What is the natural rate of unemployment?

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The unemployment rate is the composite of three distinct types of unemployment: frictional, cyclical, and structural. This fact poses a potentially serious problem for government policymakers because high unemployment rates are not necessarily indicative of a slack economy. Structural change as well as cyclical factors affect the unemployment rate. If policymakers are not able to distinguish higher unemployment rates due to a change in the structure of employment from higher unemployment rates due to a weak economy, then they run the risk of implementing expansionary policies at the wrong time, thereby creating or adding to inflationary pressures. Hence, to adequately gauge the state of the economy, it is necessary to know what portion of the current unemployment rate is due to purely cyclical phenomena as opposed to structural and frictional.

The natural rate of unemployment is defined simply as the rate of unemployment that is compatible with a steady inflation rate. The natural rate can therefore be thought of as the rate of unemployment that would occur in the absence of cyclical fluctuations. In other words the natural rate is essentially the sum of structural and frictional unemployment. Because structural and institutional factors change over time, the natural rate of unemployment will also vary. However, the need to understand the determinants of the natural rate and its relation to the actual rate of unemployment is quite real as the cost of error may be accelerating inflation or deflation.

The purpose of this article is to answer the question: What is the natural rate of unemployment? The answer relies heavily on the pioneering work of Lilien (1982) and is in two parts. First, a working definition of the natural rate of unemployment is developed. Second, with this definition, estimates of the natural rate of unemployment are calculated.

The analysis indicates that the natural rate of unemployment has been quite variable over the last 27 years, reaching a high of 7.01 percent in the third quarter of 1981 and attaining a low of 3.48 percent in the first quarter of 1966. But to understand the performance of the economy, it is the difference between the natural rate and actual rate of unemployment that is significant. This difference has varied widely over time. From 1958 through 1966 the natural rate was well below the actual; the reverse held from 1967 to 1973. From 1974 through 1976 the actual rate again exceeded the natural rate although in more recent years the reverse appears once more to be the case.

Because the difference between the natural and actual rates of unemployment is thought to be indicative of the degree of tightness in the labor market, this measure should be positively correlated with the inflation rate. Indeed, the correlation coefficient between the difference and the inflation rate as measured by the Consumer Price Index is 0.46. This compares with an almost zero correlation of inflation with the actual unemployment rate.

Categories of unemployment

In general it is useful to distinguish conceptually among three distinct types of unemployment in analyzing the historical pattern of the unemployment rate.[1] First, there is frictional unemployment. Frictional unemployment arises as a result of the normal labor turnover that occurs in a healthy dynamic economy. At any given time employed workers change jobs, lose jobs, or leave the labor force. Similarly, unemployed workers may find employment or may decide to stop seeking employment, while still others may enter or reenter the labor force. Even in the best of times there is some unemployment that arises from this dynamic friction in the economy.

The type of unemployment that is perhaps perceived and felt most acutely is cyclical unemployment. As its name suggests, it is the type of unemployment that is associated with business cycles. Decreases in aggregate demand such as occur during recessions cause a general overall decline in labor demand. The real wage rate is relatively unresponsive to

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these changing conditions, that is, real wages do not decline as labor demand declines.[2] As a result, unemployment occurs. If real wages were free to adjust to these changed conditions in the labor market, then recessions would not produce any noticeable increase in the unemployment rate. Cyclical unemployment is temporary and when demand conditions return to their previous level, the excess labor supply disappears. Even permanent declines in aggregate demand result in only temporary unemployment because sooner or later wages in a competitive economy must adjust so as to equate labor supply and labor demand, though now at a lower equilibrium wage rate.

The third type of unemployment is probably the least understood and also the most traumatic to endure. Unlike cyclical unemployment, structural unemployment is the result of shifts in the *relative* demand for different types of labor. Whether these relative shifts in labor demand are caused by changes in relative factor prices (e.g., an oil price shock), technological innovations, changes in tastes and preferences, or perhaps changes in institutional or other characteristics of the economy, is not important. The essential point is that as labor demand for one type of labor falls relative to another, a temporary mismatch occurs between the skills that employers desire and those that the work force actually possesses. This produces only temporary unemployment because in time those who are structurally unemployed will either retrain to find employment in the now higher labor demand industries, relocate to find jobs requiring the types of skills they already have, or perhaps leave the labor force altogether, in which case they are not counted as unemployed. How long this process takes depends upon the costs of education, the costs associated with relocating or finding employment further from one's original location, and the costs of job search, and, of course, additional opportunity and psychological costs.

In terms of these three components, the natural rate of unemployment is simply the rate that would occur in the absence of cyclical fluctuations. It is the sum of frictional and structural unemployment.

Historical perspective

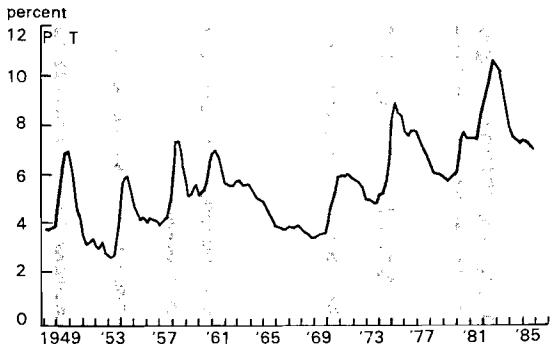
Figure 1 presents the civilian unemployment rate quarterly from 1948 through 1985 with the periods between business cycle peaks and troughs shaded for reference. There appear to be three distinct phases. The decade of the 1950s is characterized by three recessions, with unemployment peaking at each economic downturn. Between these periods, the unemployment rate hovered somewhere between four and five percent. Even when the unemployment rate reached its highest value of 7.37 percent, it was substantially below the two-digit unemployment rates of recent years.

The decade of the 1960s was one of economic growth with no major recessions recorded after 1961. And as a result, the unemployment rate drifted downwards from a high at the depth of the recession of 7.00 percent to a low in 1969 of 3.40 percent.

