

Is Low Unemployment Inflationary?

ROBERTO CHANG

The author is a research officer in the macropolicy section of the Atlanta Fed's research department. He thanks Robert Eisenbeis, Frank King, Mary Rosenbaum, and Eric Leeper for useful comments and suggestions.

FROM A VARIETY OF PERSPECTIVES, THE MACROECONOMIC PERFORMANCE OF THE U.S. ECONOMY HAS BEEN VERY SATISFACTORY IN RECENT YEARS. IN PARTICULAR, BROAD-BASED MEASURES OF INFLATION HAVE STABILIZED BETWEEN 2½ AND 3 PERCENT WHILE UNEMPLOYMENT HAS FALLEN BELOW 5½ PERCENT. HOWEVER, MANY OBSERVERS REMAIN UNEASY, BELIEVING THAT THE CURRENT SITUATION IS FRAGILE AND TEMPORARY. THIS BELIEF IS, IN TURN, ROOTED IN A LESS OBVIOUS VIEW THAT THE CURRENT RATE OF UNEMPLOYMENT IS “TOO LOW” TO BE CONSISTENT WITH LOW AND STABLE INFLATION.

This state of affairs becomes most visible on the first Friday of every month, when the Bureau of Labor Statistics releases the latest data on employment and unemployment in the United States. Recently, these data releases have often been followed by sharp changes in financial markets. In particular, markets have taken lower-than-expected unemployment rates to mean that inflation is about to accelerate, resulting in falling stock prices and increasing interest rates.

The average citizen would find this to be a rather strange ritual. Isn't low unemployment good for the country? And why is low unemployment supposed to lead to higher inflation anyway? These are important and difficult questions. An influential economic theory, however, argues that the answers are easy and widely found in macroeconomics textbooks. Low unemployment, this theory implies, is unambiguously “good” only up to a point. If unemployment falls below this point, known as the nonaccelerating inflation rate of unemployment (NAIRU), inflation tends to accelerate.¹ Opinions about the current location of the NAIRU vary, but many published estimates place it close to 6 percent.² Since recent unemployment figures have been consistently below that

range, adherents to this theory predict that inflation will accelerate.

So far these predictions have turned out to be wrong. That their failure should not be a surprise is one of the themes of this article. More precisely, this article argues that the concept of the NAIRU is of very limited use for predicting inflation, understanding its causes, or forming policy. There is both empirical and theoretical support for this view. On the empirical side, the article discusses evidence showing that the NAIRU is highly variable and that there is a great deal of uncertainty about where it is at any particular point in time. These findings imply that, in practice, one cannot know if unemployment is above or below that value supposedly consistent with stable inflation. On the theoretical side, this article argues that even if such a value became known, it would be irrelevant. Contemporary economic theory implies that movements of the unemployment rate may be positively or negatively related to inflation, depending on the nature of the fundamental shocks causing the unemployment changes. Identifying such shocks is possible and helpful for predicting the inflation implications of unemployment changes; but given that these shocks can be identified, whether current unemployment

is above or below the NAIRU provides no additional useful information about prospective changes in inflation.

The Phillips Curve, the Natural Rate, and the NAIRU

The idea that unemployment may be too low to be consistent with stable inflation is of relatively recent vintage. Its origins can be traced to the 1960s and 1970s discussion about how to interpret the then recently discovered “Phillips curve,” an empirical association between inflation and unemployment. Some aspects of this debate are useful for the discussion that comes later.

As some readers may recall, Phillips’s (1958) analysis of almost a century of U.K. data shocked the economics profession. Phillips focused on the relationship between wages and unemployment and discovered the striking fact that the rate of change in nominal wages had a negative correlation with unemployment. Soon afterward, Samuelson and Solow (1960) showed that a similar relation held in U.S. data. Moreover, Samuelson and Solow argued that changes in nominal wages were positively related to overall inflation, thus recasting the wage-unemployment relation discovered by Phillips into the inverse relation between price inflation and unemployment commonly known as the Phillips curve.

