.2760) | (0.1401) | (0.1198) | (0.0757) |
| West South Central | 0.7077*** | 0.8406*** | –0.2395* | –0.1880* | 0.7683*** | 1.2456*** |
| | (0.2087) | (0.1207) | (0.1544) | (0.1204) | (0.0526) | (0.0750) |
| Mountain | 1.3379*** | 1.0218*** | –0.1161 | –0.3058*** | 0.6418*** | 1.2519*** |
| | (0.2923) | (0.1271) | (0.1715) | (0.1246) | (0.0642) | (0.0766) |
| Pacific | 1.1861*** | 1.0751*** | –0.2514* | –0.0295 | 0.5606*** | 1.3016*** |
| | (0.2921) | (0.1327) | (0.1720) | (0.1366) | (0.0721) | (0.0809) |

Notes: The dependent variable is measured as annualized quarterly regional employment growth rates. Regional employment growth is assumed to depend upon a constant, the current and two lags of the state of the economy, and a single lag of own-region employment growth. Maximum likelihood estimates are reported. Standard errors are in parentheses. ***Indicates marginal significance below 1 percent; **indicates marginal significance below 5 percent; and *indicates marginal significance below 10 percent. The mean log-likelihood is 6.48760 at the maximum.

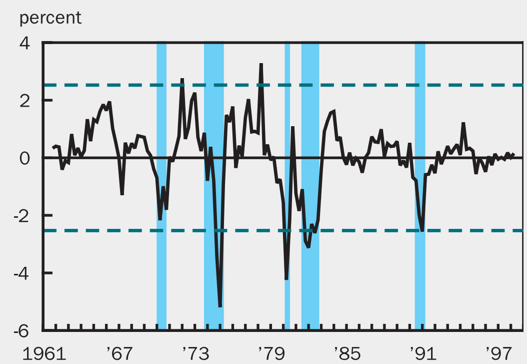
Source: See table 2.

and is shown in figure 3 for the smoothed estimates. The estimated employment cycle roughly corresponds to the timing of the NBER business cycle in the sense that contractions occur at approximately the same time as the NBER recessions. Interestingly, business cycle peaks as measured here typically precede the NBER-dated peaks and recoveries tend to precede the NBER-dated recoveries. This is particularly notable in light of the fact that the measure of cyclical activity constructed here is based upon employment data alone. It is a well-known empirical regularity that employment lags the business cycle. This can be seen from carefully comparing real gross domestic product (GDP) growth and aggregate employment growth in figure 4. So cyclical measures constructed from employment data alone might be reasonably expected to lag as well. As figure 3 shows, however, this hypothesis is not supported by the data.

Given the high real GDP growth rates of recent quarters, as shown in figure 4, we might expect the business cycle to be abnormally high over this period.

**FIGURE 3**

**Smoothed estimates of business cycle, 1961:Q4–98:Q2**

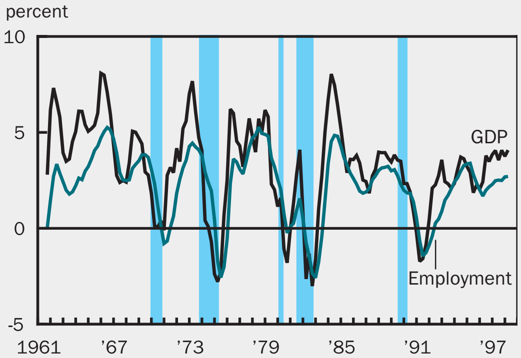



Notes: See box 2 for details of calculations. The horizontal lines represent a band of plus or minus two standard deviations. Shaded areas indicate recessions, as defined by the National Bureau of Economic Research.

Sources: U.S. Department of Labor, Bureau of Labor Statistics, 1960–98, employment database available at ftp://ftp.bls.gov/pub/time.series and author's calculations.

**FIGURE 4**

**Alternative measures of the business cycle, 1961:Q4–98:Q2**




Notes: Growth rates were calculated as four quarter log differences in the respective variable. Gross domestic product (GDP) data in 1992 chain-weighted dollars; employment data for total civilian nonfarm payroll employment. All data are seasonally adjusted. Shaded areas indicate recessions, as defined by the National Bureau of Economic Research.

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, 1961–98, *National Income and Product Accounts*, and U.S. Department of Labor, Bureau of Labor Statistics, 1961–98, employment database available at ftp://ftp.bls.gov/pub/time.series.