Unsurprisingly, structural unemployment was not an issue at this time. Indeed, the pattern of unemployment is very well explained by two components: cyclical and frictional. The business cycles of the 1950s and early 1960s attest to the significance of the cyclical element, while the relatively economically calm remainder of the 1960s underscores the importance of frictional unemployment.

Economists and policymakers of the time alike recommended a seemingly reasonable unemployment rate target for policy of around three percent. This three percent level was called, with perhaps unconscious irony, the full employment rate of unemployment. While the nomenclature is unfortunate, the term was meant to indicate the level of unemployment that would occur in the absence of cyclical factors. From the perspective of the 1950s and 1960s, then, the full employment level of un-

Figure 1
Civilian unemployment rate



employment was essentially the frictional level of unemployment.

The 1970s and 1980s to date exhibit a much different unemployment rate pattern. Over this time the unemployment rate rose from a low of 4.17 percent in the first quarter of 1970 to a high of 10.60 percent in the fourth quarter of 1982. As in previous years, the unemployment rate responded to cyclical factors, peaking in the trough of each of the four major recessions. But, the unemployment rate appears to be trending upwards during the period so that the average unemployment rate from 1970 through 1985 was 6.94 percent as compared to 4.51 percent and 4.78 percent respectively for the 1950s and 1960s. In addition, the unemployment rate appears to be much more volatile in these later years: The calculated standard deviation is 1.50, compared to standard deviations of 1.28 and 1.08 in the two earlier decades.

Demographic change

This abrupt change in the pattern exhibited by the unemployment rate suggests that there were factors involved other than merely frictional and cyclical unemployment. One possible explanation is that the underlying labor force demographics changed, thereby adversely affecting the unemployment rate. Specifically, the labor force composition changed over the 1970s relative to what it was in the 1960s in such a way that the labor force now contains a significantly higher proportion of individuals subject to higher unemployment rates, such as nonwhites, females, and youths.

A simple way of testing the effects of the changing demographic composition of the labor force on the unemployment rate is to compare the actual civilian unemployment rate (UR) with a fixed-weight unemployment rate (WUR). Specifically, the unemployment rate is calculated as:

$$UR_t = \sum_{i=1}^{I} \gamma_{it}\ UR_{it} \qquad i = 1, \ldots, I \qquad [1]$$

where UR_t is the unemployment rate at time t, i indexes the I demographic groups, γ_{it} is the fraction of the total labor force in group i at time t, and the sum of the γ_{it}'s equals one.

The fixed-weight unemployment rate at time t is calculated as:

$$WUR_t = \sum_{i=1}^{I} \gamma_{i\tau}\ UR_{it} \qquad i = 1, \ldots, I \qquad [2]$$

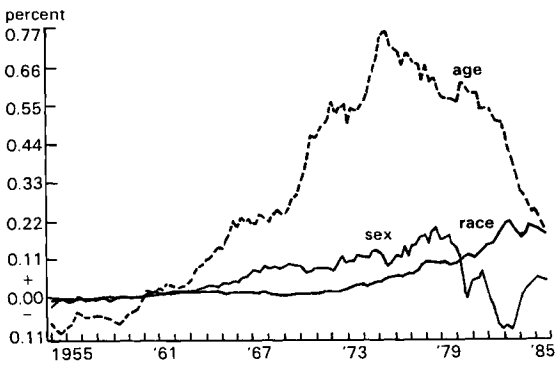
where τ is some pre-assigned base period. Thus, the fixed-weight unemployment rate computes what the civilian unemployment rate would have been if the demographic composition of the labor force had remained as it was in base period τ.

Figure 2 plots the differences between the actual quarterly unemployment rate and various fixed-weight measures where the base period τ is selected to be the first quarter of 1960.[3] Positive values indicate that the demographic changes that have occurred relative to the first quarter of 1960 unfavorably affect the unemployment rate while negative values indicate that the unemployment rate would have been higher if the demographic composition of the labor force had been the same as in the base period. The calculations were done for race, sex and age categories.[4]

As is obvious from Figure 2, the increase in the proportion of females, nonwhites, and young people in the labor force resulted in a small increase in the unemployment rate. The most important effect occurred as a result of changes in the age distribution. At its peak in 1975, the changing age distribution contributed around three quarters of a percentage point to the overall unemployment rate. However, this effect has been decreasing as the labor force has aged.

In contrast, the changing racial composition of the labor force tended to increase the

Figure 2
Effect of changing demographics on the unemployment rate



unemployment rate at an accelerating rate over the 1970s and early 1980s, reaching its maximum effect in 1983. But race never contributes more than one quarter of a percentage point to the aggregate unemployment rate.

Finally, the increased labor force participation of women relative to 1960 has for the most part adversely affected the unemployment rate, contributing approximately an additional two tenths of a percentage point in 1978. However, since 1979 the relation between the sex composition of the labor force and the unemployment rate has become less marked due to a decline in the unemployment rate of females relative to males.

This change is not necessarily attributable to lower levels of sex discrimination. An alternative explanation may be that women are clustered in jobs that are relatively more protected from market forces. For example, blue collar jobs are more frequently filled by men than women. Those blue collar jobs that are located in declining industries would contribute to a higher unemployment rate for males than for females, all other things equal.

Thus, it seems that the changing demographic composition of the labor force has resulted in an increase in the civilian unemployment rate since 1960, but the magnitude of the effect is quite modest—adding less than one percentage point to the total unemployment rate. Even after controlling for changes in the demographic composition of the labor force, the unemployment rate of the 1970s and early 1980s is still significantly higher and more volatile than in the previous two decades.

Changing industrial composition

Just as the demographic distribution (and possibly the geographic distribution) of the labor force provides clues to analyzing the more recent behavior of the unemployment rate, the distribution of employment across industries also plays a role. It is the changes in the distribution of employment across industries that is most closely related to the concept of structural unemployment. As noted previously, structural unemployment arises due to relative shifts in the demand for different types of labor causing a period of economic adjustment during which time some displaced labor will be temporarily unemployed. Changes in the relative demands for labor will be accompanied by changes in the distribution of employment across industries.

