Restructuring, the NAIRU, and the Phillips Curve

Geoffrey M.B. Tootell

Assistant Vice President and Economist, Federal Reserve Bank of Boston.
The author thanks his colleagues at the Fed for useful comments. Faith N. Kasirye provided valuable research assistance.

Recent news stories about corporate downsizing have increased concerns that the labor market is being permanently restructured. The press implicitly, and some economists explicitly, have concluded that this "restructuring" in the labor market has increased the rate of unemployment that is consistent with stable inflation. (This rate is known as the NAIRU, the non-accelerating-inflation rate of unemployment, the unemployment rate below which inflation tends to rise, and above which inflation tends to fall.) This article examines both macroeconomic data and more disaggregated data in search of evidence for such a conclusion. It finds that neither type of data supports a conclusion that the NAIRU has risen in the past few years.

The policy implications of this debate are significant. Knowledge of the level of the NAIRU is important to monetary policy formation; it helps define the short-run trade-off between unemployment and inflation. If unemployment is below the NAIRU, eventually, inflation will increase; if it is above the NAIRU, inflation will eventually decline. Unless the actual level of inflation is above the desired level, any unemployment above the NAIRU is a waste of resources; the lost output associated with the higher level of unemployment will not move inflation toward its desired level. On the other hand, if inflation is higher than its desired level, unemployment must rise above the NAIRU if the level of inflation is to decline. Thus, knowledge of the level of the NAIRU increases the Federal Reserve's ability to reach its inflation target.[1]

Recent articles by Motley (1990) and Weiner (1993) have suggested that the NAIRU is currently higher than traditional estimates. These studies draw this conclusion by examining macro data in a Phillips curve framework. Neither the approach nor the debate is particularly new; in the late 1970s and early 1980s instability in the Phillips curve was used as evidence for an increase in the NAIRU.[2] However, this study's examination of the Phillips curve provides little support for the conclusion that the NAIRU has increased. Phillips curve estimates of the

NAIRU are found to hover around the historical estimate of 5.7 percent.[3]

Even if the historical macro evidence does not show that the NAIRU has increased, a structural break in the relationship between unemployment and inflation may still have occurred recently; insufficient time may have elapsed for this structural break to reveal itself in the macro data. Consequently, this study examines several hypotheses offered to explain why the NAIRU may have changed recently.

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One such hypothesis suggests that defense downsizing, along with its postulated increase in interindustry employment variance, has increased the mismatch between the skills demanded and the skills possessed in the labor market—the skills mismatch theory. Alternatively, it has been suggested that the variation in economic activity between regions of the United States has risen; thus, increased interregional variation has increased the geographical mismatch between the unemployed and the vacant jobs. Either of these two occurrences could raise structural unemployment and the NAIRU. However, recent movements in both the interregional and intersectoral variances provide little support for the hypothesis that the NAIRU has increased.

The remainder of this article presents the relevant data in this debate. The first section examines the evidence contained in the macro data. The second section examines some of the more frequently cited reasons for a recent structural shift in the labor market. Neither type of data supports the hypothesis that the NAIRU has risen. The third section concludes with a brief assessment of the difficulties of estimating the NAIRU.

I. The Macro Evidence

In two recent articles, Motley (1990) and Weiner (1993) resurrected a debate that occurred in the 1970s, finding instability over time in the Phillips curve relationship. Since one way to estimate the NAIRU is as a byproduct of the estimation of the Phillips curve, any instability in the Phillips curve might affect the estimation of the NAIRU. Most recently, Weiner finds that the Phillips curve changed substantively in the early 1970s. Given this shift, he argues, including data prior to 1973 when estimating the Phillips curve will bias the estimate of the NAIRU. By excluding the early part of the sample data, both Motley and Weiner get higher estimates of the NAIRU.[4] Before examining the different specifications and samples that can be used to estimate the NAIRU, however, it is useful to explain the relationship between estimates of the NAIRU and estimates of the Phillips curve. The validity of truncating the sample is then examined.

The Phillips Curve

The estimation of the Phillips curve has undergone several transformations since the original article by A.W. Phillips (1958), but the intuition behind it remains essentially unchanged. When slack exists in the labor market, wages tend to decline or do not rise as quickly as expected. Conversely, when the labor market is overheated, wages tend to rise or rise more quickly than expected. Since wages are the major cost to production, the behavior of prices follows suit. The Phillips curve simply translates labor market slack, unemployment, into inflation.

Because workers are concerned with real wages, even a rudimentary specification of the Phillips curve must include expectations of inflation:

$$\dot{P} = \beta * (Ur - Ur^*) + \gamma * (\dot{P}^E), \qquad (1)$$

where P stands for prices, Ur is the unemployment rate, Ur* is the NAIRU, and a dot over a variable symbolizes a percentage change in that variable. β is assumed to be less than zero; the expectations-aug-

[1] Alternatively, if the Fed targeted nominal GDP and cared about the level of inflation, it would need to know the growth rate of potential output while the economy groped toward the NAIRU.

[2] See Gordon (1982) for an analysis of this debate.

[3] In January 1994 the U.S. Bureau of Labor Statistics changed the survey used to measure the rate of unemployment. Since the new measure is available only since then, this study examines only the relationship between inflation and the old measure. The precise relationship between the new measure and inflation is not yet as clear.

[4] Motley was not convinced that the NAIRU had in fact changed, however, since the shorter sample increased the error surrounding the estimated NAIRU (1990, p. 13).

mented Phillips curve assumes that today's inflation depends negatively on the amount of slack in the labor market. The slack is measured by the difference between the current rate of unemployment and the NAIRU. Furthermore, γ is assumed to equal 1. Today's expectations of inflation affect the actual level of inflation because people are concerned about real wages and prices, not nominal values. If, for example, workers and firms believe that all prices will increase by 10 percent, they too will increase the price of their output, or their labor, by 10 percent. With the assumption that $\gamma = 1$, equilibrium real wages and relative prices are independent of the level of inflation.