The discovery of the Phillips curve generated a heated debate about its implications for economic policy. In particular, research focused on whether a monetary authority such as the Federal Reserve could “buy” less unemployment at the cost of faster inflation. Some argued that the existence of a Phillips curve implied that unemployment could be permanently lowered if inflation were kept at a permanently higher level. Others, in particular Friedman (1968) and Phelps (1968), argued that there was an inflation-unemployment trade-off in the short run but not in the long run. In justifying their thesis, Friedman and Phelps coined the term “natural rate of unemployment.”

To understand Friedman and Phelps’s argument, consider first an economy without price surprises, so actual inflation is always equal to previously expected inflation. In such an economy, some workers would always be observed to be unemployed and looking for a job. This phenomenon may simply reflect the fact that, since workers and jobs are heterogeneous, unemployed workers and

firms may take time to search for adequate matches. Hence, even if inflation were always perfectly foreseen, the economy would experience a positive rate of unemployment that Friedman and Phelps called “natural.”

What if inflation were not perfectly foreseen? Friedman and Phelps argued that unexpectedly high inflation would make actual unemployment fall below its natural rate, but only in the short run. This decline would happen, in particular, if wage contracts had been negotiated on the basis of previously expected inflation, in which case an inflation surprise would reduce real (inflation-adjusted) wages and stimulate employment. One implication is that a monetary authority could indeed “buy” lower unemployment by inducing inflation to rise above previously expected inflation. But this effect would be only temporary because economic agents would eventually learn to forecast inflation correctly, and the difference between expected inflation and actual inflation would tend to disappear.³

Although unexpected accelerations in inflation, engendered by monetary policy, may “cause” unemployment to fall below the natural rate, the converse need not hold. Given monetary policy, the Friedman-Phelps theory had no implications for whether movements in the unemployment rate have an independent effect on inflation.

In subsequent research, a subtly but clearly different view on the relation between inflation and unemployment emerged. According to this view, inflation tends to accelerate whenever unemployment falls below a particular number, which has come to be known as the “nonaccelerating inflation rate of unemployment,” or NAIRU.

The NAIRU concept was first proposed by Modigliani and Papademos, who posited the existence of a rate of unemployment “such that, as long as unemployment is above it, inflation can be expected to decline” (1975, 142).

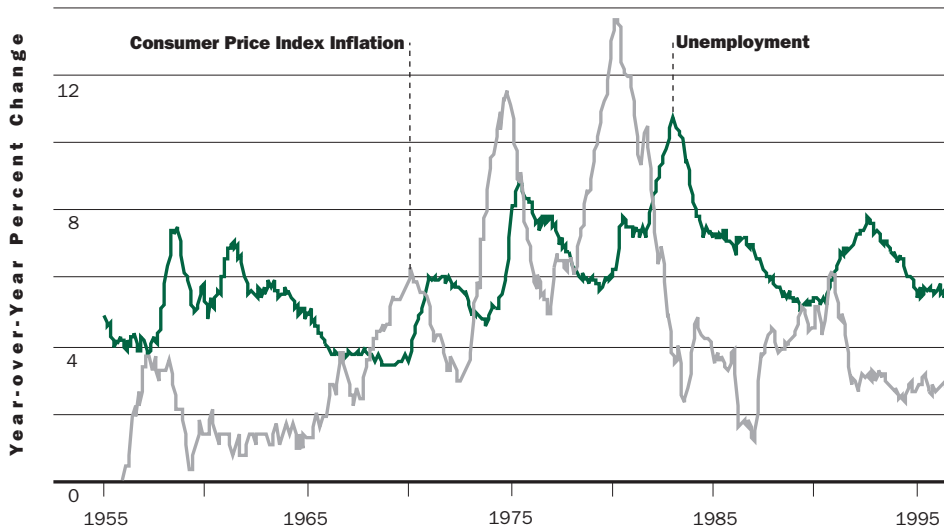
Contemporary economic theory implies that movements of the unemployment rate may be positively or negatively related to inflation, depending on the nature of the fundamental shocks causing the unemployment changes.

