Measuring labor market turbulence

Ellen R. Rissman

According to the terms of the Full Employment and Balanced Growth Act of 1978, the Federal Reserve is charged with promoting *full employment*.[1] However, there is no widespread agreement about what constitutes full employment or how it should be measured.

One might expect that what is meant by full employment is that there is no unemployment. However, having an economy operating at 0 percent unemployment is suboptimal. The labor market is dynamic and in a constant state of flux. At any given moment, some individuals are entering or exiting the labor market, some are transiting from unemployment to employment, while others are switching jobs or leaving jobs. Thus, one would expect that the economy would naturally produce some level of unemployment as individual participants in the labor market seek the best employment opportunities. Policies aimed at eliminating unemployment altogether would interfere with the economic forces at work that encourage workers to search for better employment opportunities.

In defining the full employment level of unemployment, a natural starting point is to distinguish among three main types of unemployment: frictional, structural, and cyclical. *Frictional* unemployment is the result of *imperfect information* available to both employers and workers in a labor market. Given the distribution of demand, new entrants do not know where their best opportunities lie. A worker must therefore search for a job and is unemployed until an acceptable job is located. When a worker accepts a position with an employer, there are many attributes about the job and the worker that are unknown at the outset but are revealed over a period of time. An employer may discover that the employee is not as productive as expected or the employee may find that the job characteristics are not what he or she had imagined when accepting the position. In any case, separations that result in some period of unemployment naturally occur.

Structural unemployment is the result of shifts in relative demand for different types of labor. These shifts in labor demand across industries, skills, or geographic areas cause unemployment because they result in a temporary mismatch between worker skills and/or locations and firm requirements and/or locations. If wages were flexible and adjusted instantaneously to changes in labor demand, then no unemployment would result. Nor would unemployment occur if labor mobility and the acquisition of new skills were costless. In reality, wages do not appear to adjust quickly to these imbalances. Furthermore, the location of alternative employment, the worker's subsequent relocation, and the acquisition of new skills are time-consuming and costly activities that result in at least some period of unemployment. As the labor market adjusts to sectoral shifts, the unemployment these changes create will diminish over time.

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The transformation from an agricultural to industrial economy, the movement from goods-producing industries to service-producing industries, and the decline in funding for defense-related activities are all examples of sectoral shifts. All these shifts result in a relative decline in employment in the affected sector. Structural unemployment is the result of workers adjusting to their changing employment opportunities.

Finally, *cyclical* unemployment occurs when there is a *general* decline in labor demand combined with downwardly rigid real wages. In the event of a cyclical downturn, labor demand falls simultaneously in many sectors but real wages do not fall fast enough to bring the labor market back to equilibrium quickly. The distinction between cyclical and structural unemployment is in the breadth of the sectors affected. In the case of sectoral shifts, one sector's employment falls while another's expands. In the case of cyclical unemployment, all sectors are more or less affected simultaneously, with labor demand declining across many sectors of the economy at one time. Another distinction is that sectoral shifts are usually one-sided in that they are not likely to reverse themselves, at least over a short period. Unlike structural change, a cyclical downturn is likely to be only temporary with recessions followed by expansions.

Given this rough framework of frictional, structural, and cyclical unemployment, the full employment level of unemployment can be defined as the sum of frictional and structural unemployment. It is the level of unemployment that is consistent with the economy growing along a stable equilibrium path with neither contractions or expansions. Alternatively, it is the amount of unemployment that is generated due to the normal functioning of the labor market, given that there are no general disturbances to labor demand across sectors. Because it is a result of the normal functioning of the labor market, this type of unemployment can be viewed as the natural rate of unemployment.

Typically, we think of frictional unemployment as being essentially constant over time. Admittedly, this is an oversimplification, because changes in the cost of search or the way in which information about job openings is disseminated can affect the frictional rate. In contrast, structural unemployment varies over time in response to changes in relative demand for labor or economic turbulence. For the policymaker whose job is to promote full employment, correctly gauging structural unemployment is essential. If frictional unemployment is 3 percent but the economy is in turmoil and structural unemployment adds an additional 4 percent, then a policy geared toward attaining a preset 4 percent level of unemployment will likely succeed only in raising inflation. Such an event seems to have been at work in the "stagflation" of the 1970s when both unemployment and inflation were high by historical standards. Policymakers failed to recognize that the late 1970s were particularly turbulent so that the full employment level of unemployment was also high.[2]

In formulating a measure of the natural rate of unemployment, it is necessary to quantify what is meant by economic turbulence. The purpose of this article is to measure economic turbulence using data on employment shares across broad industry categories. The procedure differs substantially from that which has been proposed previously in the literature, in that it filters out movements in employment share in a given industry that are related to the cycle. First, I describe briefly how turbulence has been measured in other research. I then develop a model of net employment growth that addresses some of the problems inherent in the other measures. The Kalman filter estimating procedure is a statistical technique, discussed below, that is ideally suited to addressing the estimation problems. Results of the empirical exercise are given next. Using these results, I then propose an alternative measure of economic turbulence.