Unfortunately for policymakers, the NAIRU is not known, so equation 1 cannot be estimated directly. If, however, one estimates the equation,

$$\dot{P}_t = \alpha + \beta*(Ur_t) + \gamma*(\dot{P}_t^E) + \varepsilon_t, \qquad (2)$$

one can derive a simple estimate of the NAIRU. Readjusting equation 1, and comparing it to the regression in equation 2, produce an estimate of the NAIRU that is contained in the constant term of equation 2,

$$Ur^* = -(\alpha/\beta). \qquad (3)$$

It is assumed that, in the long run, expectations cannot deviate from reality. Thus, when inflation is stable, the actual inflation rate must equal its expected value. In this way, estimates of the NAIRU can be derived from estimates of the Phillips curve. More complicated specifications of the Phillips curve might allow for lags in the effect of the unemployment rate on current prices, as changes in wages may lag unemployment and changes in prices may lag changes in wages. In that case, the sum of the coefficients on the unemployment rate variables would replace the sole β coefficient in equation 3.

More problematic, however, is finding an estimate of inflationary expectations. The most common approach in the literature has been to use long lags of past rates of inflation to predict future inflation. Since inflation is a slow-moving process, many lags are needed. A more complete version of the Phillips curve, and one more consistent with previously estimated specifications, is, thus, provided in equation 4.

$$\dot{P}_t = \alpha + \sum_{i=0}^{n} \beta_i(Ur_{t-i}) + \sum_{i=1}^{k} \gamma_i(\dot{P}_{t-i}) + \varepsilon_t \qquad (4)$$

The expectation for inflation is represented by a weighted average of the k lags of inflation, and the γ_is are assumed to sum to 1. The estimate of the NAIRU is simply minus the constant term, α, divided by the summation of the coefficients on the current and lagged unemployment rates, $\Sigma\beta_i$.

Historically, various versions of this equation have produced estimates of the NAIRU of approximately 5.75 percent using the old measure of the unemployment rate.[5] Weiner (1993), however, produces an estimate for the NAIRU of around 6.3 percent for 1994. Weiner's approach differs in two major ways from that implied in equation 4. First, Weiner and others, like Perry (1970) and Motley (1990), have incorporated changes in the age and gender composition of the labor force. This adjustment tends to increase the estimate of the NAIRU in the 1970s and decrease it in the 1980s. Weiner goes on, however, to examine the stability of the Phillips curve over the last 30 years. He argues that a structural break occurred in the relationship in the early 1970s. The Phillips curve that he estimates is stable across the 1970s and 1980s but not across either of these periods and the 1960s.[6] Therefore, he omits the 1960s from the sample. It is this sample truncation that is primarily responsible for his higher estimate of the NAIRU.

The Phillips curve simply translates labor market slack, unemployment, into inflation.

It is always dangerous to omit observations from the estimation; tests lose power and short-run perturbations are given more significance than they deserve. Furthermore, any justification for truncating the sample and, therefore, the conclusion that the best estimate of the NAIRU has increased, depends on whether only certain parts of the Phillips curve are unstable. Weiner (1993) and Motley (1990) do not discuss exactly which coefficients in the Phillips curve are unstable. In estimating the NAIRU, only the stability of the particular part of the equation that

[5] As noted above, the pre-1994 measure of unemployment is used in this paper. The sample ends in 1993:IV, just before the new measure was released.

[6] The exact test is not quite clear. Is it a test of equality of all the coefficients in the model or only certain ones? See Weiner (1993).

pertains to the estimate of the NAIRU is important: the constant term divided by the sum of the coefficients on the unemployment rate and its lags. It does not matter, for example, if the formation of inflation expectations contained in the Phillips curve has changed through time, or even if the exact sequence of coefficients on the unemployment rate and its lags has evolved. These coefficients can change while the estimate of the NAIRU remains constant. It is the stability of the NAIRU that is important for policy and that is at the heart of this debate.

Using the old BLS measure of unemployment, the NAIRU appears closer to the 5.5 to 5.8 percent range than to the 6.3 percent range suggested recently.

The remainder of this paper will test whether the NAIRU has increased. The next section examines the Phillips curve using different measures of inflation and different specifications to test the robustness of the finding of instability. Next, the stability of the NAIRU is examined directly. Finally, the various explanations for a possible recent breakdown in the relationship are explored.

The Empirical Results

The robustness of findings of instability in the Phillips curve is examined for a traditional Phillips curve specification over the 1960s, 1970s, and 1980s.[7] This study examines two different price measures—the consumer price index excluding food and energy and the implicit price deflator—as well as one wage measure—nonfarm labor compensation.[8]

Unfortunately, the two price measures, to varying degrees, tend to capture import price inflation. Inflation due to increases in imported goods prices should be ignored when estimating the NAIRU, since it does not result from conditions in the domestic labor market. If, for example, an economy resting at its NAIRU is buffeted by foreign price shocks, domestic measures of inflation tend to increase. The resulting increase in domestic inflation has no bearing on the actual NAIRU, but it tends to bias upward the estimate of the NAIRU unless the foreign effect is included in the model. Although the price indices suffer from this problem, wages, the measure originally studied in the Phillips curve, is less prone to this mismeasurement.

A traditional Phillips curve specification is used to test for stability of the NAIRU for all measures of inflation examined in this study. Inflation is assumed to depend on the contemporaneous rate of unemployment and a one-quarter-lagged rate of unemployment; further lags of the unemployment rate do not add significantly to the explanatory power of the equation. The relationship between the unemployment rate and inflation is modeled as linear, as in Gordon (1982) and Motley (1990), rather than nonlinear, as in Blanchard (1984) and Phillips (1958). The alternative of a log linear specification was less powerful in most instances. Furthermore, the inflation expectation was assumed to be formed using a long lag (12 quarters) of past inflation rates. The coefficients on lagged inflation were always constrained to sum to 1, assuming that people care only about relative wages and prices. The data could not reject the hypothesis that this constraint holds.[9] Also included in the model were dummy variables for the Nixon wage and price controls, since these controls artificially limited wage and price inflation when they were in effect.[10] Finally, the import price deflator was included in the equations, in an attempt to capture foreign price increases not driven by excess demand in the domestic labor market.[11]

The first test of instability follows Weiner (1993)

[7] Most of the specifications examined in this article require estimating more coefficients than in Weiner (1993); thus, the middle sample period is slightly longer. Furthermore, the results are updated through the fourth quarter of 1993.