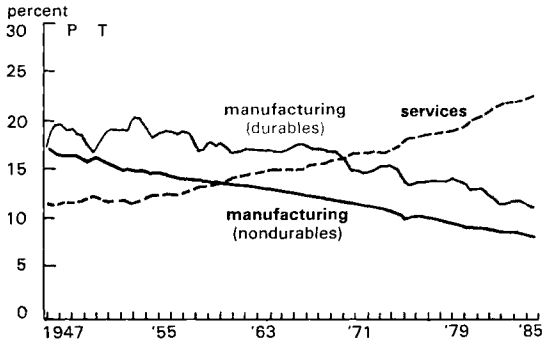
Perhaps the most prominent movement in the employment profile in recent history is the change of the private economy from one based upon manufacturing and other traditional industries to one based upon services and service-related industries.[5] Figure 3 presents this trend for selected industries, and prompts important observations. First, the decline in manufacturing and concurrent rise in the share of employment in services are not recent phenomena. The graph shows that these adjustments have been occurring almost continuously throughout the post-World War II period.

Secondly, even within manufacturing there are notable differences between the behavior of employment shares in durable and nondurable goods. The decline in nondurable goods has proceeded much more smoothly than the decline in employment share in durable manufacturing.

This steady decline in the relative importance of nondurable manufacturing is not necessarily an indication of structural change in the sense that it documents the ebb and flow of the fortunes of the industry in question. *The historical pattern is also consistent with a steady stream of technological innovation which enables production to remain unchanged while employment levels decline.* While the steady decline in employment share is almost certain to contribute to the flow of unemployment, it may well be that the unemployment generated is much less in volume and of shorter duration than that which would occur in industries experiencing a more sporadic, volatile decline such as durable manufacturing. The reason is that rational workers are more likely to be able to predict and therefore cushion or even avoid the blow of unemployment altogether by preparing for the event sufficiently in advance.

The third observation concerning the patterns seen in Figure 3 pertains to the effect of business cycles on the distribution of employment across industries. Recessions clearly and consistently are associated with declines in employment share in durable goods manufacturing. It is well known that business cycles have a differential impact across industries, affecting some more adversely than others.[6] Just why this occurs depends upon the nature of the demand for the good as well as the costs of in-

Figure 3
Share of total employment in selected industries



ventorying. If the good is viewed as a luxury item or requires a relatively large expenditure, then purchases are more likely to be postponed during periods of low aggregate demand, when discretionary income falls. For example, housing starts and new construction are particularly susceptible to changes in the economic outlook. In addition, those industries with high inventory costs are less able to smooth production and are therefore more susceptible to the vagaries of the market.

The post-World War II era has seen considerable change in the distribution of employment across industries. Such shifts in employment are likely to generate unemployment temporarily as displaced workers search for employment. Large movements in employment across industrial sectors are likely to be associated with temporary increases in the unemployment rate because these movements signify a change in the underlying structure of the economy. However, change in and of itself does not cause unemployment. The unemployment arises because of friction or inertia in the economy which make it difficult for individuals to adapt instantaneously. Given these frictions, the larger is the flow of workers into and out of the various industries, the more likely it is that a larger volume of unemployment will be generated.

One way of measuring these flows is to define a variable $\hat{\sigma}_t^2$ where:

$$\hat{\sigma}_t^2 \equiv \sum_{i=1}^{I} s_{it-1} \left[g_{it} - g_t\right]^2, \qquad [3]$$

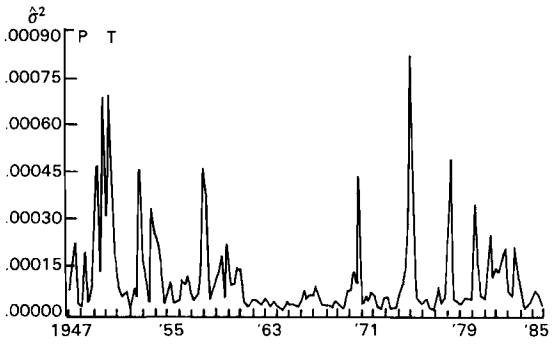
s_{it} is the share of total employment in industry i at time t, g_{it} is the growth rate of employment in the i^{th} industry between period t and period $t-1$, and I is the number of industries. Thus, $\hat{\sigma}_t^2$ is the weighted sum of squared deviations of industry growth from average aggregate growth where the weights are given by the employment share of the i^{th} industry.

This measure captures those employment flows that are associated with changes in the distribution of employment across industries and not those changes in employment that occur as a result of economic growth. Furthermore, those industries experiencing a large deviation in employment growth relative to the average growth rate of employment are given more weight in the calculation due to the squaring of the term in parentheses. Such a weighting scheme is appropriate if, for example, large deviations in employment growth from the average are associated with disproportionately large increases in unemployment. For further details on the interpretation of $\hat{\sigma}_t^2$ see Box, *Measuring employment flows.*

Figure 4 displays the measure of employment adjustment $\hat{\sigma}_t^2$ from the first quarter of 1947 through 1985.[7] There appear to be many periods of rapid employment adjustment across industries during the post-war period. Frequently, these adjustments are coincidental with business cycles as noted in the preceding discussion of industry employment shares. The period from 1947 to 1960 is marked by three episodes of employment adjustment corresponding roughly with the recessions in 1950, 1954, and 1958. The more stable 1960s exhibit very little change in the distribution of employment across industries. The 1970s and early 1980s in contrast indicate a pronounced change in employment shares occurred in late 1970 and again in 1975 and 1978. The 1980s are surprisingly stable in comparison to the experience of the 1970s, providing preliminary evidence that structural change was perhaps not a major contributing factor to the historically high unemployment observed in the 1982 recession.

The effect of employment adjustment across industries on the civilian age-weighted unemployment rate is analyzed over the period from 1954 through the third quarter of 1985.[8] The results of the analysis are found in Table 1, which presents the estimates and associated

Figure 4
Measure of employment adjustment across industries



standard errors of the parameters of interest as well as some additional descriptive statistics.