Developing a measure of structural change

The problem of measuring structural shifts was first tackled by Lilien (1982), who examined employment shares for broad industry categories and proposed the following measure of structural change:

$$1)\quad \sigma_t = \left[\sum_{i=1}^{I} S_{it}(g_{it} - g_t)^2\right]^{1/2},$$

where i refers to the ith industry, $i = 1, ..., I$; S_{it} is the share of industry i's employment in total employment; g_{it} and g_t are industry i's annual employment growth and aggregate employment growth respectively; and t indexes time. Lilien's σ measures dispersion in annual employment growth across industries. In practice, Lilien used annual data from 1948 through 1980 and a decomposition of aggregate employment into 11 industries. Inspection of Lilien's measure, reproduced in figure 1 using quarterly data for 10 industry categories, shows clear peaks during cyclical downturns.

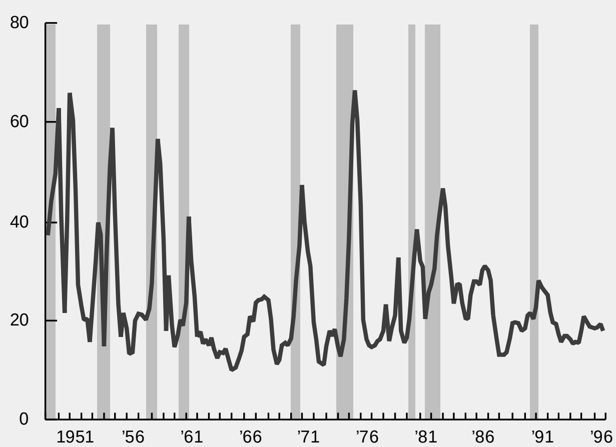
Abraham and Katz (1986) pointed out that Lilien's measure of sectoral shifts was flawed in that dispersion can increase either because of shifts in the distribution of employment brought about by structural change or because of shifts that occur as a result of normal business cycle activity having a differential impact across industries. They argued that the normal course of the business cycle will cause Lilien's dispersion measure to have peaks during economic downturns independent of any structural disturbance.

It has been widely documented that the business cycle systematically affects the distribution of employment across industries.[3] For example, manufacturing's employment share typically declines during an economic downturn while the service sector's share typically increases. This pattern of cyclical shocks affecting the distribution of employment across industries makes the interpretation of Lilien's measure problematic. Did σ increase during recessions due to the normal effects of the business cycle or did it increase because the business cycle is somehow coincident with structural change? Because of the problem in disentangling the source of these distributional shifts, it is difficult to argue that Lilien's σ is a measure of structural change alone, and his results that structural change leads to higher unemployment are suspect.

Since Lilien's attempt to address the effects of economic turbulence on the unemployment rate, several authors have refined his measurement of structural change. For example, Loungani, Rush, and Tave (1990), Brainard and Cutler (1993), and Genay and Loungani (1997) used data on stock market price dispersion as evidence of structural change. Their rationale is that stock market prices should respond to sectoral shifts while their dispersion is not influenced by cyclical activity. Neumann and Topel (1991) and Rissman (1993) took a different tack. They looked at permanent changes in the distribution of employment across industries, noting that if the shifts were only temporary, they were cyclical by definition. The main difficulty with this approach is that it relies on future information to determine whether a current shift is "permanent." The analysis supports the notion that the stagflation of the 1970s was the result of structural change combined with general tightness in the labor market. However, the approach's reliance on this concept of permanence in measuring structural change makes it difficult to use as a policy tool.

FIGURE 1

Lilien dispersion measure



Note: The shaded areas indicate recessions in this and all subsequent figures in this article.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, various issues.

A model of net employment growth

The approach taken here is in the same spirit as Neumann and Topel (1991) and Rissman (1993). However, the procedure does not rely upon ad hoc definitions of permanence to separate shifts in the distribution of employment across industries into those that are structural in origin from those that are cyclical. A model of net employment growth is proposed that explicitly incorporates cyclical movement as well as an idiosyncratic or structural shift. It is this idiosyncratic portion, which is by construction independent of the business cycle, that is used to measure economic turbulence in a way that is reminiscent of Lilien's original work.

The turbulence measure constructed here is more intuitive and does not suffer from the difficulty in applying it to a policy context in a timely manner.

As in equation 1 above, let S_{it} be the share of total employment in industry *i*. Define $y_{it} \equiv \Delta \ln S_{it} = g_{it} - g_t$, where g_{it} and g_t are industry *i* and aggregate employment growth, respectively. Figure 2 shows net annualized growth rates (y_{it}) using quarterly data for the following industries: construction, services, mining, finance, insurance, and real estate, government, nondurable manufacturing, wholesale trade, transportation and public utilities, durable manufacturing, and retail trade from 1955 through 1996Q3. There are several important points to note. First, the scale differs markedly from industry to industry, with mining exhibiting relatively stable net employment growth punctuated by a few large swings. Other industries, such as nondurable manufacturing and transportation and public utilities, show a similar pattern but with more moderate swings. Second, some industries show a noticeable trend in employment share; these include a shrinking durable and nondurable manufacturing sector and an expanding services industry. Third, there is a pronounced cyclical pattern in some industries, most notably in durable manufacturing, construction, services, retail trade, and wholesale trade.