Instead, the estimated cycle suggests business conditions are currently hovering around neutral. The reason for the apparent disparity is quite simple. The business cycle as constructed here depends solely upon comovements in regional employment growth. However, employment growth has recently been close to its long-term average, as is also apparent in figure 4. The employment-based measure of the business cycle constructed here reflects this trend employment growth as implying neutral economic conditions.

GDP has exhibited such strong growth in recent quarters because of the increase in productivity of the economy and not because of any substantive increase in employment growth. High productivity growth will tend to increase output without a concomittant rise in employment. This is what appears to have happened in the latter part of the sample. Conversely, when productivity growth is low and employment growth remains stable, output-based measures of the cycle are likely to show deeper recessions than employment-based measures.

What happens to regional employment growth when the economy experiences an aggregate one-time shock, that is, a change in the common shock $u_t$? A positive cyclical shock of one standard deviation in magnitude increases the cycle by a unit of 1 at the time it occurs. This, in turn, affects regional employment growth contemporaneously. The following quarter the shock disappears but its effects linger and are felt in two ways. First, the shock has an evolving effect on the business cycle through its autoregressive structure.[16] This effect translates into movements in regional employment growth that also evolve over time. Second, the shock affects regional employment growth through the lag of regional employment growth (feedback).

Figure 5 traces the effect of a one standard deviation one-time aggregate business cycle shock on the cycle and also on regional employment growth. The effect of the aggregate disturbance on the business cycle itself dissipates smoothly over time. The regions' responses show more complicated dynamics, with the largest impact being felt at the same time the disturbance occurs and one quarter thereafter. The effect then fades over time. (In the West South Central region, the shock's initial effect is smaller but the effect lingers slightly longer than in other regions.)

In East North Central, for example, the cyclical shock contemporaneously increases employment growth by 1.75 percent per annum relative to its long-term average. The following quarter as these other feedbacks influence regional employment growth, the effect remains about the same at 1.71 percent, despite the value of the shock returning to 0. However, as time progresses, the cyclical shock's effect fades so by the seventh quarter following the shock, employment growth in the East North Central region is only 0.14 percent higher per annum than it would have been in the absence of the disturbance.

Recall that the variance of the cyclical shock has been scaled to equal unity. Because the current state of the economy depends upon past realizations of the business cycle as well as the aggregate shock, its variance will reflect these dynamics. The variance of $C_t$ is computed as