[8] The compensation measure is nonfarm labor compensation. Alternatively the employment cost index was spliced onto the compensation measure after it began in 1981:II. The results are not affected by the exact measure of compensation used. Weiner used the deflator for personal consumption expenditures; this variable is not used here to estimate a Phillips curve since it is not the variable of interest to policymakers nor is it closely related to the labor market.

[9] For example, in the deflator equation the log likelihood ratio for this constraint, distributed as a χ^2 with 1 degree of freedom, was 0.05, well below its critical value of 3.9.

[10] The Nixon variable equals 1 from 1971:III to 1972:III, and zero otherwise. The Nixoff variable equals 1 from 1974:II to 1975:I, and zero otherwise.

[11] In order to be parsimonious, two lags were selected as they were the only significant ones. Motley (1990) constrained the coefficients on a similar variable to sum to zero, arguing that supply shocks do not get imbedded in inflationary expectations. A priori, the case for that claim is not strong; empirically imposing that constraint was rejected.

Table 1
Stability of the Phillips Curve: Full Sample with Different Constants for Each Decade

	GDP Deflator		CPI_{XFE}	
Constant	.007*	.008*	.007*	.008*
Σ Unemployment Rate	−.0012*	−.0015*	−.0012*	−.0016*
$\Sigma\dot{P}$	1.0	1.0	1.0	1.0
$\Sigma\dot{M}$	.057*	.048*	.081*	.075*
Nixon	−.0027	−.0021*	−.0046*	−.0038*
Nixoff	.0049*	.0054	.0059*	.0063*
1970s		.0011		.0015
1980s		.0007		.0019*
Log Likelihood	591.14	591.72	594.52	597.29
No. of Observations	135.0	135.0	135.0	135.0
Estimated NAIRU	5.6		5.5	
Estimated NAIRU 1960s		5.4		5.0
Estimated NAIRU 1970s		6.1		5.9
Estimated NAIRU 1980s		5.8		6.2

*Significant at the 5 percent level.
Note: 1970s represent 1973:I through 1982:IV; 1980s represent 1983:I through 1993:IV. The estimated NAIRUs are calculated using the unrounded coefficients.

and Gordon (1982). The equation allows the constant term to differ between the 1960s, 1970s, and the 1980s.[12] Table 1 provides the estimated coefficients for the two price Phillips curves. The Phillips curve using the GDP deflator shows no statistically significant difference between the three periods; both dummies are insignificant. If the core CPI is used instead, the constant term for the 1980s is significantly greater than zero, implying a higher NAIRU in that decade for that specification.[13] This evidence, thus, is mixed. However, since the GDP deflator is less affected by foreign price shocks, the insignificance of the decennial dummies in the GDP deflator equation may be more reflective of changes in the actual NAIRU. Further, note that the NAIRUs estimated over the full sample hover around 5.5 percent, far from the 6.3 percent asserted as the current estimate by those who believe that some sort of labor market restructuring has occurred.

Table 2 examines whether the group of coefficients in each equation is identical over the three subperiods. For both the GDP deflator and the core CPI, one cannot reject the hypothesis that the groups of coefficients are identical for the 1960s and 1980s. On the other hand, for both of these price series, the hypothesis that the estimated coefficients are identical over the 1970s and 1980s is strongly rejected. For these two price measures, and this test, the results contradict Weiner's; if anything, the 1960s and the 1980s seem identical, with the 1970s as the outlier, not the 1970s and 1980s together and the 1960s the anomaly, as he found.

Table 2 also presents the pattern of NAIRU estimates over the three periods. The estimated NAIRU in the 1960s is about 5.5 percent; it rises to about 6.5 percent in the 1970s and then falls to around 6.0 percent in the 1980s. This 6.0 percent approaches the estimate Weiner produced for the 1980s. Since it cannot be rejected that the coefficients are identical between the 1960s and the 1980s, the NAIRU estimate combining these two subsamples should be examined. In that case, the estimated NAIRU ranges from 5.5 to 5.8, depending on the price measure used.

It is possible that any instability in the Phillips curve occurs for reasons unrelated to changes in the NAIRU. For example, the method of forming inflationary expectations may have changed; the individual coefficients on the lagged inflation rates could differ between the subsamples.[14] Although the process that produces the best inflation forecast might change over time, this instability has little to do with the long-run value of the NAIRU. Also, a test of whether the set of all coefficients differs across time periods could obscure differences among individual coefficients. A more relevant test for labor market restructuring and its effects on inflation would be an examination of the stability of the estimated NAIRU over the three subperiods.

Table 3 shows the results of likelihood ratio tests of the stability of the NAIRU over the different subperiods, for the two measures of price inflation. With these two price measures it can be rejected that the NAIRU is the same between any two of the three sample periods. In short, the results using these two price measures are ambiguous. Broad tests of the

[12] The exact subsamples selected are meant to follow Weiner as closely as possible yet still allow for enough degrees of freedom to estimate the equations reliably. The three periods are 1960:I to 1972:IV, 1973:I to 1982:IV, and 1983:I to 1993:IV.

[13] The equation for the GDP deflator produces an estimate of the NAIRU in 1980s of about 5.8 percent. If the core CPI is used the estimate for the NAIRU in the 1980s is around 6.2.

[14] For example, in the 1970s, when inflation accelerated, expectations may have become more responsive to changes in inflation.