Other variables included in the analysis are measures of unanticipated changes in real Gross National Production (GNP) and unanticipated money growth (M). Unanticipated real GNP is calculated as the residuals from the estimated ARIMA process generating real GNP where the estimates are obtained by the maximum likelihood method. Unanticipated money growth is computed as discussed in Barro (1978).

Columns (1) through (3) of Table 1 present estimates of ordinary least squares regressions on various sets of variables including two lagged dependent variables.[9]

All three models reported in Table 1 indicate that unanticipated movements in real Gross National Product are negatively associated with the age-weighted unemployment rate. Thus, realizations of real GNP above trend tend to decrease the unemployment rate while realizations below trend tend to increase the unemployment rate.

Intuition suggests that unanticipated money growth should also be negatively associated with the unemployment rate if unanticipated positive changes in monetary growth signal expansionary monetary policy. As seen in columns (2) and (3) of Table 1, the coefficient on unanticipated money growth is negative only for current realizations and positive for lagged values. However, the magnitude of the effect is imprecisely determined as seen by the large associated standard errors.

Finally, the inclusion of current and lagged values of the measure of employment

Table 1
The effect of employment adjustment on the unemployment rate

	(1)	(2)	(3)
GNP_t	−0.018 (0.002)	−0.019 (0.002)	−0.016 (0.002)
GNP_{t-1}	−0.011 (0.003)	−0.012 (0.003)	−0.008 (0.003)
GNP_{t-2}	−0.005 (0.002)	−0.005 (0.003)	−0.004 (0.002)
M_t	—	−3.215 (3.556)	−2.551 (3.312)
M_{t-1}	—	2.444 (3.700)	1.054 (3.417)
M_{t-2}	—	3.313 (3.946)	2.721 (3.619)
$\hat{\sigma}^2_t$	—	—	790.443 (212.599)
$\hat{\sigma}^2_{t-1}$	—	—	393.051 (234.715)
$\hat{\sigma}^2_{t-2}$	—	—	−387.709 (234.671)
$\hat{\sigma}^2_{t-3}$	—	—	106.700 (215.610)
$\hat{\sigma}^2_{t-4}$	—	—	−603.343 (199.532)
UR_{t-1}	1.387 (0.074)	1.385 (0.076)	1.308 (0.086)
UR_{t-2}	−0.406 (0.076)	−0.402 (0.079)	−0.319 (0.086)
C	0.093 (0.087)	0.078 (0.091)	0.030 (0.083)
R^2	0.976	0.977	0.982
Q	5.74	5.43	3.80

adjustment has a clear and significant effect on the unemployment rate. Increases in the amount of interindustry employment adjustment have an initial adverse affect upon the unemployment rate, as expected. Thus, the larger are the changes in the distribution of employment across industries, the higher is the unemployment rate. The long term effects of such shifts in employment are not immediately obvious, however, due to the inclusion of the two lagged dependent variables in the regression model. The difficulty arises because current changes in $\hat{\sigma}^2$ affect not only the current unemployment rate but also future unem-

Measuring employment flows

To further motivate the use of $\hat{\sigma}_t^2$, defined in equation [3], let e_{it} be employment in industry i at time t and let $e_t \equiv \sum_{i=1}^{I} e_{it}$ be the total level of employment in the economy at time t. The change in the number of people employed in industry i between periods t and $t-1$ is simply $e_{it} - e_{it-1}$. However, employment changes can occur for two reasons: economic growth and shifts in the underlying industrial composition of employment. For purposes of measuring structural change and relating structural change to the unemployment rate, adjustments in employment due to shifts in the employment distribution across industries alone are of interest. Thus, the expression $e_{it} - s_{it-1}e_t$ is simply the difference between employment in industry i at time t and the amount of employment in industry i that would have occurred at time t if the i^{th} industry had grown at the same rate as the aggregate economy, i.e. the employment share of industry i had remained unchanged. Obviously, if no change in employment share had occurred, then the expression $e_{it} - s_{it}e_t$ equals zero. Similarly, if $e_{it} - s_{it-1}e_t$ is positive (negative), then the i^{th} industry's employment share is rising (falling).

The change in employment attributable solely to changes in employment share and not economic growth can be rewritten in terms of growth rates as $e_{it-1}(g_{it} - g_t)$. Since the unemployment rate is assumed to respond to the magnitude and not the direction of employment changes, the total volume of employment flows attributable to shifts in the distribution of employment is simply calculated as $\sum_{i=1}^{I} e_{it-1} \mid g_{it} - g_t \mid$ which is proportional to $\sum_{i=1}^{I} s_{it-1} \mid g_{it} - g_t \mid$. Finally, by squaring the amount within the absolute value signs, the original expression for $\hat{\sigma}_t^2$ results. As discussed briefly in the text, by squaring $\mid g_{it} - g_t \mid$ those industries experiencing relatively large deviations of employment growth from the aggregate are given more weight in the calculation. Since structural shifts of large magnitudes are thought to have a disproportionately large impact upon the unemployment rate, such a weighting scheme is appropriate.

ployment rates. Simulations show that the maximum effect of an increase in the volume of interindustry employment changes is felt after a one-quarter lag, damping thereafter.

It should be noted that while the coefficient estimates on current and lagged values of $\hat{\sigma}^2$ are quite large in magnitude, the actual values of $\hat{\sigma}^2$ are relatively small, with an average value over the entire time period of $1.3x10^{-4}$. If, for example, a one standard deviation increase in $\hat{\sigma}^2$ occurred at time 0, the unemployment rate would rise by only 0.20 percent in the first quarter, 0.36 percent in the second quarter, and 0.16 percent after one year.

While the evidence reported in Table 1 suggests that the volume of interindustry movement of employees is positively related to the unemployment rate, the interpretation that the associated movements in the unemployment rate are due to structural change is not that easily justified. Thus, drawing inferences about structural unemployment or the natural rate of unemployment from the results found in Table 1 is inappropriate. The difficulty arises because of the simultaneous effect of cyclical and structural factors on employment flows. As illustrated in Figure 3, the ebb and flow of employment shares is dependent upon the stage of the business cycle. In durable manufacturing recessions are invariably associated with declining employment shares and therefore a greater amount of employment adjustment. The problem therefore is to develop a measure that distinguishes employment flows attributable only to structural factors from employment flows attributable to purely cyclical factors.