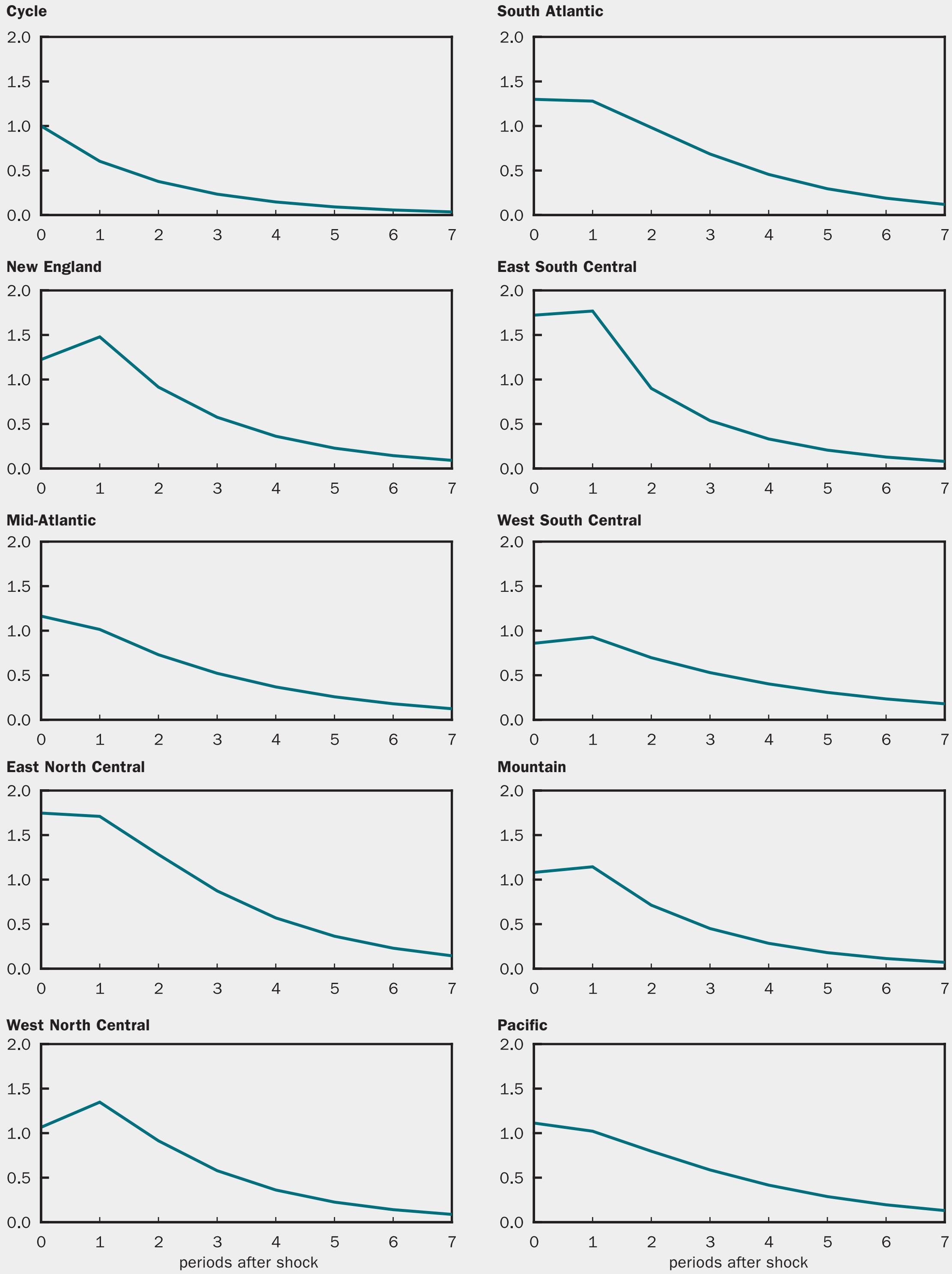
$$\operatorname{var}(C_t) = \frac{(1-\phi_2)}{(1+\phi_2)\left[(1-\phi_2)^2 - \phi_1^2\right]} = 1.596.$$

Consequently, a one unit increase in $u$ corresponds approximately to a one standard deviation shift in the cycle of $(1.596)^{1/2} = 1.263$.

Table 4 illuminates the relative importance of the business cycle and the regional idiosyncratic shocks in explaining the variance of each region's employment growth. (The calculations are shown in box 5.) Clearly, regional shocks are more important in some regions than in others. In West South Central, for example, the regional shock accounts for almost 60 percent of the variance in the region's employment growth rate. Regional idiosyncratic shocks account for a somewhat smaller but still sizable proportion of

**FIGURE 5**

**Effect of one standard deviation cyclical shock**
(percent)




Note: The panels trace the effect of a one standard deviation shock of +1 in the cyclical disturbance on the cycle and each region separately, taking into account the dynamics of the cycle and the dependence of current regional employment growth on lagged regional employment growth.

Source: Author's calculations.

the total variance in New England, Mid-Atlantic, Mountain, and Pacific. This compares with East South Central, where almost 90 percent of the region's total variance is attributable to variance in the aggregate shock. The East North Central, West North Central, and South Atlantic regions appear to be influenced in large part by the aggregate shock.

The model has been estimated under the assumption that the regional disturbances are uncorrelated with each other for all leads and lags and are serially uncorrelated. This is a strong assumption and a test is useful to assess the validity of the estimated model. According to the model estimated above, all comovement is ascribed to the common cyclical shock. If the model is true, then errors made in forecasting regional employment growth in one region should not be useful for predicting regional employment growth in another region. One can construct a simple diagnostic test in which the estimated one-step-ahead forecast errors in a region's employment growth are regressed against lags of the one-step-ahead forecast errors in other regions.[17] If the model describes the data well, lags of another region's forecast errors should not be significantly different from 0 in these regressions. In other words, errors made in forecasting another region's employment growth should not significantly aid in the prediction of a given region's employment growth.