Table 2
Stability of the Phillips Curve: Subsamples

	GDP Deflator						CPI_{XFE}					
	Full Sample	1960s	1970s	1980s	1960s & 1980s	1970s & 1980s	Full Sample	1960s	1970s	1980s	1960s & 1980s	1970s & 1980s
Constant	.007*	.011*	.020*	.014*	.008*	.010*	.007*	.009*	.021*	.007*	.006*	.010*
Σ Unemployment Rate	−.0012*	−.002*	−.0030*	−.0023*	−.0015*	−.0016*	−.0012*	−.0016*	−.0034*	−.0012*	−.0010*	−.0017*
$\Sigma\dot{P}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$\Sigma\dot{M}$	.057*	.085	.0016*	.043	.064	.037*	.081*	−.091	.090*	.013	−.016	.072*
Nixon	−.0027	−.0021			−.0024		−.0046*	−.0030			−.0033*	
Nixoff	.0049*		.0048			.0049*	.0059*		.0046			.0068*
Log Likelihood	591.14	226.25	179.67	217.29	430.02	378.95	594.52	245.39	169.99	228.86	462.75	365.13
No. of Observations	135.0	51.0	40.0	44.0	95.0	84.0	135.0	51.0	40.0	44.0	95.0	84.0
Estimated NAIRU	5.6	5.4	6.8	6.0	5.5	6.1	5.5	5.6	6.3	6.0	5.8	6.1
Log Likelihood Ratio					27.05	36.01					23.0	67.43

*Significant at the 5 percent level.
The likelihood ratio test is distributed as a χ^2 with 18 degrees of freedom. The 5 percent critical value of the statistic is 28.9.
Note: 1960s represent 1960:II through 1972:IV; 1970s represent 1973:I through 1982:IV; 1980s represent 1983:I through 1993:IV. The estimated NAIRUs are calculated using the unrounded coefficients.

group of coefficients suggest stability between the 1960s and the 1980s, with the 1970s as an outlier, while a more specific test of the stability of the NAIRU alone suggests that all three periods are different.

Yet, do these ambiguous results on the stability of the Phillips curve provide good information on shifts in the NAIRU or good information on the imperfections of these price measures? During the 1970s, the economy endured several severe energy price shocks. The resulting stagflation resulted in simultaneous increases in inflation and the unemployment rate.[15] Since these price disturbances were of foreign origin, independent of the strength of the domestic economy, the measured NAIRU would look much higher than its actual value. Even if the actual NAIRU had remained constant in the 1970s, the measured rate over that period would have increased substantially, highlighting the dangers of truncating the sample. Thus, if anything, one would, a priori, suspect that estimates of the NAIRU that include the 1970s would be biased upward, particularly when examining measures of inflation that do not effectively filter foreign price shocks. And, in fact, Table 2 shows that the estimated NAIRU over the three samples rises in the 1970s and falls back down in the 1980s.

The presence of large and frequent foreign price

Table 3
Stability of the NAIRU across Subperiods

	1960s vs. 1980s	1970s vs. 1980s	1960s vs. 1970s
GDP Deflator			
Log Likelihood Ratio	12.66	39.31	41.25
Estimated NAIRU	5.5	6.1	6.6
CPI_{XFE}			
Log Likelihood Ratio	7.64	37.13	54.35
Estimated NAIRU	5.7	6.1	6.6

Note: Critical value for χ^2 with 1 degree of freedom at the 5 percent level = 3.9.
1960s represent 1960:II through 1972:IV; 1970s represent 1973:I through 1982:IV; 1980s represent 1983:I through 1993:IV.

[15] Although the oil price shocks were really price level adjustments, the Phillips curve regression interprets them as inflation since they took a long time to work themselves through the economy. Furthermore, evidence that these one-shot changes became embedded in inflationary expectations is found in the rejection well beyond the 1 percent level that the coefficients on import prices sum to zero.

Table 4
Compensation Phillips Curve Estimates

	Full Sample	Full Sample	1960s	1970s	1980s	1960s & 1980s	1970s & 1980s
Constant	.0072*	.0096*	.0068	.0145*	.0069	.0081*	.0092*
Σ Unemployment Rate	−.0015*	−.0019*	−.0012	−.0022*	−.0014*	−.0016*	−.0018*
$\Sigma\dot{P}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$\Sigma\dot{Q}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$\Sigma\dot{M}$	.065*	.016	−.162	.028	−.059	−.068	.078*
Nixon	.00008	.00145	.004			.004	
Nixoff	.0056*	.00717*		.005*			.005
1970s		.0036*					
1980s		−.0002					
Log likelihood	559.01	565.47	225.17	191.78	200.95	400.23	357.56
NAIRU	4.9	4.9	5.7	6.5	4.8	5.0	5.2
NAIRU 70s		6.8					
NAIRU 80s		4.8					

*Significant at the 5 percent level.
Note: 1960s represent 1960:II through 1972:IV; 1970s represent 1973:I through 1982:IV; 1980s represent 1983:I through 1993:IV.

shocks during the 1970s necessitates a search for a cleaner price measure. Not only was labor compensation the first measure examined by Phillips in 1958, but it should be less responsive to foreign price shocks than the PCE deflator, the core CPI, or the GDP deflator. Nominal wage inflation should depend on three different variables, the unemployment rate, expectations about future price inflation, and productivity growth:

$$\dot{W} = \alpha + \sum_{i=0}^{n} \beta_i(Ur_{t-i}) + \sum_{i=1}^{k} \gamma_i(\dot{P}_{t-i}) + \sum_{i=1}^{L} \theta_i(\dot{Q}_{t-i}). \quad (5)$$

Workers and firms care only about real wages and prices, so expectations of future price increases are incorporated into wage increases, and these price coefficients sum to 1. Furthermore, in equilibrium labor is assumed to be paid its marginal product, so the coefficients on the lagged productivity terms sum to 1; thus, these constraints ensure that, in the long run, the increase in the real wage is equal to the increase in labor productivity.[16]

[16] This assumption is valid if production has constant elasticity of substitution. The log likelihood ratio for the constraint that the coefficients for the productivity terms sum to 1, distributed as a χ^2 with 1 degree of freedom, was 0.4, well below its critical value of 3.9. In the long run, wages, prices, and productivity growth do, in fact, move together, as suggested by equation 5. In an unconstrained regression, compensation, prices, and productivity are cointegrated.