1. It is worth noting that several authors have also used the term natural rate to refer to the NAIRU. To avoid confusion, this article will make a distinction between the two concepts. The distinction is important because, as discussed below, the natural rate concept developed by Friedman (1968) and Phelps (1968) is not the same as the NAIRU concept, although their values may coincide.

2. For instance, the Congressional Budget Office (1996, 5) recently estimated that the NAIRU was 5.8 percent in 1995.

3. The Friedman-Phelps view further implies that the monetary authority can keep the unemployment rate permanently below its natural rate only by perpetually engineering unexpected increases in inflation. If people’s expectations of inflation are relatively slow to adjust, ever-accelerating inflation is required. This implication does not hold true if expectations of inflation are fully “rational,” as first demonstrated by the work of Lucas (1972) and Sargent and Wallace (1976).

CHART 1 Inflation and Unemployment, 1955-96 (Monthly)



The intuition is that low unemployment is likely to intensify wage pressures and consequently to result in a generalized wage increase. Assuming that firms manage to pass this cost increase to consumers in the form of higher prices, a fall in unemployment is likely to be associated with an increase in inflation. Similarly, an increase in unemployment must result in a fall in inflation. There must therefore be a level of unemployment such that inflation can be expected to remain constant; this level is the NAIRU.

Readers may note that the Friedman-Phelps natural rate and the NAIRU are different concepts. Friedman and Phelps defined the natural rate as an equilibrium whose value was determined by the characteristics of the labor market. In contrast, the NAIRU is posited as an empirical value rather than an equilibrium value. More importantly, the theory of the NAIRU implies that low unemployment may cause inflation to increase independently of the causes of the low unemployment and, in particular, of monetary policy; this is not an implication of the Friedman-Phelps natural rate theory.

The NAIRU concept pervades current policy discussions and is the main concern of this article. Since Modigliani and Papademos's article numerous studies have, not surprisingly, focused on the estimation of the NAIRU. If there were in fact a strong, stable relation between unemployment, a known NAIRU, and inflation, then one could compare current unemployment with the NAIRU to accurately predict future inflation. But this is not the world we live in, as the discussion below will show.

A First Look at the NAIRU

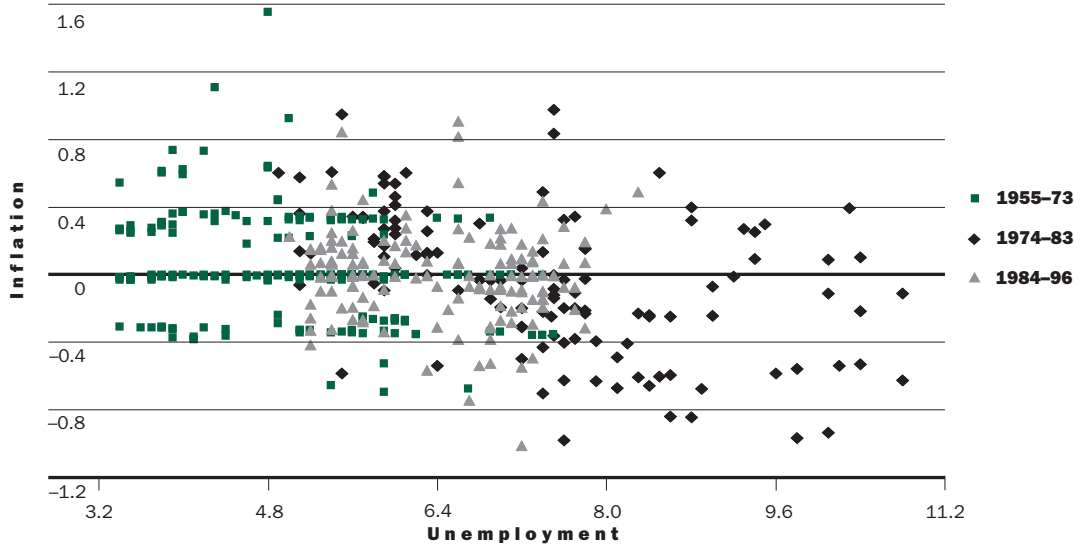
To understand the details and some of the problems associated with estimating the NAIRU, it is helpful to have a broad idea of the historical behavior of