The data shown in figure 2 suggest three reasons why industry employment growth can differ from the aggregate. First, an industry's employment share may be trending upward or downward over long periods of time. Second, the business cycle can cause employment shares to deviate from the aggregate. As mentioned above, economic downturns tend to cause durable manufacturing employment to decline relatively more than total employment, while the converse holds true for services. Finally, there is an idiosyncratic portion that is industry-specific, an example of which occurred in the mid-1970s in nondurable manufacturing.

Assume that y_{it} has the following specification:

2) $$y_{it} = a_i + b_i(L)C_t + u_{it},$$

where a_i is a constant varying across industries. It is interpreted as the mean net employment growth in industry *i*. From figure 2 we expect, for example, this term to be negative in nondurable manufacturing and positive in services. C_t is a measure of the business cycle (discussed more fully below); u_{it} is the idiosyncratic shock affecting industry net employment growth at time *t*. The idiosyncratic shock incorporates anything that cannot be explained by normal business cycle activity or long-term trends. One example of an idiosyncratic shock would be a strike.

It is assumed that $b_i(L)$ is a polynomial in the lag operator. Specifically,

3) $$b_i(L) = b_i^0 + b_i^1 L + b_i^2 L^2.$$

The polynomial $b_i(L)$ is a flexible but parsimonious way to allow for the effect of the cycle on net employment growth to have a differential impact across industries. It permits the cycle to lead in one industry and lag in another. It also permits the cycle to have a greater impact in one industry than in another. For example, if an economic downturn typically causes a decline in construction employment share prior to a decline in durable manufacturing, then the coefficient on contemporaneous C_t would be close to zero in durable manufacturing and negative in construction.

Since Mitchell (1927) and later Burns and Mitchell (1946), the concept of a business cycle has been defined 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." Thus, the business cycle is essentially unobservable but can be inferred only through its effects on many dimensions simultaneously.[4] In developing a measure of the business cycle, it is assumed that the business cycle component, C_t, is directly unobservable. However, its time series properties are restricted to follow an AR(2) specification so that:

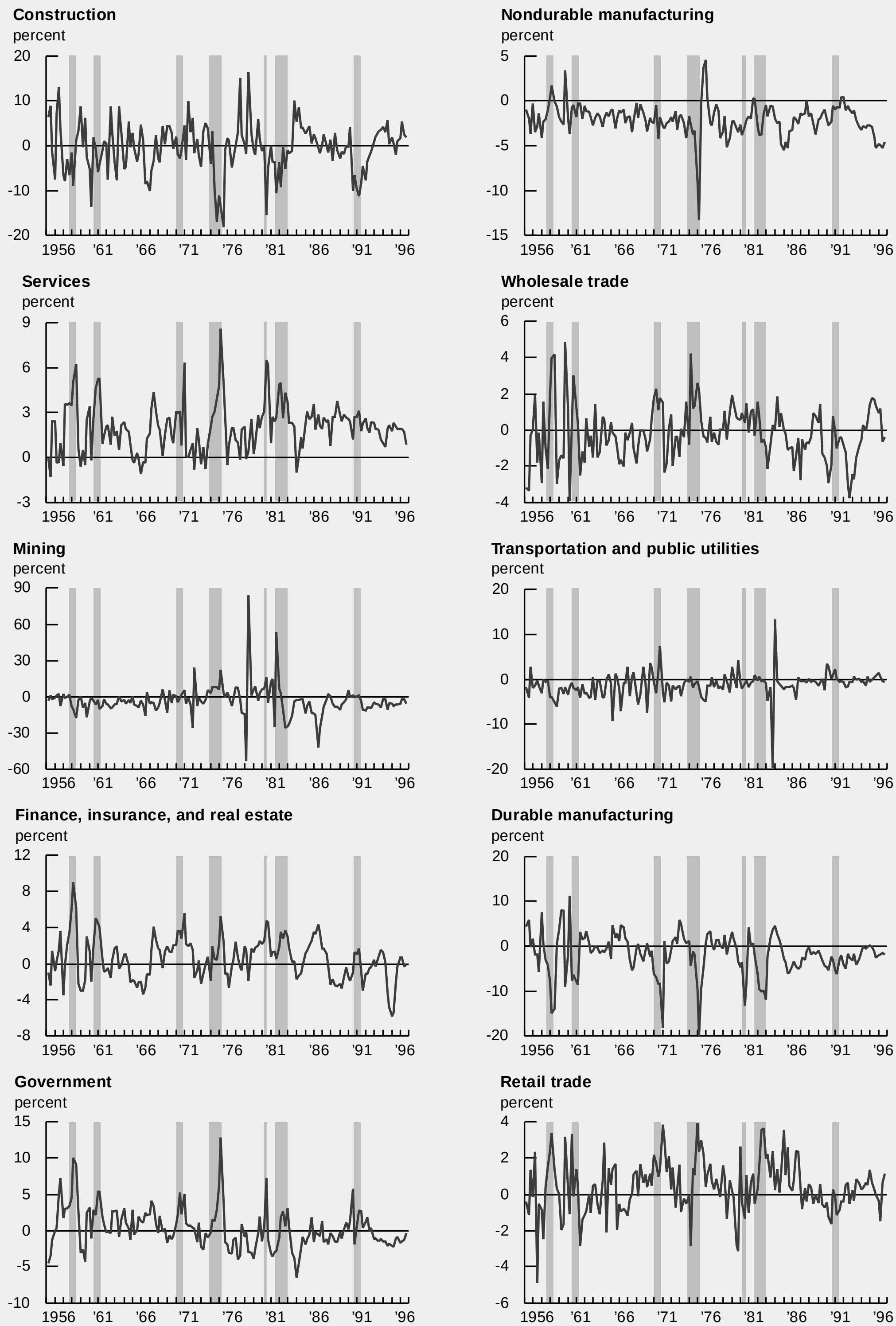
4) $$C_t = \phi_1 C_{t-1} + \phi_2 C_{t-2} + \varepsilon_t .$$