In table 5, $p$-values are reported for the regressions described above, testing for the significance of forecast error lags. If the model fits the data well, the $p$-values should be large. Small $p$-values indicate that the independent variable has some predictive content for the dependent variable. Because of natural variation, we would expect about 10 percent of the regressions (that is, eight or nine) to have $p$-values of less than 0.100 even if the hypothesis was true. Table 5 shows that, in fact, ten of the regressions show significantly low $p$-values. More significantly, most of these low $p$-values are in regressions involving the predictive content of forecast errors in the West South Central region.

One obvious reason why the West South Central region may wield such influence in regional employment growth stems from the industrial composition of the area. The West South Central states are heavily dependent on oil and gas production. Disturbances to these industries, in turn, have repercussions for other industries and regions of the country. My results imply that, in addition to the common cyclical factor affecting all regions, there might be another factor involved in explaining regional employment growth patterns. This factor is likely related to oil price shocks. Further research is necessary to test this hypothesis.

The main advantage of estimating a Kalman filter model of the sort presented here is its ability to obtain estimates of the underlying cyclical and regional disturbances, as shown in figure 6. The analysis suggests that New England experienced some positive shocks in the late 1970s and early 1980s, coinciding roughly with well-documented growth in technology and business services at that time. However, some time in the late 1980s, the region experienced a series of large negative shocks. These shocks correspond to the timing of the S&L crisis and the credit crunch. At about this time, computers were making the transition from mainframe to desktop and some larger New England employers were cutting back their labor force in large numbers. Employment growth in New England has recovered to some extent and is approximately in line with what is predicted by the model.[18]

The Mid-Atlantic region is heavily influenced by New York. Regional employment growth has held fairly steady, with the stock bust of 1987 causing lower employment growth. The East North Central region experienced a large negative disturbance during the period surrounding the first oil price shock and smaller negative ones in 1978 and in 1980. For much of the 1980s through mid-1990s, employment growth shocks in this area were small and tended to be positive. This likely reflects the bottoming out of the farm crisis in 1986 and strong export growth. The farm crisis also appears to have had an effect on employment

**TABLE 4**

**Steady state regional employment growth variance due to cycle and shock, 1961:Q2–98:Q3**

| Region | Steady state employment growth variance | Percent of variance from cyclical shock | Percent of variance from regional shock |
|---|---|---|---|
| New England | 7.3284 | 60.5 | 39.5 |
| Mid-Atlantic | 4.6298 | 64.8 | 31.3 |
| East North Central | 10.7283 | 85.5 | 14.5 |
| West North Central | 4.9939 | 85.1 | 14.9 |
| South Atlantic | 5.9623 | 81.9 | 18.1 |
| East South Central | 8.0531 | 89.7 | 10.3 |
| West South Central | 6.3430 | 40.3 | 59.7 |
| Mountain | 5.9528 | 55.2 | 44.8 |
| Pacific | 5.7963 | 57.4 | 42.6 |

Note: See box 5 for a discussion of the calculations.
Source: See table 2.

## BOX 5

### How important are regional shocks?

The steady state variance of regional employment growth reported in table 4 is, in general, a complicated function depending upon the variance of the idiosyncratic shock, the variance of the cyclical disturbance, the cross-correlation structure between regions, and the dynamics of the model. To construct a measure of the steady state variance of regional employment growth, first rewrite the model in terms of a vector AR(1) process. Specifically, let $\underline{z}_t = (y_{1t}, y_{2t}, \ldots, y_{9t}, C_{t+1}, C_t, C_{t-1})'$ and rewrite the model as:

$$\underline{z}_t = \Pi \underline{z}_{t-1} + \underline{v}_t,$$

where $\underline{v}_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots, \varepsilon_{9t}, u_t, 0, 0)'$ and the matrix $\Pi$ is formed as follows:

$$\Pi = \left[\begin{array}{c|c} \Gamma_{9x9} & C_{9x3} \\ \hline 0_{3x9} & A_{3x3} \end{array}\right],$$

where the matrix $\Gamma$ has $\gamma_1, \ldots, \gamma_9$ along the diagonal and 0 elsewhere, and $A$ is defined in box 4. Let the variance–covariance matrix of $\underline{v}_t$ and $\underline{z}_t$ equal $\Sigma$ and $\Omega$, respectively. Then

$$\Omega = \Pi\Omega\Pi' + \Sigma,$$

which has the following solution:

$$\text{vec}(\Omega) = [\text{I} - (\Pi \otimes \Pi)]^{-1}\text{vec}(\Sigma).$$

In this case the total steady state variance of a region's employment growth is the sum of two terms, one reflecting the variance of the idiosyncratic regional shock, and the other reflecting the variance of the cyclical disturbance. Calculating the percentage attributable to each of the two shocks follows easily.

growth in the West North Central region. The West South Central region appears to have more volatility, and experienced a large negative disturbance in the mid-1980s. This shock is most likely the result of the oil price bust, followed by a recovery in the industry. Finally, the Pacific region was hit by a series of negative shocks in the early 1990s due to cutbacks in defense spending.[19] The Pacific region seems to have recovered to a large extent.