unemployment and inflation. Chart 1 depicts the behavior of civilian unemployment and the inflation rate since 1955. The most notable aspect of this chart is the dramatic increase in inflation that started in the mid-sixties and ended in the early eighties, and the subsequent disinflation. In 1965 inflation was less than 2 percent a year; in 1980 it surpassed 13 percent. Much of the increase is widely believed to have been caused by the oil shocks of 1973 and 1979, and in fact the chart shows a rapid increase in inflation following each of these dates. It has to be noted, though, that the increase in inflation actually started much earlier. The trend toward higher inflation was broken around 1980, and the first half of the 1980s witnessed a rapid decrease in inflation toward the 4 to 6 percent range. This change in inflation behavior has been widely attributed to strongly contractionary monetary policy starting in October 1979 and called, accordingly, the "Volcker deflation." Finally, inflation since 1991 has been surprisingly stable at around 3 percent.

In Chart 1, unemployment shows a slightly upward trend over the 1955-96 period but considerable variation around its trend. Until the early seventies, unemployment was about 5 percent on average. Its fluctuations were much larger during the decade following the first oil shock; average unemployment during that period was 7½ percent, and it surpassed 10 percent in 1982, reflecting the contractionary effects of the Volcker deflation. Since 1984 unemployment has been declining, averaging a little less than 6 percent.

In Chart 1 it is not obvious that there may be a special level of the unemployment rate above which inflation would be expected to decline. However, the Modigliani-Papademos definition of the NAIRU suggests a different and more informative way to look at the same data. Their definition implies that inflation is expected to decline

C H A R T 2 Unemployment versus Inflation Changes, 1955-96



whenever unemployment is above the NAIRU. Hence there should be a negative relation between expected changes in inflation and the difference between unemployment and the NAIRU. If, in addition, this relation is assumed to be linear, a plausible hypothesis for inflation, unemployment, and the NAIRU is given by

$$E_t[\pi(t+1) - \pi(t)] = \beta[u(t) - u^*], \quad (1)$$

where $\pi(t)$ denotes the inflation rate in period t , $u(t)$ the unemployment rate in period t , u^* the NAIRU, β a coefficient whose expected sign is negative, and $E_t[\cdot]$ is short notation for “expectation given information available up to period t .” That is, provided that β is indeed negative, an equation such as (1) implies that, if this month’s unemployment is above the NAIRU u^* , inflation should be expected to decline next month. Neither β nor u^* are directly observable; instead, they must be inferred from the data.

Versions of equation (1) are the basis of most attempts to estimate the NAIRU. The intuition for work of this kind, and some of the problems associated with it, can be grasped from a scatter diagram of unemployment against subsequent changes in inflation, such as Chart 2. Each point in the chart represents a particular month’s unemployment rate, measured against the horizontal axis, and the subsequent month’s change in inflation, measured against the vertical axis. In particular, observations above the horizontal axis represent months in which inflation increased. If equation (1) were to hold in the data, the observations depicted in Chart 2 would be distributed around a line of negative slope that intersects the horizontal axis at precisely the NAIRU, u^* .

At first glance the chart suggests that there is a negative relation between the unemployment rate and sub-

sequent changes in inflation, in particular for extreme values of the unemployment rate. When unemployment has been below 5 percent, inflation has historically increased more often than decreased. Conversely, unemployment rates above 8 percent have been mostly associated with falling inflation rates. However, the relationship in the middle range of unemployment rates between 5 and 8 percent is much less clear: for each value of unemployment in that range, the number of observations above the horizontal axis is about the same as the number of observations below it. Hence, if the NAIRU is defined as “a rate of unemployment such that inflation is as likely to increase as to decrease,” Chart 2 suggests that the data are not likely to yield a very precise estimate of the NAIRU.