The imposition of an AR(2) process generating the business cycle allows for Mitchell's characterization of recessions followed by expansions in a succinct way.

To completely specify the model, it is necessary to assume something about the two types of shocks, u_{it} and ε_t, where u_{it} can be

FIGURE 2

Net employment by industry



Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, various issues.

thought of as a sectoral disturbance and ε_t is a business cycle shock. Specifically, I assume that the two types of shocks are mean zero, $E(u_{it})$, $E(\varepsilon_t) = 0$, for all t and i. Furthermore, the shocks are serially uncorrelated, $E(u_{it}u_{it-s}) = E(\varepsilon_t\varepsilon_{t-s}) = 0$ for all i, t, and $s \neq 0$.[5] Nor are the shocks correlated with one another, $E(\varepsilon_t u_{it-s}) = 0$ for all i, t, and s.[6] The shock in one industry is uncorrelated with the shock in another industry, $E(u_{it}u_{jt-s}) = 0$ for all s, $i \neq j$.[7] Finally, each shock has a finite variance, $E(u_{it}^2) = \sigma_i^2$ and $E(\varepsilon_t^2) = \sigma_\varepsilon^2$.

Estimation

The Kalman filter is a statistical technique that is useful in estimating the parameters of the model specified above. These parameters include a_i, b_i^0, b_i^1, b_i^2, ϕ_1, ϕ_2, σ_ε, and σ_i. In addition, the unobserved processes ε_t and u_{it} can be estimated and used to construct the common cycle C_t.[8] To start, 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, while the measurement equation relates observables to the state. Let y_t be an $N \times 1$ vector of observed variables at time t. In the model of net employment growth described above, the elements of y_t correspond to the difference between industry and aggregate employment growth for the i industries.

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

$$5)\quad y_t = Cz_t + Du_t + Hw_t,$$

where $t = 1, ..., T$; C is an $N \times m$ matrix; u_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.[9]

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:

$$6)\quad z_t = Az_{t-1} + B\varepsilon_t + Gw_t$$

for $t = 1, ..., T$, where A is an $m \times m$ matrix, B is an $m \times g$ matrix, and ε_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. In the model of net employment growth constructed above, the unobserved state variable is the cycle C_t. It is further assumed that $E(\varepsilon_t u_t') = 0$ and the ε_t and u_t are orthogonal to all previous y and z.[10]

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 on the system at time t and that it does so 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, ε_t and u_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 model of net industry employment growth proposed above can be put into the following state space form with $z_t = (C_t, C_{t-1}, C_{t-2})'$; $y_t = (y_{1t}, ..., y_{8t})'$. The system matrices are given below:

$$A = \begin{bmatrix} \phi_1 & \phi_2 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} b_1^0 & b_1^1 & b_1^2 \\ b_2^0 & b_2^1 & b_2^2 \\ \vdots & & \\ b_8^0 & b_8^1 & b_8^2 \end{bmatrix}$$

$$D = \begin{bmatrix} \sigma_1 & 0 & \dots & 0 \\ 0 & \sigma_2 & \dots & 0 \\ & & \ddots & \\ 0 & \dots & & \sigma_8 \end{bmatrix}$$

$$B = \begin{bmatrix} \sigma_\varepsilon \\ 0 \\ 0 \end{bmatrix}$$

$$G = 0$$
$$H = (a_1\, a_2 \dots a_8)'$$
$$u_t = (u_{1t}\, u_{2t} \dots u_{8t})'$$
$$w_t = 1.$$

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.[11] The cycle as formulated here represents that portion of net employment growth that is common across the various industries, while allowing the cycle to differ in its impact on industry employment growth in terms of timing and magnitude through the b_j^i parameters.[12] 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 what movements are common and what are idiosyncratic.

Results

Although the data introduced in figure 2 cover ten industry categories, in practice the model was estimated using only eight sectors. Mining is a small sector in terms of its share of total employment. However, its employment is also quite volatile over the time period considered due to strikes and union activity. Because of its volatility and relatively small magnitude in the total, it was omitted from the Kalman filter exercise. There is a potential multicolinearity