Table 4 presents estimates of this more traditional Phillips curve. As in the equation for the GDP deflator, the constant terms do not differ between the 1960s and the 1980s. In fact, as can be seen in column 2, the constant term for the 1970s is statistically significantly higher than those for the other two decades. Comparing all the coefficients in each subsample produces results different from the price equations, however. With compensation growth, it can be strongly rejected that all of the coefficients in the model are identical for any of these three periods. It is not clear from this test whether these differences occur because inflation expectations are formed differently over different subsamples, because productivity changes are incorporated into wage changes

Table 5
Stability of the NAIRU in Compensation Phillips Curve

	1960s and 1980s	1970s and 1980s	1960s and 1970s
Likelihood Ratio	2.02	46.97	24.83
Estimated NAIRU	5.3	5.8	6.5

Note: 1960s represent 1960:II through 1972:IV; 1970s represent 1973:I through 1982:IV; 1980s represent 1983:I through 1993:IV.
The likelihood ratio is distributed as a χ^2 with 1 degree of freedom whose critical value at the 5 percent level is 3.89.

differently across these periods, or because each sample has a different NAIRU.

Table 5 examines whether the NAIRU is different across these subperiods. As can be seen in column 1, the hypothesis that the NAIRU is the same in the 1960s and the 1980s cannot be rejected. The hypothesis that the NAIRU in the 1970s is the same as the NAIRU in the 1980s can, however, be strongly rejected. As with the price measures, the estimated NAIRU is higher when the sample includes the decade of the 1970s; again, the 1970s seem to be the anomaly, not the 1960s. As shown in Table 5, omitting observations from the 1970s, and only constraining the NAIRUs to be identical across the two other periods, produces an estimate of the NAIRU of about 5.3 percent.

The evidence appears to suggest that if the sample is to be truncated, it is the 1970s and not the 1960s that should be removed. Using the compensation Phillips curve, which avoids many of the upward biases in the estimation of the NAIRU inherent in the other price measures during this sample period, the NAIRU in the 1980s has not changed significantly from that in the 1960s. This conclusion is not surprising, because foreign price shocks that drive a wedge between the actual and the measured NAIRUs occurred more frequently in the 1970s. Whether the 1960s and the 1980s or simply the full sample is used to estimate the NAIRU, however, it appears closer to the 5.5 to 5.8 percent range than to the 6.3 percent range suggested recently.

The Composition of the Labor Force

One frequent explanation for a shift in the NAIRU is a change in the demographic composition of the labor force. Much of the Phillips curve literature simply assumes that demographics affect the NAIRU. For example, Perry (1970) constructed a weighted measure of unemployment, based on the assumption that the composition of the labor force affected the NAIRU; Gordon (1982) used that measure; Blanchard (1984) used the unemployment rate for married males; and Motley (1990) and Weiner (1993) constructed their own measures.

It is not altogether clear, however, why demographics should affect the NAIRU. Clearly, a measure of the attachment of the population to the labor force is essential in determining the natural, full-employment rate of unemployment. It is not, however, obvious why the NAIRU cannot be higher than the natural rate, or whether the NAIRU should be strongly affected by changes in demographics. Furthermore, it is not at all clear that weighting the unemployment rate based on estimated relationships between the natural rates of different subgroups accurately captures the effects on the Phillips curve of changes in the demographic composition of the labor force.[17] There is no reason to believe that the amount of wage pressure produced by one subgroup when below its "full employment" unemployment rate would be similar to the amount of wage pressure produced by another. The substitutability between subgroups, and the wage dynamics in the different markets if they are distinct, must be known before predictions about the NAIRU can be derived from information about the demographic composition of the labor force. Moreover, the natural rate of unemployment for many of these subgroups is notoriously variable.[18] The importance of these compositional variables, however, is an empirical question.

It is not altogether clear why demographics should affect the NAIRU; in fact, including the two largest shift factors in labor force composition, teens and women, has little if any effect on any of the Phillips curves.

Table 6 presents estimates of the Phillips curve for all three price and wage measures, including various labor force composition measures. If the share of the labor force of certain groups does affect the NAIRU, these labor force shares should be significant in the Phillips curve equation. For example, as teens became a larger percentage of the labor force, the NAIRU should have increased, and the coefficient

[17] The population is typically broken down into subgroups by age, gender, race, and marital status, for example.

[18] For example, the labor force participation of women changed significantly over the sample period studied here, as did their mean unemployment rate. Any adjustments of the unemployment rate in the later part of the sample based on the female unemployment rates found in the earlier part of the sample would be invalid; the "natural rate" would be overestimated as the labor force participation of women rose.

Table 6
Labor Force Compensation and the Phillips Curve

	GDP Deflator		CPI_{XFE}		Compensation	
Constant	.0055*	.0061*	.0029	.0089*	.010*	.0024
Σ Unemployment Rate	−.0013*	−.0012*	−.0014*	−.0012*	−.0013*	−.0014*
$\Sigma\dot{P}$	1.0	1.0	1.0	1.0	1.0	1.0
$\Sigma\dot{Q}$					1.0	1.0
$\Sigma\dot{M}$	.0056*	.0053*	.082*	.089*	.063*	.045
Nixon	−.0026*	−.0029	−.0044*	−.004*	−.00003	−.006
Nixoff	.0051	.005*	.0064*	.0058*	.0051	.0057*
LFW	.0053 (.0063)		.014* (.0056)		−.012 (.010)	
LFT		.012 (.023)		−.028 (.019)		.060* (.030)
Log Likelihood	591.39	591.26	596.34	595.22	559.79	560.90

*Significant at the 5 percent level. Standard errors are given in parentheses.
LFW: percentage of labor force represented by women. LFT: teens.

on the share of teens in the labor force in the Phillips curve equation should be positive and statistically significant. If the composition of the labor force is important, then using an unadjusted unemployment rate in the estimation should produce inflation errors correlated with changes in these compositional variables.