A closer look at Chart 2 should reveal a second aspect of the data that is relevant for this discussion: the relationship between changes in inflation and unemployment, and by inference the NAIRU, has moved significantly over time. To illustrate this behavior, observations in Chart 2 are distinguished by different symbols corresponding to three different subperiods, 1955-73, 1974-83, and 1984-96. Splitting the sample in this way is loosely motivated by the fact that the oil shocks of 1973 and 1979 and the Volcker disinflation were large, unusual events that affected both unemployment and inflation.

It is clear that the observations in Chart 2 are not just randomly distributed across the three periods under consideration. Observations before 1974, the squares in the chart, appear mostly to the left, showing that unemployment was relatively low. Observations between 1974 and 1983, depicted as diamonds, appear to the right, because unemployment in that period was relatively high. Finally, observations from 1984 on, marked by triangles, are in the middle part of the chart. Using these data to

look for a value of the unemployment rate at which inflation is “as likely to increase as to decrease,” it is hard to deny that the value is different for each of the three periods considered. In other words, Chart 2 suggests that the NAIRU has not been constant. It seems to have been lower in the first period than in the second and to have fallen after 1983 (although not to the pre-1974 level). Chart 2 thus suggests that the NAIRU is an elusive number. Its precise location is difficult to infer from the data, and it moves around over time. These conclusions, obtained from the visual inspection of Chart 2, are confirmed by more formal statistical evidence, to which the discussion now turns.

There Is No Reliable NAIRU Estimate

To understand the statistical estimation of the NAIRU, start by supposing that equation (1) is true. Estimating the NAIRU then amounts to estimating

the parameters β and u^* in (1), which requires some quick manipulations. To simplify notation, define the change of the monthly inflation rate, $\Delta\pi(t+1) = \pi(t+1) - \pi(t)$. A minor difficulty is that the left-hand side of (1) is not the observed value of $\Delta\pi(t+1)$ but its expected value conditional on information available up to

period t , which is unobservable. To handle this problem, let $\epsilon(t+1) = \Delta\pi(t+1) - E_t \Delta\pi(t+1)$ denote the error in predicting $\Delta\pi(t+1)$. One can now replace the left-hand side of (1) by the difference between the observed change in inflation and the error in predicting it, $\Delta\pi(t+1) - \epsilon(t+1)$. Finally, define $c = \beta u^*$. Inserting these definitions in (1), one obtains

$$\Delta\pi(t+1) = -c + \beta u(t) + \epsilon(t+1). \quad (2)$$

Equation (2) is very useful. It is a linear equation, and its parameters β and c can be estimated using ordinary least squares.⁴ Since c is equal to βu^* , an estimate of u^* is simply given by the estimate of c divided by the estimate of β . This way of estimating the NAIRU is fairly common in the literature.⁵

Once an equation such as (2) has been estimated, standard statistical techniques allow assessment of the precision of the estimated coefficients c and β and consequently the precision of the estimated NAIRU u^* . The degree of precision is usually summarized using confi-

dence intervals. A 95 percent confidence interval for u^* , in particular, provides upper and lower bounds for the unemployment rate that should contain u^* with 95 percent probability. Standard techniques are also available for testing whether assuming that β , c , and the NAIRU are constant, as is implicit in equations (1) and (2). Recalling the discussion of Chart 2, it is clear that testing for the stability of the NAIRU is particularly important given that the data suggest that the NAIRU has changed over time.