TABLE 1

Industry parameter estimates

	a_i	b_i^0	b_i^1	b_i^2	σ_i
Construction	–0.3485 (0.4080)	1.5066*** (0.4767)	0 —	–1.1822*** (0.4751)	5.3410*** (0.2928)
Finance, insurance, and real estate	0.7105*** (0.2121)	–0.1153 (0.4412)	–2.5989*** (0.8989)	1.8965*** (0.4906)	1.3818*** (0.1305)
Nondurable manufacturing	–1.8524*** (0.2755)	–1.3249 (1.2392)	7.9403*** (2.6071)	–5.6518*** (1.4115)	2.1258*** (0.2214)
Durable manufacturing	–2.0159*** (0.1427)	0.3486** (0.1583)	0 —	–0.6204*** (0.1697)	1.6831*** (0.0934)
Transportation and public utilities	–1.0823*** (0.2231)	–0.5984 (0.7081)	0.6484 (1.1678)	0.3093 (0.6041)	2.7181*** (0.1480)
Government	0.4897*** (0.1791)	0.6014 (0.6916)	–3.9610*** (1.4223)	2.9241*** (0.7973)	1.9315*** (0.1227)
Retail trade	0.4520*** (0.1252)	–0.1265 (0.2619)	–0.6693* (0.4980)	0.4476* (0.2835)	1.2814*** (0.0723)
Wholesale trade	–0.0661 (0.1129)	0.3073 (0.3883)	–1.7170** (0.7901)	1.4448*** (0.4675)	1.3817*** (0.0802)
Services	2.0935*** (0.0850)	–2.0076*** (0.2137)	1.6630*** (0.3662)	0.0053 (0.2085)	1.1031 —
Mining	–2.8766*** (0.9441)	–0.3666 (2.3739)	1.7568 (4.0674)	–0.6197 (2.3155)	12.2508 —

*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

problem that occurs because the sum of the y_{it}'s is approximately 0. By omitting a second industry, in this case services, from the estimation, the problem is avoided.

Estimation of the parameters a_i, b_i^0, b_i^1, b_i^2, ϕ_1, ϕ_2, σ_ε, and σ_i was carried out for the period from 1954Q2 to 1996Q3.[13] The Kalman filter estimation procedure also produced estimates of the business cycle C_t and the two shocks ε_t and u_{it} over the same time period. After having obtained estimates of the business cycle, C_t conditional on information prior to time t, a Kalman smoothing technique was applied that uses all available information through 1996 to generate smoothed estimates of C_t.[14]

Table 1 shows the results of the Kalman filtering exercise for the industry parameters a_i, b_i^0, b_i^1, b_i^2, and σ_i. Note that the estimation results also include parameter estimates for services and mining, although they were not directly included in the Kalman filtering exercise. These estimates were derived from a secondary procedure. After having estimated the common cycle, C_t, two additional regressions were run essentially treating C_t as a known exogenous variable. Each regression is of the form found in equation 2. The standard errors reported in table 1 for both services and mining are too small, in that they do not take into account the uncertainty in the estimates of C_t.

There are several interesting points to note. First, the constant term is significant in all but construction and wholesale trade, indicating that in these two industries there is no discernible long-term trend in employment share. The remaining industries exhibit the familiar story of declining employment share in goods-producing industries and the mirrored increasing employment shares in service-producing industries. Finance, insurance, and real estate, as well as government, retail trade, and services, show the expected increasing employment share over the long term. Conversely, the goods-producing industries of durable and nondurable manufacturing, transportation and public utilities, and mining exhibit shrinking employment share over the period. Second, the contemporaneous parameters b_i^0 are significantly different from 0 only in construction, nondurable manufacturing, and services.[15] F-tests support the notion that the business cycle has a pronounced effect in all industries examined with the exception of transportation and public utilities and mining, which are both characterized by a relatively large standard error in the idiosyncratic shock. Net employment growth in construction has a large idiosyncratic portion as evidenced by the large standard error, σ_i. However, it also exhibits strong cyclical activity.

Equation 4 is estimated as

$$7)\quad C_t = \underset{(0.0744)}{1.5598}\; C_{t-1} - \underset{(0.0674)}{0.7154}\; C_{t-2} + \varepsilon_t,$$

where $\sigma_\varepsilon = 0.4558$. The smoothed estimates for C_t are shown in figure 3.[16] The National Bureau of Economic Research (NBER) dates business cycle peaks and troughs. The actual dating scheme the NBER uses is somewhat vague and left open to interpretation, with a wide array of information being considered. The period of time from business cycle peak to subsequent trough is termed a contraction and these NBER contractions are shaded in figure 3. In contrast, the Kalman filter technique employed here relied only on information about the employment shares in the eight industries examined. Gross domestic product, for example, did not enter into the estimation. Yet the estimates of the cycle, C_t, are remarkably similar in timing