Structural change

There are a variety of ways to extract the purely cyclical effect on the distribution of employment across industries from the purely structural. These techniques all rely upon an assumption that cyclical changes in employment are temporary while structural changes are more or less permanent by definition.

In attempting to eliminate the effect of cyclical factors on the distribution of employment across industries, calculations can proceed along one of two lines. A measure of the variability of employment shares (or possibly employment growth) across industries can be calculated first and then decomposed into a permanent (structural) component and a temporary (cyclical) one. Alternatively, the employment share or level in each industry is decomposed into its permanent and cyclical elements and then, using only the permanent portion, a single measure of permanent change in employment distribution is devised. The first approach, while computationally easier, may obscure much of the underlying dynamics which by hypothesis are what give rise to structural unemployment. For this reason the second approach is preferred.[10]

As noted above, certain industries experience relatively smooth changes in employment shares over time while others experience much more volatile changes. While both of these types of changes can be permanent, intuition suggests that abrupt permanent changes in employment share add more to the volume of unemployment than do smoothly occurring changes. Thus, the permanent portion of changes in employment shares that is not explainable by past experience is the appropriate measure of structural change.

Calculating the difference between the actual employment share in industry i at time t and that which would be expected based upon past behavior is relatively straightforward. However, separating this measure into its permanent and temporary components is a more complicated endeavor. See Box, *Measuring structural change.*

Assuming that deviations of employment shares from trend in industry i at time t can be accurately decomposed into permanent changes (Δ_{it}^P) and temporary changes (Δ_{it}^T) , then the measure of permanent structural change for the aggregate economy at time t (Δ_{it}^P) is simply defined as:

$$\Delta_t^P \equiv \left[\sum_{i=1}^{I} (\Delta_{it}^P)^2 \right]^{1/2} . \qquad [4]$$

Similarly, the measure of temporary change in employment shares (Δ_{it}^T) , is defined as:

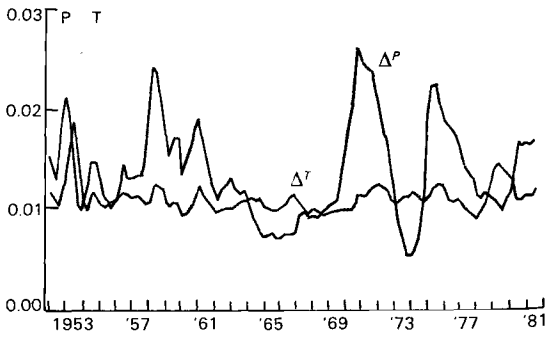
$$\Delta_t^T \equiv \left[\sum_{i=1}^{I} (\Delta_{it}^T)^2 \right]^{1/2} . \qquad [5]$$

Because the expression in parentheses is squared, effectively those industries experiencing relatively large permanent changes in employment shares are weighted more heavily in the calculation.

The behavior of Δ^P and Δ^T from the first quarter of 1952 through the third quarter of 1981 is examined in Figure 5.[11] As can be seen, permanent changes in the distribution of employment across industries correspond closely to business cycles, exhibiting quite noticeable peaks in 1958, 1961, 1970, and 1975, and possibly in 1980. In contrast, temporary changes in the employment distribution do not appear to be significantly correlated with the business cycle.

A comparison of the measurement of employment adjustments, $\hat{\sigma}^2$, with the constructed measure of permanent structural change, Δ^P, yields some interesting insight. The crude measure of employment adjustment records its largest value in 1975, leading to the premature conclusion that structural change was most

Figure 5
Permanent and temporary changes in the distribution of employment across industries



Measuring structural change

Let $\underline{s}_t$ be the $Ix1$ vector of employment shares at time t. Thus $\underline{s}_t'$ is simply defined as $(s_{1t}, s_{2t}, \ldots, s_{It})$ for $t = 0, \ldots, T$ where $'$ indicates the transpose and s_{it} is the employment share of industry i at time t. The vector of employment shares is assumed to be related to its past and future values. Specifically, assume that

$$\underline{s}_t = (1 - a_t)\sum_{j=1}^{J} \beta_j \underline{s}_{t-j} \qquad [i]$$

$$+ a_t \sum_{j=1}^{J} \beta_j \underline{s}_{t+j} + \varepsilon_t$$

where a_t is some time varying parameter, the β_j's are geometrically declining weights, $\sum_{j=1}^{J}\beta_j = 1$ and ε_t is an additive independent and identically distributed random error term. Thus, the current vector of employment shares is assumed to be a two-sided moving average of its past and future values. Subtracting $\sum_{j=1}^{J} \beta_j \underline{s}_{t-j}$ from both sides of equation [i], the following results:

$$\underline{s}_t - \sum_{j=1}^{J} \beta_j \underline{s}_{t-j} = \qquad [ii]$$

$$a_t[\sum_{j=1}^{J} \beta_j \underline{s}_{t+j} - \sum_{j=1}^{J} \beta_j \underline{s}_{t-j}] + \varepsilon_t$$

The left hand side of equation [ii] can be interpreted as the deviation in current employment shares from its expected value based upon past experience. This deviation is seen to be the sum of two components: a temporary component, ε_t, and a permanent component,

$$a_t[\sum_{j=1}^{J} \beta_j \underline{s}_{t+j} - \sum_{j=1}^{J} \beta_j \underline{s}_{t-j}].$$

Equation [ii] can be estimated by ordinary least squares assuming a fixed J and specific values for the β_j's. The permanent component for the i_{th} industry is simply defined as:

$$\Delta_{it}^{P} \equiv \qquad [iii]$$

$$\hat{a}_t[\sum_{j=1}^{J} \beta_j s_{it+j} - \sum_{j=1}^{J} \beta_j s_{it-j}]$$

where '^' indicates the estimated value of the parameter, while the temporary component is calculated as the regression residual:

$$\Delta_{it}^{T} \equiv s_{it} - \sum_{j=1}^{J} \beta_j s_{it-j} \qquad [iv]$$

$$- \hat{\alpha}_t[\sum_{j=1}^{J} \beta_j s_{it-j} - \sum_{j=1}^{J} \beta_j s_{it-j}].$$

pronounced at that time. The more refined measure of permanent structural change, on the other hand, clearly indicates that structural change was far less important a factor in the 1975 recession than it was in the 1970 recession. Interestingly enough, even the recession that occurred in 1958 appears to have been associated with a more pronounced permanent change in the structure of employment than was the 1975 recession.