Equation (1) is unduly restrictive in that it restricts the expected change in inflation to respond only to the current value of unemployment relative to the NAIRU. It may be more realistic to assume that the expected change in inflation also responds to past unemployment, as would be the case if increases in wages were translated only gradually to consumer prices. Similarly, people’s expectations concerning the change in inflation may depend on current and previous changes in inflation. These considerations imply that lags of unemployment, relative to NAIRU, and lags of inflation changes should be included as explanatory variables in (1). Accordingly, the following generalization of (1) was analyzed:

$$E_t \Delta\pi(t+1) = \beta_0 [u(t) - u^*] + \beta_1 [u(t-1) - u^*] + \dots + \beta_{11} [u(t-11) - u^*] + \alpha_0 \Delta\pi(t) + \dots + \alpha_{11} \Delta\pi(t-11). \quad (3)$$

The alphas and betas are coefficients to be estimated, in addition to the NAIRU, u^* . In contrast to (1), equation (3) allows the expected change in inflation between periods t and $(t+1)$ to be influenced by the deviations of unemployment from the NAIRU in the previous twelve months. Also, the expected change of inflation can be influenced by the twelve previous changes in inflation.

The coefficients of (3) were estimated by ordinary least squares. For brevity, details are omitted and only the main findings are reported here. For the full 1955-96 sample displayed in Chart 1, NAIRU was estimated to be 6.14. This estimate is close to others found previously.⁶ A second finding was that this estimate of NAIRU is rather imprecise: a 95 percent confidence interval is given by the range of unemployment rates between 5.38 and 6.90.

The wide range for the location of the NAIRU is consistent with the lack of precision found in previous work. Indeed, the results presented here are on the optimistic side. In a recent, convincing paper Staiger, Stock, and Watson examined a large number of alternative procedures and concluded, “Our main finding is that the natural rate is measured quite imprecisely. For example, we find that a typical value of the NAIRU in 1990 is 6.2 percent, with a 95 percent confidence interval for the NAIRU in 1990 being 5.1 to 7.7 percent” (1996, 2).

Readers may note that Staiger, Stock, and Watson’s “typical” confidence interval is much larger than the one estimated here. In fact, for a specification very close to

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(3), Staiger, Stock, and Watson argue that perhaps a better way to estimate a 95 percent confidence interval yields an interval from 4.74 to 8.31.⁷

From the perspective of policy analysis, the main implication of these findings is that the range of uncertainty about the location of the NAIRU is often too large to be useful. Consider, in particular, the recent debate about whether the unemployment rate signals increasing inflation. Since unemployment has been in the 5.5 to 6.5 percent range for the last three years, there is no way to tell, on the basis of observed data, whether current unemployment is above or below the NAIRU; it is well within the confidence bands.

Returning to equation (3), further analysis shows that the coefficients and hence the implied value of the NAIRU have changed over time. One can test and easily reject the hypothesis that the coefficients of (3) are constant over the three subperiods underlying the discussion of Chart 2 above, namely 1955-73, 1974-83, and 1984-present.⁸ Estimates of the NAIRU were at 5.91 for the first subperiod, 7.44 for the second, and 6.04 for the most recent subperiod. Hence the statistical analysis is consistent with the hypotheses obtained from the visual inspection of Chart 2. It also agrees with most of the literature.

The instability of the NAIRU raises further difficulties. Estimating a moving NAIRU requires specifying how the NAIRU moves over time but, unfortunately, current economic theory provides little guidance on the economic determinants of changes in the NAIRU. As a consequence, recent studies have focused on models in which the u^* is viewed as slowly varying over time but in a way that has no relation with other economic events. This strategy does imply that the NAIRU's location at different times can be estimated and its changes predicted. However, there are at least two important problems with it. The first is that the work of Staiger, Stock, and Watson has shown that forecasts of the NAIRU obtained in this manner are also subject to very wide confidence intervals. For example, when they estimated a version of (3) allowing u^* to be a smooth function of time, they found

the 95 percent confidence interval for u^* in January 1990 to be 4.17 to 8.91.