FIGURE 3

Kalman filter estimates of the business cycle

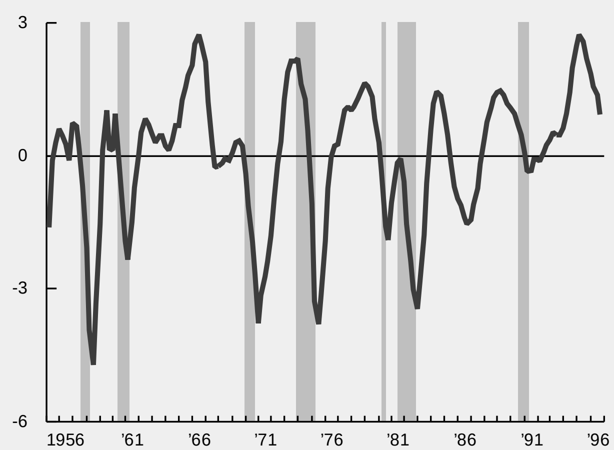
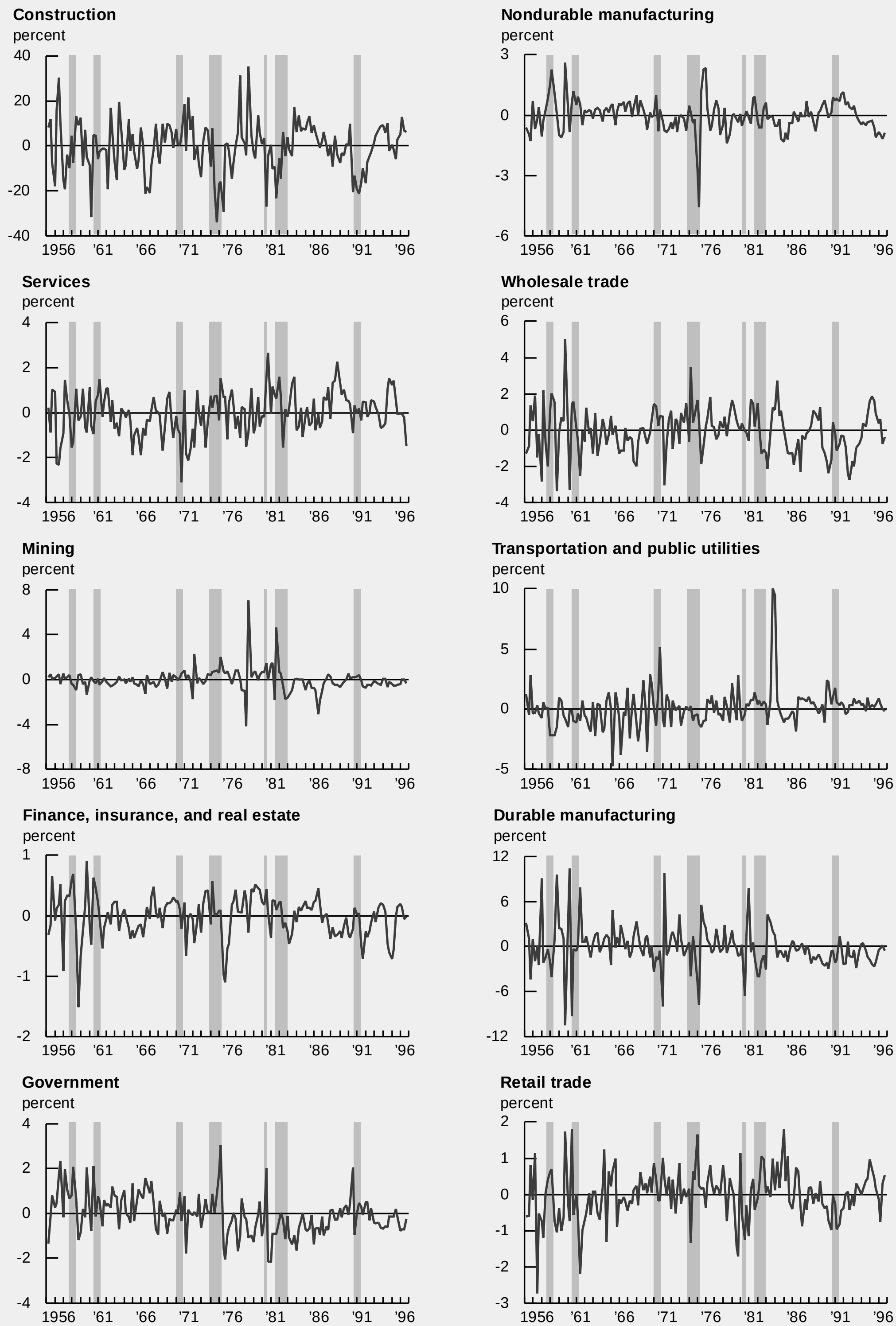


FIGURE 4

Idiosyncratic shocks by industry



to the NBER expansions and contractions. C_t typically declines prior to the peak of an NBER expansion and has a turning point *consistently* within one quarter of the dated NBER trough. The "mini-recession" of the mid-1980s shows up clearly. According to this estimation technique, the 1990–91 recession was only a minor event in comparison to prior recessions. This is because the most recent contraction was more broadly based than earlier ones. The traditional pattern of contractions characterized by shifts in employment shares from goods-producing industries to service-producing industries was not as pronounced, since employment in all sectors was more or less affected. In addition, the recovery was slow to take off relative to other recoveries. Finally, although C_t is currently above the expected long-term average of 0, its recent decline has been quite sharp. If history sets any precedent, it would indicate that declines of this magnitude are followed by contractions. However, it should be noted that there is substantial uncertainty associated with these measures, both because of normal parameter uncertainty and model uncertainty.