## Conclusion

The business cycle is not observable directly. Instead, it must be inferred from observing many data series simultaneously. Casual observation suggests

## TABLE 5

### Significance of lagged regional employment growth forecast errors

| j↓ i→ | New England | Mid-Atlantic | East North Central | West North Central | South Atlantic | East South Central | West South Central | Mountain | Pacific |
|---|---|---|---|---|---|---|---|---|---|
| New England | **0.083** | 0.288 | 0.652 | 0.650 | 0.381 | 0.639 | 0.189 | 0.762 | 0.336 |
| Mid-Atlantic | 0.423 | **0.063** | 0.699 | 0.450 | 0.551 | 0.385 | 0.639 | 0.500 | 0.786 |
| East North Central | 0.294 | 0.863 | 0.161 | 0.304 | **0.074** | 0.438 | 0.316 | 0.200 | 0.678 |
| West North Central | 0.997 | 0.973 | 0.769 | 0.834 | 0.273 | 0.885 | 0.250 | 0.878 | 0.839 |
| South Atlantic | 0.693 | 0.766 | 0.735 | 0.767 | 0.698 | 0.987 | 0.860 | 0.854 | 0.330 |
| East South Central | 0.934 | 0.612 | 0.410 | 0.209 | 0.931 | 0.721 | 0.693 | 0.970 | 0.651 |
| West South Central | 0.219 | 0.214 | **0.007** | **0.070** | **0.003** | **0.008** | 0.749 | **0.031** | **0.048** |
| Mountain | 0.706 | 0.380 | 0.538 | 0.942 | 0.713 | 0.885 | 0.403 | 0.599 | 0.345 |
| Pacific | 0.501 | **0.026** | 0.271 | 0.339 | 0.744 | 0.692 | 0.190 | 0.480 | 0.382 |