In fact, including the two largest shift factors in labor force composition, teens and women, has little, if any, effect on any of the Phillips curves. Four of the six coefficients are statistically insignificant, and the two that are significant derive all their explanatory power at the expense of the constant terms. The results indicate that using the simple unemployment rate should not produce any problems for this analysis, a finding which is consistent with Fair (1978).

The macro data suggest that the NAIRU is about 5.5 to 5.7 percent. If concerns about the stability of the coefficients across time were to force a truncation of the data, it is the 1970s, not the 1960s, that should be dropped, producing a lower estimate of the NAIRU than the full sample estimate. The macro evidence does not support a conclusion that restructuring has occurred in the labor market.

On the other hand, if the Phillips curve relationship shifted only very recently, it would take a while for the errors to become large enough to reflect that change. The next section of the paper looks at some commonly asserted explanations of why the relationship between the unemployment rate and the inflation rate may have suddenly and recently changed for the worse.

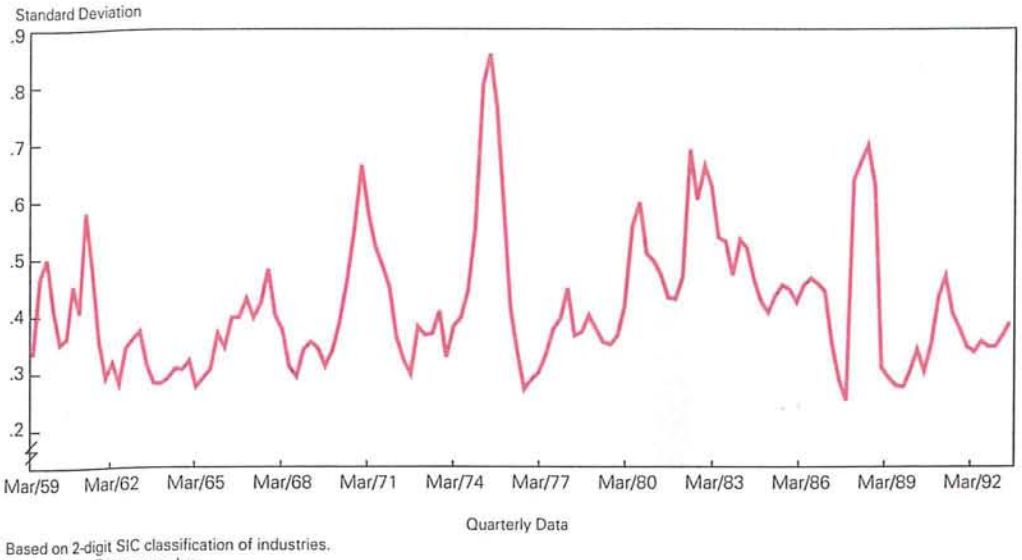
II. Causes of Recent Restructuring

Two hypotheses have been set forth asserting that the historically estimated Phillips curve relationship has recently broken down. The one most frequently cited is that a large shift from defense to civilian production has increased the mismatch between workers' skills and the skills demanded by employers. Somewhat related to this explanation is an alternative view that a geographical mismatch between workers and jobs has worsened since the mid 1980s; an unusually high variance in economic performance across different sections of the country has resulted in job openings and unemployed workers being located in different regions. The serious downturn in the Southwest in the 1980s, and the proportionately more severe and enduring downturns in the Northeast and in California of late, are cited as evidence in support of this second hypothesis.

If the interindustry variation in employment growth were to increase, the NAIRU might also increase. The higher variance would require much more movement of employment across industries. Since skills from one industry may not be as useful in another, more time-consuming job search and re-

Figure 1

Standard Deviation of Annual Growth in Employment across Industries



Based on 2-digit SIC classification of industries.
Source: Data Resources, Inc.

training might be required for the unemployed to find work; this would increase the unemployment rate without necessarily putting increased downward pressure on wages, since the pool of "correctly" skilled labor would not increase along with the unemployed. Increasing aggregate demand in this case would not increase the demand for these currently mismatched, unemployed workers but would simply increase the demand for the workers who already have jobs; as a result, wages would tend to rise at a higher level of unemployment, implying that the NAIRU has increased.

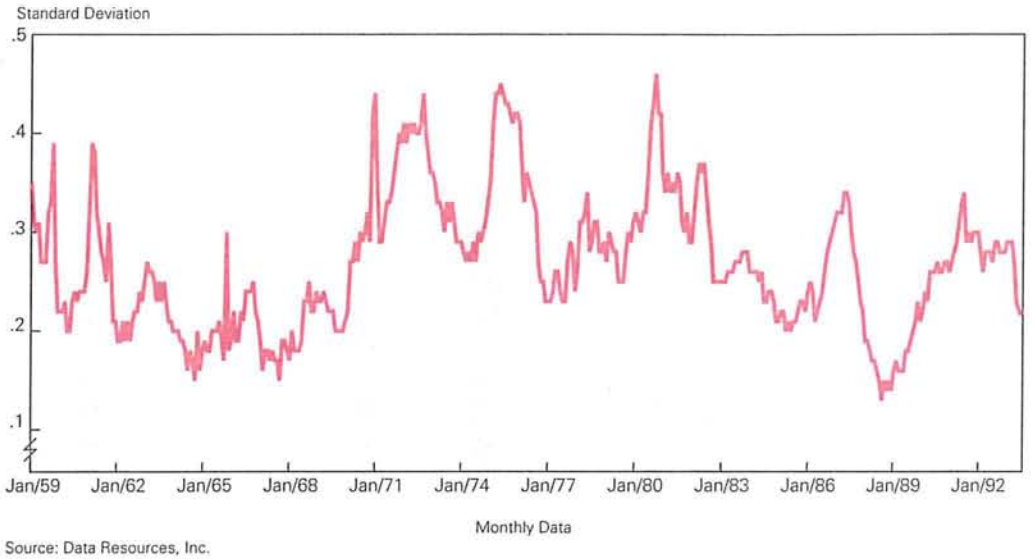
A second explanation offered for labor market restructuring is that interregional variation has increased. This hypothesis asserts that only the coasts performed poorly while the rest of the country did well in the last recession and the early part of the recovery. If true, job growth would be strong everywhere but California and New England, exactly where the largest excess supplies of labor are to be found. The increased variation between regions would require that the unemployed in New England and California migrate to other parts of the country to find employment or that capital migrate to these coastal regions. The matching of job openings to unemployed workers is much more difficult when the two are concentrated in different regions of the country, and the NAIRU could increase because of the migration necessary to find employment and the increased time spent searching for a new job.