In addition to the estimates of the business cycle generated by the Kalman filter, the idiosyncratic shocks, u_{it}, are also of interest. The estimated u_{it}'s are shown in figure 4 for the 10 industry categories. Note that the scale varies widely, with construction exhibiting the largest shocks and retail trade the smallest on average. Transportation and public utilities exhibited relatively small disturbances with the exception of a large shock in the early 1980s. This disturbance coincides with the timing of the Professional Air Traffic Controllers Organization (PATCO) strike early during President Ronald Reagan's first term in office. Similarly, mining has experienced only small disturbances with the exception of a few large deviations. The large swings in the late 1970s are related to the strike by the Bituminous Coal Operators Association, affecting approximately 160,000 workers. In addition, the relatively large disturbances in nondurable manufacturing occurring in 1975 are likely due to the oil price shock's effect on the petroleum and chemicals industries.

Measuring economic turbulence

The measure proposed here is in the spirit of Lilien (1982), in that it focuses on the dispersion in employment growth across broad industry categories. However, Lilien's measure failed to recognize the effects of the business cycle on dispersion. Thus, the measure of sectoral shifts he proposed does not clearly separate the cycle from the sectoral shifts it purports to measure. In measuring sectoral shifts, the portion of dispersion in employment growth that is unrelated to the business cycle is of importance; in other words, it is the idiosyncratic shock, u_{it}, that reflects the shifts in employment growth that are orthogonal to the business cycle.

Let $\hat{\sigma}_t$ be the measure of dispersion. It is defined as

$$8)\quad \hat{\sigma}_t = \left[\sum_{i=1}^{I} \hat{S}_{it}\hat{u}_{it}^2\right]^{½},$$

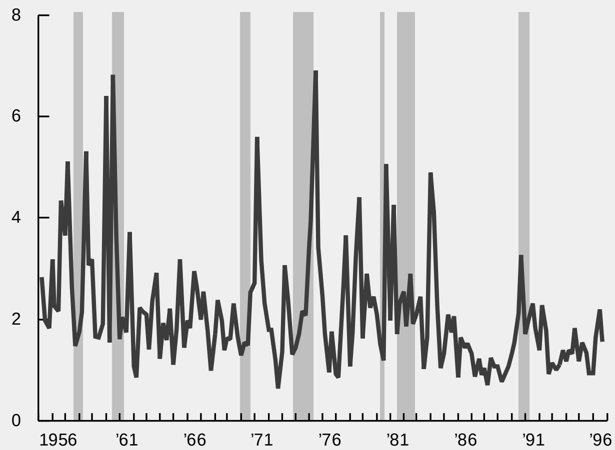
where $\hat{S}_{it}$ is a measure of employment shares in industry i that is constructed to be independent of the cycle, and the $\hat{u}_{it}$'s are the estimates of the idiosyncratic shock to net employment growth in industry i that are obtained directly from the Kalman filter.[17] In other words, $\hat{\sigma}_t$ is a measure of the variance of changes in employment shares across industries where these changes are not directly related to the business cycle.

This turbulence measure, $\hat{\sigma}_t$, is shown in figure 5. Note that all ten industries have been included in the measure with services and mining disturbances estimated by auxiliary regressions of the form described above. Compared to Lilien's measure of sectoral shifts found in figure 1, this acyclical measure fluctuates quite a bit more. However, the timing of the peaks is similar to that found in Lilien. It clearly indicates that the early 1970s to early 1980s was a period of structural change, so that one would expect to see a rise in the natural rate of unemployment over this period. That the timing of this increase in dispersion is coincidental with economic contractions is not problematic here, because the common business cycle has been purged from the measure and the increased dispersion reflects shifts that are probably fundamentally linked to the changes brought about by the oil price shocks.

Since the early 1980s, the economy has been remarkably stable, with no large sectoral shifts impinging upon the labor market. The brief increase in dispersion recorded in the early 1990s was much smaller in magnitude than the peaks observed in the previous two decades. In fact, the turbulence measure shows that the current state of labor demand is very

FIGURE 5

Turbulence measure, including services and mining



stable by historical standards with little deviation in employment distribution. Thus, we would expect to see a lower natural rate than would be found in the 1970s and 1980s and, indeed, even in the earlier part of the 1990s.

Is there any way to identify the increased dispersion in employment growth with changes in specific industries? In other words, can we point to the spike in the mid-1970s as being related to changes occurring in a particular sector? To address this question, an alternative measure of dispersion has been constructed, σ_j^*, in which

$$9) \quad \sigma_{jt}^* \equiv \left[\sum_{i \neq j} \hat{S}_{it} \hat{u}_{it}^2\right]^{1/2}.$$

Thus, σ_j^* is a measure of what dispersion would be if there were no disturbance in industry *j* over the entire time period.[18] The ratio:

$$10) \quad \rho_{jt} \equiv \sigma_{jt}^* / \hat{\sigma}_t$$

gives a rudimentary indication as to what percentage of the current turbulence is attributable to industry *j*.

The turbulence of the 1970s provides an interesting insight. Most of the increase in employment dispersion in the early 1970s was directly attributable to disturbances in durable manufacturing, combined with transportation and public utilities. In contrast, the increase in turbulence that occurred about the time of the 1974–75 recession was due to industry-specific shocks in construction and nondurable manufacturing and, to a lesser extent, disturbances in durable manufacturing and finance, insurance, and real estate. Surprisingly, the most recent increase in turbulence in the early 1990s was due primarily to a disturbance in the government sector.