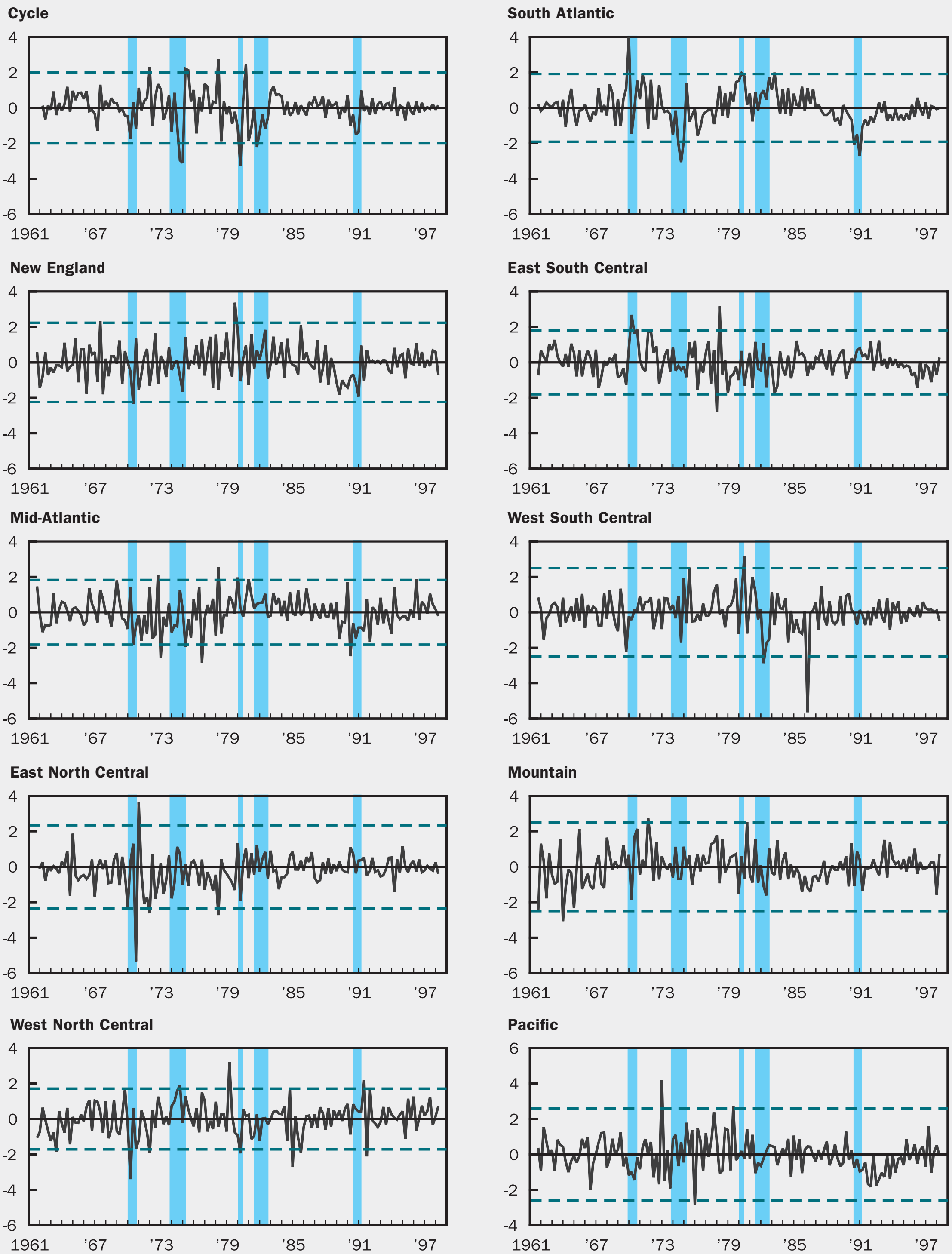
Notes: The table reports *p*-values for OLS regressions of the form:

$$e_{it} = c + \beta_1 e_{jt-1} + \beta_2 e_{jt-2} + \ldots + \beta_6 e_{jt-6} + \upsilon_t,$$

where $e_{it}$ and $e_{jt}$ are the estimated one-step-ahead forecast errors at time $t$ for regional employment growth and $i, j = 1, \ldots, 9$. The *p*-values reported in the table are the significance levels for the test of the null hypothesis that the $\beta$ coefficients are 0. Low *p*-values indicate that the hypothesis is not consistent with the data. Numbers in bold indicate a *p*-value less than 0.100.
Source: See table 2.

**FIGURE 6**

**Estimates of cyclical and regional shocks, 1961:Q4–98:Q2**
(percent)




Notes: The horizontal lines represent two standard error bands. Shaded areas indicate recessions, as defined by the National Bureau of Economic Research.
Source: U.S. Department of Labor, Bureau of Labor Statistics, 1961–98, employment database available at ftp://ftp.bls.gov/pub/time.series.

that all regions experience some cyclicality in employment growth, despite the fact that some regions show above-average employment growth over long periods and other regions consistently report below-average employment growth. The fact that these regions move more or less in tandem over time provides a way to construct a measure of the business cycle.

In this article, I define the business cycle as comovements in regional employment growth. I estimate the cycle using the Kalman filter and maximum likelihood techniques. The estimates of the cycle obtained from the model are quite consistent and conform with more traditional measures of the business cycle, for example, GDP growth or the unemployment rate.

Because employment growth is distinct from productivity growth, the estimates of the cycle do not exhibit the large expansion in the most recent period that output-based measures do. In fact, current estimates of the business cycle show that the economy is well balanced, in the sense that there are no cyclical shocks that seem to be expanding or contracting regional employment growth above or below long-term averages. If employment growth contributes to inflation, this balance in the economy seems to imply that, despite high output growth, inflation is under control.

Sectoral disturbances appear to be an important determinant of regional employment growth—at least in some regions. This is particularly true for the West South Central, Mountain, Pacific, New England, and Mid-Atlantic states. Regional shocks play a far less important role in explaining regional employment growth in the East North Central, West North Central, South Atlantic, and East South Central regions, where most of the movements are related to aggregate fluctuations.