Structural change and the unemployment rate

The calculation of permanent and transitory changes in the distribution of employment across industries is a refinement of the measure of interindustry employment flows $\hat{\sigma}_t^2$ employed previously. It is constructed so as to give meaning to the concept of structural change. If structural change is rapid and accompanied by large employment shifts, then

unemployment is thought to be the by-product as workers struggle to adapt to the changing situation.

Analysis of the relation between the computed permanent and transitory variation of the employment distribution and the unemployment rate may proceed along lines similar to that presented in Table 1. However, it is implicitly assumed there that once demographic changes have been controlled for, all other unemployment results from cyclical, structural, or frictional factors where frictional unemployment is assumed to be some constant amount. In essence, this assumption denies the existence of other factors, particularly institutional arrangements, that have an effect upon the unemployment rate.

Changing institutional conditions are not cyclical by nature. Nor should they be thought of as contributing to structural unemployment because structural unemployment as defined here is the result of the changing relative demand for different types of labor. These changing institutional characteristics are most properly associated with frictional unemployment. As discussed elsewhere, frictional unemployment arises due to the functioning of a dynamic labor market where workers are continuously making decisions as to the proper allocation of their labor. These decisions are based upon the parameters of the underlying institutional framework. Thus, when this framework changes, it will also have an effect upon the decisions of the workers to seek work or quit work, and therefore it will have an effect upon the frictional rate of unemployment.

Much research has been devoted to analyzing the effect of unemployment insurance on job search. Critics argue that the existence of such unemployment insurance schemes lowers the costs of job search and therefore encourages unemployed workers to remain unemployed for a longer duration than they would have in the absence of such benefits. Thus, more lenient benefits tend to increase the unemployment rate. While this may in fact occur initially, it is also quite possible that by encouraging people to search longer for employment, better job matches between employees and employers will result, thereby having a negative long-run effect on the unemployment rate.

The regression models presented in Table 2 analyze the effect of permanent and transitory changes in the distribution of employment on the age-weighted unemployment rate. As presented previously, other explanatory variables include deviations in real Gross National Product from trend and unanticipated money growth. In light of the preceding comments on institutional arrangements, an additional variable is included (SI) which is social insurance expenditures as a percentage of Gross National Product.[12] This variable is assumed to proxy for the costs associated with unemployment.

Table 2 presents ordinary least square estimates from regressions on the civilian age-weighted unemployment rate over the period from 1954 through the third quarter of 1981. Parameter estimates and their associated standard errors in parentheses are reported along with some descriptive statistics. As in the regressions reported in Table 1, the models of Table 2 include two lagged dependent variables. Therefore, the OLS estimates are asymptotically equivalent to maximum likelihood estimates only if the errors are not heteroskedastic. The adjusted Box-Pierce statistic (Q) is reported testing for autocorrelation of the estimated residuals for a lag length of six quarters. Judging from the small magnitude of this statistic, the residuals appear to be "white noise".

The results indicate that structural change adversely affects the unemployment rate while transitory changes in the distribution of employment across industries have no discernible effect. As in Table 1, the inclusion of lagged dependent variables in the regression model complicates the interpretation of the coefficients. This occurs because current structural change not only affects the current unemployment rate but also influences the future time path of the unemployment rate directly through a one-quarter lag and indirectly through the two lagged dependent variables.

Figure 6 reports the results of a simulation based upon the parameter estimates found in column (1) of Table 2. The effect of a one standard deviation temporary increase in Δ^P at time 1 on the time path of the unemployment rate is analyzed. By temporary, it is meant that the disturbance occurs at time 1 after which Δ^P returns to its previous level. As seen in the graph, although current structural change adversely affects the unemployment rate both currently and into the future, the effects damp quite quickly. A one standard deviation rise in

Table 2
Structural change and the unemployment rate

	(1)	(2)
GNP_t	−0.009	−0.009
	(0.003)	(0.003)
GNP_{t-1}	−0.008	−0.008
	(0.003)	(0.003)
GNP_{t-2}	−0.002	−0.002
	(0.003)	(0.003)
M_t	−7.740	−7.413
	(3.330)	(3.444)
M_{t-1}	3.083	3.293
	(3.492)	(3.564)
M_{t-2}	−0.563	−0.358
	(3.780)	(3.848)
Δ_t^P	94.448	96.450
	(14.734)	(16.439)
Δ_{t-1}^P	−86.213	−88.514
	(14.683)	(16.545)
Δ_t^T	—	0.537
		(35.092)
Δ_{t-1}^T	—	9.103
		(36.516)
SI_t	3.332	3.158
	(1.038)	(1.114)
UR_{t-1}	1.185	1.177
	(0.078)	(0.082)
UR_{t-2}	−0.247	−0.239
	(0.078)	(0.081)
C	0.018	−0.072
	(0.101)	(0.224)
R^2	0.978	0.978
Q	3.30	3.49

Δ^P at time 1 causes the unemployment rate to rise by approximately one half of a percentage point that quarter. The following quarter when Δ^P returns to its previous level, the unemployment rate is still larger than it would have been by approximately one tenth of a percentage point. Within four quarters of the structural change the effect on the unemployment rate is small, being only one hundredth of a percentage point and continuing to decline thereafter. Thus, the long-term effects, i.e. greater than one year, of structural change on the unemployment rate are negligible.

The evidence provided in Table 2 and Figure 6 suggests that the unemployment rate adjusts quite rapidly to changes in the underlying structure of employment. This is surprising because it is widely held that structural change is responsible for creating a large pool of chronically unemployed workers. However, the numbers indicate that most of the effect occurs within two quarters of the disturbance and long-term effects are minimal. This evidence is at least partially corroborated by statistics on the distribution of unemployment by duration.