In fact, neither of these variances is particularly high right now. Figures 1 and 2 present the intersectoral and interregional variations. Both measures are highly cyclical, and neither grew particularly large during the recent recession. By far the largest interindustry variance occurred after the 1974–75 oil shock, which hit the auto and auto-related sectors hard while simultaneously stoking our energy industry. Intersectoral variation is actually low now relative to the past, and there is no evidence that interindustry mismatch has raised the NAIRU.

Interregional variation is also low, relative to its past values. The hump in the mid 1980s represents the collapse of the Southwest economy due to the drop in oil prices, and the increase in this variable since 1988 reflects both the problems in New England and California and the normal effects of the last recession. Still, interregional variation was not abnormally high during this recession, nor is it abnormally high now. Neither measures of regional nor mea-

Figure 2

Standard Deviation of Annual Growth in Employment across States



Source: Data Resources, Inc.

sures of sectoral dislocation suggest that the NAIRU has increased recently.

No matter what their values, however, these two variances seem to have little effect on the NAIRU. If either variation is important in the determination of the NAIRU, it should be significant in estimates of the Phillips curve. Columns 2, 5, and 8 of Table 7 reproduce the basic Phillips curve specification used throughout this paper, but include as a determinant of inflation the intersectoral variance, measured as the variation of annual employment growth across all 66 2-digit industry groupings for each year from 1959 to 1993. As can be seen, this variation does not help explain inflation beyond the variables already used.

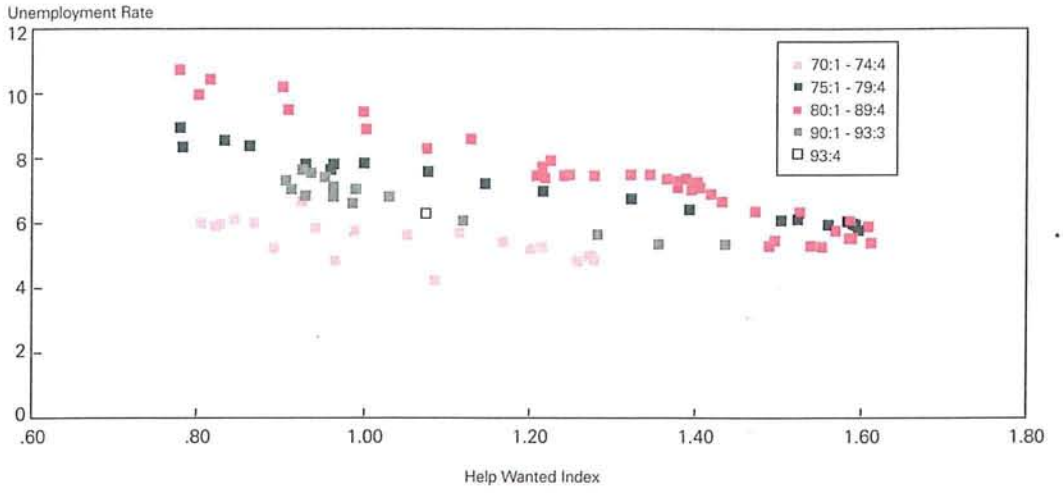
Alternatively, if increases in the interregional variances increased the NAIRU, a measure of the interregional variation should be a significant determinant of inflation, beyond the variables already included in the Phillips curve. The first, fourth, and seventh columns of Table 7 include this variation in the Phillips curve estimation. It is not statistically significant in any of the equations. Neither of these variance measures appears to affect the NAIRU. There is no evidence that a rise in the geographical or intersectoral mismatch between the unemployed and the vacant jobs has increased the natural rate of unemployment.

Higher interregional and intersectoral variations produce the same result—they increase the mismatch between the labor that is demanded and the labor that is unemployed. A higher mismatch, for whatever reason, could increase the NAIRU. This mismatch can also be measured by the position of the Beveridge curve. Figure 3 plots the relationship between the level of unemployment and the level of job vacancies, as measured by an index of help-wanted ads. The red squares seem to represent one Beveridge curve. As the economy expands, the unemployment rate falls and job vacancies rise, moving down that curve. The higher the mismatch between vacant jobs and unemployed workers, or the higher the frictional rate of unemployment, the farther the curve will be from the origin. Thus, for any given unemployment rate, help-wanted advertising should be high if the mismatch has increased. As can be seen by the clear square and the grey squares, help-wanted ads are currently low, given the unemployment rate. The Beveridge curve did shift out, but the shift occurred in the late 1970s and early 1980s (represented by the black and red squares) when interregional and inter-

Figure 3

Relationship between Unemployment and Job Vacancies

(Beveridge Curve)



sectoral variances were at their peaks. This indicator of the degree of mismatch in the labor market does not support that rising frictional unemployment has increased the NAIRU.