There are obviously many ways one could define the business cycle. The tack taken here is to define it relative to regional employment growth patterns. This is not to say that all other information should be excluded from the analysis. However, the focus on an employment-based measure helps shed light on regional issues. Furthermore, a comparison of an employment-based cyclical measure versus an output-based measure may aid in our understanding of productivity.

Finally, the methodology employed permits the recovery of a series of regional employment shocks. The timing of such disturbances may be helpful for assessing what factors may explain regional declines or expansions that are not anticipated by long-term patterns or cyclical influences. Although speculative, it appears that oil shocks and defense contracts might help explain the origin of regional shocks. The model estimated here is somewhat simplistic, in that it does not allow for regional spillovers that are not accounted for by the aggregate shock. By examining the regional disturbances that the model estimates and formulating a better notion of the underlying economics behind these regional shocks, one could develop a richer understanding of regional dynamics.

NOTES

[1]A comprehensive list is outside the scope of this article. A few references include Barro (1977, 1978), Mishkin (1983), Gordon and Veitch (1986), and Litterman and Weiss (1985).

[2]Blanchard and Watson (1986).

[3]Mitchell (1927).

[4]Clark (1998), p. 202.

[5]A more appropriate nomenclature might be the "employment cycle" since it is constructed by filtering out the common movements in employment across regions. In contrast, the "business" cycle is typically modeled as comovements in less narrowly focused series. For example, Stock and Watson (1989) construct their Coincident Economic Index with reference to industrial production, total personal income less transfer payments in 1982 dollars, total manufacturing and trade sales in 1982 dollars, and employees on nonagricultural payrolls.

[6]The New England states are Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island. Mid-Atlantic contains New York, Pennsylvania, and New Jersey. East North Central comprises Wisconsin, Michigan, Illinois, Indiana, and Ohio. South Atlantic contains Maryland, Delaware, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida. East South Central states are Kentucky, Tennessee, Alabama, and Mississippi. West South Central contains Oklahoma, Arkansas, Louisiana, and Texas. The East North Central states are Minnesota, Iowa, Nebraska, Kansas, North Dakota, South Dakota, and Missouri. The Mountain states are Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico. Pacific contains Alaska, Hawaii, Washington, Oregon, and California.

[7]These trends have been noted by previous researchers, including Blanchard and Katz (1992).

[8]The timing of the cyclical upturns and downturns in regional employment growth is somewhat different from that proposed by the NBER dating. It is well known that employment reacts with a small lag to cyclical events so, for example, the trough of the recessions is typically a short time after the NBER dating of the trough.

[9]This observation was made by Mitchell (1927).

[10]Seasonally unadjusted data are reported monthly by the BLS and are available on the BLS Labstat website. Calculations were carried out using quarterly data that have been seasonally adjusted using the PROC X11 procedure. Hawaii has been omitted from the calculations due to a lack of data for mining.

[11]A richer model might incorporate other cyclical series as well, such as gross domestic product (GDP) or industry employment. However, because the objective is to describe regional employment patterns, the business cycle is constructed by looking at comovements in regional employment patterns alone.

[12]The discussion here follows Harvey's (1989) analysis of common trends.

[13]A more subtle point is raised in Stock and Watson (1989). Given three data series that are serially uncorrelated but are correlated with each other, it is always possible to restructure the model with a single index. This common factor captures the covariance of the three series. Over-identification occurs when there are more than three observable variables (there are nine here) or when the variables are serially correlated.

[14]The BFGS algorithm was used in maximizing the likelihood function. In practice, numerical difficulties arose in which the Hessian matrix failed to invert when the model was estimated with the sole restriction that lags of the cycle do not enter into the East North Central Region. The problem was resolved by restricting the South Atlantic region to depend solely upon the contemporaneous cycle as well.

[15]Details of this procedure can be found in chapter 4 of Harvey (1989).

[16]The evolution of the business cycle following a temporary one standard deviation shock is found in the first panel of figure 5.

[17]The one-step-ahead forecast error is simply defined as:

$$\hat{e}_{it} \equiv y_{it} - \hat{y}_{it|t-1},$$

where the forecast error $\hat{e}_{it}$ is calculated as the difference between the actual regional employment growth rate at time $t$ and the model's prediction of regional employment growth based upon information up to time $t-1$.

[18]Bradbury (1993) examines employment over the 1990–91 recession and the recovery in New England.

[19]See Gabriel et al. (1995) for a discussion of migration trends in California.

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