Table 3 reports for the period 1960 to 1985 the percentage of unemployed workers in a given year who have been unemployed for various specified lengths of time. As can be seen, the vast majority of the unemployed become reemployed (or perhaps leave the labor force) within six months of losing or leaving a job. Even in the worst year from unemployment duration standards, less than a quarter of the unemployed were unemployed for longer than twenty-six weeks. In fact, much of the change in the distribution of unemployment by duration that has occurred over this time appears to be related to cyclical factors associated with a general weakness in the labor market.

Thus, the perception that structural change leads to a more or less permanent pool of chronically unemployed workers is not entirely justified. However, this evidence should not be taken as confirmation that structural factors have an impact of only limited duration on the overall performance of the labor market. It may well be the case that structural change results in an increased frequency of unemployment rather than an increased duration so that

Figure 6
Effect of a one standard deviation increase in structural change on the unemployment rate

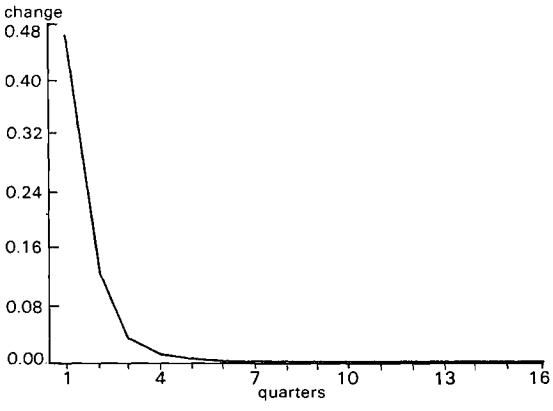


Table 3
Distribution of unemployed by duration of unemployment, 1960-1985

Year	Less than 5 weeks	5-14 weeks	15-26 weeks	27 weeks and over
1960	45	31	13	12
1961	38	29	15	17
1962	43	29	14	15
1963	43	30	13	14
1964	45	30	13	13
1965	48	29	12	10
1966	55	27	10	8
1967	55	30	9	6
1968	57	29	9	6
1969	58	29	9	5
1970	52	32	10	6
1971	45	32	13	10
1972	46	30	12	12
1973	51	30	11	8
1974	51	31	11	7
1975	37	31	16	15
1976	38	30	14	18
1977	42	30	13	15
1978	46	31	12	10
1979	48	32	12	9
1980	43	32	14	11
1981	42	31	14	14
1982	36	31	16	17
1983	33	27	15	24
1984	39	29	13	19
1985	42	30	12	15

SOURCE: *Economic Report of the President, February 1986, Table B-33.*

a worker who has been displaced by structural events may become unemployed more often in the future than those workers who have not been so affected.[13]

It also appears from Table 3 that social insurance expenditures are significantly positively associated with the unemployment rate. Thus, the evidence supports the hypothesis that increases in the amount and availability of social insurance that tend to reduce the opportunity cost of unemployment cause an increase in the unemployment rate.

Measuring the natural rate of unemployment

If the natural rate of unemployment is, as stated earlier, the sum of frictional and structural unemployment, it is now relatively straightforward to calculate the natural rate from the regression results presented previously. The natural rate is simply calculated as the rate of unemployment that would result if all cyclical variables, namely GNP and M, were set identically equal to zero over the entire time period. To implement these computations, it is necessary to specify initial values for the natural rate. However, the effect of these initial values on the calculations decreases rapidly. As a result, within two years the natural rate is virtually independent of the assumed initial values.

Figure 7 presents the actual age-weighted unemployment rate and the estimate of the natural rate of unemployment based upon the parameter estimates found in column (1) of Table 2. Initial values of the natural rate were taken to be equal to the actual values of the unemployment rate for the first and second quarters of 1954. The figure shows the estimates over the period from 1958 through the third quarter of 1981 so as to minimize the influence of this assumption about initial values on the natural rate.

As seen from the graph, the natural rate of unemployment has at times been below the actual unemployment rate and at other times has been above it. Until late 1966 the natural rate was consistently below the actual by as much as two percentage points. From late 1966 through 1973 the reverse occurred although the natural rate never exceeded the actual by more than one percentage point. The rise in the natural rate over this time is due predominantly to the relatively large amount of structural change that occurred and to a lesser extent the increase in social insurance expenditures as a percentage of GNP. From 1974 through 1977 the actual rate again exceeded the natural rate while for the brief period from 1978 to 1981 the opposite was true.

Not only has the relation between the actual and natural rates of unemployment changed over time, but the estimate of the natural rate has varied widely from a high of 7.01 percent in the third quarter of 1981 to a low of 3.48 percent in the first quarter of 1966. This variability of the natural rate makes appropriate policy-making difficult.

As suggested in the introduction, the difference between the natural rate of unemployment and the actual rate of unemployment is directly related to movements in the inflation rate. If the natural rate exceeds the actual rate, then labor market conditions are tight

Figure 7
The natural and fixed-weight unemployment rates

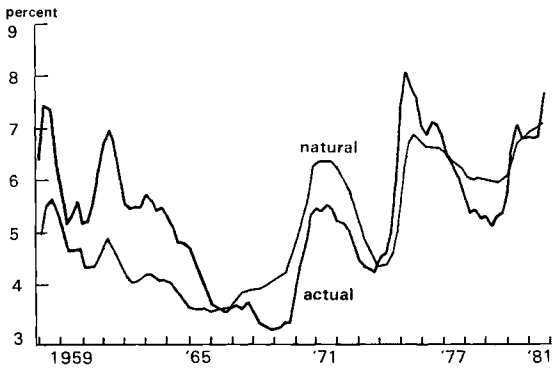
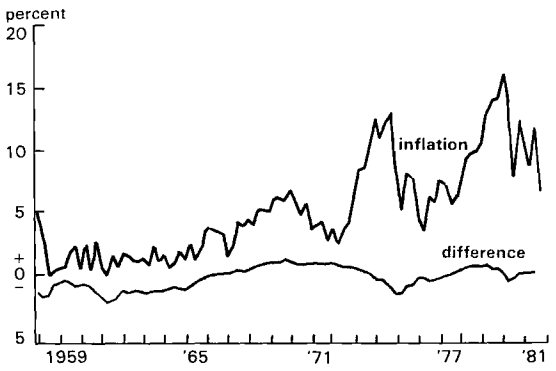