The effect of shifts in the Beveridge curve on the NAIRU can also be examined in the Phillips curve regressions. Holding the unemployment rate constant, a shift out in the Beveridge curve means that vacancies, measured by the help-wanted index, are higher. Thus, if a shift out in the Beveridge curve

Table 7

The Phillips Curve and the Beveridge Curve

	GDP Deflator			CPI_{XFE}			Compensation		
Constant	.0064*	.0066*	.0056*	.0069*	.0075*	.0047*	.0050*	.0086*	.0080*
Σ Unemployment Rate	−.0014*	−.0014*	−.0013*	−.0012*	−.0010*	−.0013*	−.0018*	−.0012*	−.0014*
$\Sigma\dot{P}$	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$\Sigma\dot{Q}$							1.0	1.0	1.0
$\Sigma\dot{M}$	.049*	.056*	.047*	.082*	.079*	.072*	.045	.061	.065*
Nixon	−.0038*	−.0027*	−.0024*	−.0042*	−.0044*	−.0044*	−.0029	.0004	−.00007
Nixoff	.0055	.0050	.0060	.0058	.0062*	.0073*	.0063	.0062*	.0050
σ Region	.0072			−.0018			.017		
σ Sector		.0028			−.0049			−.0074	
Help Wanted			.0017			.0024*			−.0011
Log Likelihood	578.22	577.95	578.92	580.05	581.33	583.17	548.65	547.86	546.84

*Significant at the 5 percent level.

increases the NAIRU, adding help wanted to the Phillips curve should produce a positive and significant variable. As columns 3, 6, and 9 of Table 7 reveal, the help-wanted index is only marginally statistically significant in the Phillips curve regression. Thus, even if the Beveridge curve had shifted out in the 1990s (which it did not), it should have had very little effect on the NAIRU.[19]

III. Conclusion

As the economy approaches capacity, the estimate of the NAIRU becomes more and more important. Recently, it has been suggested that macro data reveal an increase in the NAIRU. This paper finds little support for such a conclusion. Although regressions for a sample of the past 10 years can produce higher estimates of the NAIRU, the validity of truncating the sample in this way is dubious, and the standard errors around the NAIRUs estimated in these shorter regressions are large. On the other hand, the hypothesis that the NAIRU has increased because of some very recent restructuring in the labor market appears unfounded. The reasons often cited are not supported by the data.

Although the NAIRU can vary over a 35-year period, the actual NAIRU is not nearly as variable as the estimated NAIRU when a series of large supply shocks affect our measures of inflation over the sample period. Many factors relating to both labor supply and labor demand might cause the NAIRU to change. Attempts have been made to capture these effects, as in Perry (1970) and Clarke and Summers (1979). This approach attempts to construct the NAIRU estimate from the ground up. The problems with adjusting for the demographic effects discussed above are an example of the difficulties encountered by this approach.

Neither constructing the NAIRU nor estimating it via the Phillips curve is a foolproof method. Perhaps the best way to get a feel for the current NAIRU is to examine the last time the economy approached it. The 1987–89 period resulted in reasonably stable inflation. With a one-period lag on unemployment in the Phillips curve, the unemployment rate averaged approximately 5.7 percent over that period, roughly the full-sample estimate of the NAIRU. However, from early 1988 to the end of 1990, the unemployment rate fell below 5.7 percent, producing an increase in inflation in late 1989 and 1990, in keeping with the Phillips curve estimates in this paper. A Phillips curve estimated over the full sample does not underpredict the amount of inflation that occurred in this period. Thus, the latest incident near the NAIRU supports the conclusion of a NAIRU near 5.7 percent. Little evidence has been found to suggest that this estimate of the NAIRU has changed significantly since then.

The latest incident near the NAIRU supports the conclusion of a NAIRU near 5.7 percent, using the old BLS measure of unemployment. Little evidence has been found to suggest that the NAIRU has changed significantly since then.

Estimating the NAIRU is fraught with hazards. Deriving it from Phillips curves is risky, owing to potential coefficient instability and because our measures of inflation are imperfect for the task. Yet, when controlling for this method's most obvious problems, using the Phillips curve may be the most effective tool we have to derive an estimate of the NAIRU. This method produces a fairly consistent estimate of a NAIRU between 5.5 and 5.8 percent.

[19] In a regression over only the last 11 years, inclusion of the help wanted data lowers the estimated NAIRU to around 5.8 percent.

References

Blanchard, Olivier. 1984. "The Lucas Critique and the Volcker Deflation." *The American Economic Review*, May, pp. 211–15.

Clarke, Kim and Lawrence H. Summers. 1979. "Labor Market Dynamics and Unemployment: A Reconsideration." *Brookings Papers on Economic Activity*, vol. 1, pp. 13–60.

Fair, Ray. 1978. "Inflation and Unemployment in a Macroeconometric Model." In *After the Phillips Curve: Persistence of High Inflation and High Unemployment*, Federal Reserve Bank of Boston, Conference Series no. 19, pp. 164–93.

Gordon, Robert J. 1982. "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment." In Martin Neil Baily, ed., *Workers, Jobs, and Inflation*, Washington, D.C.: The Brookings Institution, pp. 89–158.

Motley, Brian. 1990. "Has There Been a Change in the Natural Rate of Unemployment?" Federal Reserve Bank of San Francisco, *Economic Review*, Winter (no. 1), pp. 3–16.

Perry, George L. 1970. "Changing Labor Markets and Inflation." *Brookings Papers on Economic Activity*, vol. 1, pp. 411–41.

Phillips, A.W. 1958. "The Relation between Unemployment and the Rate of Money Wage Rates in the United Kingdom, 1861–1957." *Economica*, November, pp. 283–99.

Weiner, Stuart E. 1993. "New Estimates of the Natural Rate of Unemployment." Federal Reserve Bank of Kansas City, *Economic Review*, vol. 78, no. 4, pp. 53–69.