Conclusions

The full employment level of unemployment is defined as the sum of frictional and structural unemployment. Because the amount of structural unemployment changes as shifts in the distribution of labor demand occur, the level of unemployment consistent with full employment changes over time. A necessary first step toward measuring structural unemployment is the development of a measure of economic turbulence. This measure clearly shows an increase in turbulence over the 1970s and a decline in turbulence in the 1980s and 1990s. To the extent that economic turbulence leads to an increase in the structural unemployment component of the natural rate, one would expect to find that the natural rate of unemployment rose in the 1970s and subsequently declined. Natural rate estimates that do not take into consideration the effect of turbulence on the unemployment rate would tend to understate the natural rate in the 1970s and overstate it currently.

Measuring sectoral shifts is complicated by the fact that changes in the distribution of employment across industries are driven by both cyclical and idiosyncratic factors. It is the latter which are relevant to the computation of economic turbulence. The method proposed in this article is an intuitive, alternative approach to measuring the intensity of sectoral shifts. By applying the Kalman filter to a simple model of net industry employment growth, a measure of dispersion is computed that is purged of cyclical effects. The fact that dispersion still appears to increase around the times of recessions indicates the differing character of these recessions relative to some "norm." In addition, the Kalman filter technique provides estimates of the business cycle that are surprisingly similar to other measures of economic activity.

The analysis suggests several implications for policymakers. First, an increase in the unemployment rate does not necessarily imply a weakening economy. It may instead be due to shifts in the distribution of labor demand across industries. Good economic policy must take into account the effects of sectoral shifts of all sorts, across industries (as analyzed here), occupations, or locations. Second, policymakers may be tempted to fine-tune the full employment level of unemployment by offsetting shocks in a particular industry. Effective industrial policy of this sort presumes that the policymaker can identify and understand forces affecting labor demand in these industries. Most likely these shifts are due to fundamental changes in product demand or production technology and should, therefore, not be eliminated or constrained. An appropriate role for policy in reducing structural unemployment may be to aid in reducing the costs of acquiring new skills or to provide job search assistance. Finally, estimates of the amount of turbulence in the labor market are just that—estimates. How one uses these estimates to better understand the natural rate of unemployment is subject to much uncertainty and debate. There exists no consensus as to an appropriate framework for modeling the full employment level of unemployment. Nor is there agreement as to how to measure it. Any estimate is thus subject to both parameter uncertainty and model uncertainty. The measure of economic turbulence proposed here may be used as one possible factor among many in assessing current economic conditions.

NOTES

[1]The Full Employment and Balanced Growth Act of 1978, frequently referred to as the Humphrey-Hawkins Act after its two sponsors, set specific targets of 4 percent unemployment and 3 percent inflation by 1983 and 4 percent unemployment and 0 percent inflation by 1988. Neither of these goals was achieved during the time prescribed by the legislation.

[2]See Rissman (1993) for empirical evidence on this point.

[3]See Burns and Mitchell (1946).

[4]In fact, this is the concept behind the business cycle expansion and contraction dates published by the National Bureau of Economic Research. Another example is found in Stock and Watson (1992).

[5]This assumption about the serial correlation properties of u_{it} could be relaxed fairly easily.

[6]This assumption is important for purposes of estimation.

[7]This assumption could be relaxed but with some care so that there are not too many additional parameters to be identified.

[8]See Quah and Sargent (1994) for an example.

[9]The vector w_t can also contain lagged endogenous variables.

[10]The Kalman filter applies to a much broader class of measurement equations than that discussed here. Specifically, the matrices *C*, *D*, *H*, *A*, *B*, and *G* can themselves be known functions of time.

[11]A more detailed discussion of the Kalman filter is found in Harvey (1989).

[12]Ideally, each sector should somehow be weighted according to some scheme. The estimation does not currently take this point into consideration. Rather, it treats each sector as being equally important in determining the measure of the business cycle, C_t. Clearly, an improvement would be to treat larger industries differently from smaller sectors.

[13]Preliminary results indicated a multicolinearity problem in that the Hessian failed to invert. After examination of the Hessian, the parameters b^1 for both construction and nondurable manufacturing were set to zero. These results are reported in the text.

[14]The interested reader can find more detail in chapter 4 of Harvey (1989).

[15]It is in the first two of these industries that the b_i^1 parameters are constrained to 0. It is possible that this contemporaneous value b_i^0 in these sectors is a proxy for a response at a one quarter lag.

[16]Harvey (1989) discusses this smoothing algorithm.

[17]The acyclical employment share, $\hat{S}_{it}$ is constructed from some initial starting condition, $\hat{S}_{i0}$, and imposing $C_t = 0$ for all $t = 0, ..., T$. In other words, it is what the employment share would be if the economy had not experienced any cyclical variation but responded only to idiosyncratic shocks and long-term trends. Specifically,

$$\hat{S}_{it} = \hat{S}_{i0} \exp\left(\sum_{s=0}^{t} \hat{y}_{is}\right) \text{ where } y_{is} = a_i + u_{is}.$$

[18]This measure is a crude way of addressing the issue of what role the specific industries play in total turbulence. It can be improved upon by weighting the idiosyncratic shocks by S_{it}^* where S_{it}^* reflects the imposition of $u_{jt} = 0$.

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