Figure 8
Inflation and the natural rate of employment



and inflation occurs. Conversely, if the actual rate exceeds the natural rate, then labor market conditions are slack and lower inflation or even possibly deflation results. Thus, the inflation rate should be positively correlated with the calculated difference. This indeed seems to be the case. The estimated correlation coefficient between the inflation rate and the difference between the natural and actual rates of unemployment is computed to be 0.46, indicating that the two do vary directly. In addition, there is no apparent linear relation between the inflation rate and the actual unemployment rate as the calculated correlation coefficient is a mere -0.01. Although these calculations are somewhat crude, they indicate that inflation does not depend upon the actual level of unemployment but rather the actual rate relative to the natural rate.

Figure 8 displays both the difference between the natural and actual rates and the annual inflation rate based upon quarterly data. The inflation rate from 1958 through 1966 fluctuates around two percent per year with no noticeable upward trend. During this time the actual unemployment rate was above the natural unemployment rate, implying that labor market conditions were somewhat slack. From 1967 to 1973 labor market conditions appear to be tighter as the natural rate rose above the actual. Inflation appears to be trending upwards during the same time period. Finally, the two drops in the difference between the natural and actual rates of unemployment occurring in 1975 and again in 1980 appear to coincide with rapid declines in the inflation rate.

While the two series are clearly positively related, a great deal of the variation in the inflation rate is unexplainable by changes in this measure of labor market tightness. If the estimates of the natural rate of unemployment are indeed correct, then a more adequate understanding of inflation requires incorporating other elements of the economy, such as monetary policy, into the analysis.

Conclusions

The historically high unemployment rates of recent decades are attributable in large part to a combination of two factors: rapid and pronounced structural change and low aggregate demand. Although demographic changes in the composition of the labor force have tended to adversely affect the unemployment rate, the actual impact has been quite modest.

The unemployment of the 1970s is attributable in large part to shifts in the distribution of employment across industries brought on by some sort of structural change. Unfortunately, the measure of structural change developed can be computed only with a four-year lag, thereby making policy decisions based upon such dated calculations inadvisable. Nevertheless, the need for policymakers to have some knowledge of the current magnitude of structural change is quite real.

The evidence on interindustry employment flows suggests that structural change has

not been as large a determinant of unemployment in the 1980s as it was in the 1970s. Thus, the double-digit unemployment of recent years is more closely associated with cyclical rather than structural or frictional factors.

Extrapolation of data used in the computation of Figure 7 suggests that the current natural rate of unemployment is approximately 6 percent. Given the actual unemployment rate of 7.07 for the first quarter of 1986, it appears that policymakers need not be unduly concerned with inflation at this time.

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[1] The discussion here is based to a large extent on Ronald G. Ehrenberg's and Robert S. Smith's book entitled *Modern Labor Economics: Theory and Public Policy*, 2nd edition, published by Scott, Foresman and Company, 1985.

[2] Real wages may not readily respond to decreases in aggregate demand because of long-term labor contracts which specify nominal wages, minimum wage legislation, and risk aversion on the part of workers who prefer fixed real wages and more variable employment.

[3] The unemployment rates have been constructed as in equation [1] so as to guarantee that the sum of the γ_{it}'s equals one.

[4] The age categories investigated were 16-to-19-year-olds, 20-to-24-year-olds, and those 25-years-of-age or older.

[5] Other traditional industries include construction, mining, transportation and public utilities. Service-related industries refer to wholesale and retail trades, finance, insurance, and real estate.

[6] This phenomenon was originally documented by Wesley C. Mitchell in *Business Cycles and Their Causes*, (Berkeley, CA: University of California Press, 1941).

[7] The industry categories examined include government, construction, mining, durable manufacturing, nondurable manufacturing, transportation and public utilities, services, wholesale trades, retail trades, and finance, insurance, and real estate.

[8] The dependent variable in the analysis is the fixed-weight unemployment rate adjusting for the effects of the changing age composition of the labor force. Similar calculations were also performed on the unadjusted unemployment rate but provide little additional insight.

[9] In the absence of serially correlated errors, ordinary least squares is equivalent to maximum likelihood estimation for large sample sizes. The adjusted Box-Pierce statistic (Q) is reported testing for serial correlation of the residuals through a lag length of six quarters. In all three regressions the hypothesis that the estimated residual is not serially correlated can be accepted at the five percent significance level.

[10] The measurement of permanent change in the distribution of employment across industries discussed below is found in George R. Neumann and Robert H. Topel, "Employment Risk, Sectoral Shifts, and the Geographical Distribution of Unemployment," forthcoming *Quarterly Journal of Economics*.

[11] Calculations are based upon the same ten industries as those used in computing $\hat{\sigma}^2$. The measures have been compiled assuming $J = 16$, creating a four-year lag in the estimate. As a result, values of Δ^P and Δ^T can be estimated only through the third quarter of 1981. The β_j's are assumed to be geometrically declining weights that sum to unity over 16 quarters. Therefore, $\beta_j = Cq^j$ where $C = (1 - q)/[q(1 - q^{17})]$. The results reported here are based upon the assumption that $q = 0.9$. However, in practice the actual weighting scheme used makes little difference in the final results. [See box for a discussion of the estimation.]

[12] Social insurance expenditures is available annually from the Social Security Administration's *Social Security Bulletin: Annual Statistical Supplement.* Quarterly data were calculated by linear interpolation.

[13] Some limited evidence to this effect is found in Robert E. Hall's article, "Why Is the Unemployment Rate So High at Full Employment?" in *Brookings Papers on Economic Activity*, vol. 3: 1970, pp. 369-396.

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