The second problem is that the instability of the estimated NAIRU may be a symptom of a deeper problem, namely, that equations such as (1) and (3) may be incorrectly specified. To illustrate this problem, assume in equation (1) that the NAIRU is in fact constant. The hypothesis expressed by that equation is that inflation next month is expected to be the same as it is this month, unless this month's unemployment deviates from the NAIRU. Intuition suggests that such a hypothesis is too extreme: even if there is no such deviation, it may be the case that inflation is not expected to stay the same. For example, it is plausible that people's expectations of inflation would have increased following the oil shocks of 1973 and 1979 even if the unemployment rate had not deviated from the NAIRU. Conversely, it is likely that expectations of inflation decreased following the October 1979 Federal Reserve announcement of a change toward money targets to fight accelerating inflation.

These considerations suggest that (1) should be changed to something like

$$E_t \pi(t+1) - \pi(t) = \sigma(t) + \beta[u(t) - u^*], \quad (4)$$

where $\sigma(t)$ represents the expected change in inflation when unemployment is at the NAIRU. As shown by Chart 1, $\sigma(t)$ was probably a positive number during the subperiod from 1974 to 1983 in which inflation was accelerating. Suppose that $\sigma(t)$ was zero until 1973, a positive number between 1974 and 1983, and a negative number since 1984. Then it is not hard to show that the estimated NAIRU for the second subperiod would be higher than that for the first or third subperiods, just as indicated before.⁹ But this would just be the result of the incorrect omission of $\sigma(t)$, for the earlier assumption was that the NAIRU had stayed constant at u^* for the whole 1955-96 period.

Some researchers have tried to deal with this specification problem by adding measures of supply shocks, or

4. A property of expectations conditional on an information set is that prediction errors are independent of any variable in the information set (see Goldberger 1991, chap. 5). Since $\epsilon(t+1)$ is a prediction error and $u(t)$ is assumed to be known by the public at t , $\epsilon(t+1)$ and $u(t)$ must be independent. This condition guarantees that OLS estimates of β and c are at least consistent (see Goldberger 1991, chap. 13.)

5. Recent examples include Weiner (1993), Tootell (1994), Fuhrer (1995), and Staiger, Stock, and Watson (1996).

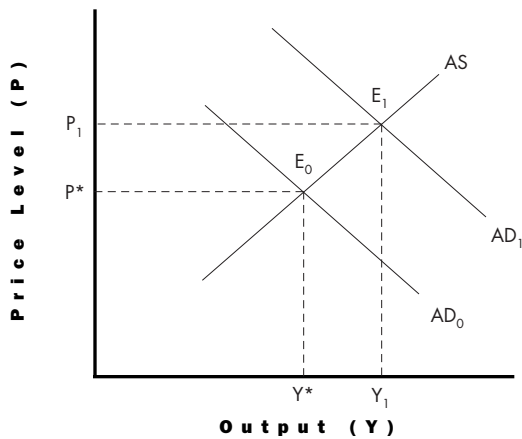
6. See footnote 5 for published estimates.

7. Two reasons underlie the differences between the estimates given here and those of Staiger, Stock, and Watson. The first is that they include in their regressions additional explanatory variables intended to control for supply shocks and Nixon-era price controls. The second reason is that Staiger, Stock, and Watson assumed that the error term in the estimated equation is normally distributed and derived exact confidence intervals based on that assumption. This study did not assume normality and derived approximate intervals based on the so-called Delta method, which is valid in large samples. For a description of the Delta method, see Goldberger (1991, 102).

8. The test is a standard one for stability of coefficients over time, as described by Harvey (1989, chap. 2).

9. For example, the assumption in the text is that $\sigma(t)$ is equal to some positive number, say n , for the 1974-83 subperiod. If one estimates (2) the regression constant c is equal to $\beta u^* - n$, and the true value of the NAIRU should be calculated to be $(c - n)/\beta$ and not c/β . Hence the standard procedure would overestimate the NAIRU for the 1974-83 subperiod.

CHART 3
Effect of an Aggregate Demand Shock



policy shocks that may shift inflationary expectations, to (1) or (3). Also, some have examined specifications that do not constrain expected inflation changes to be zero when unemployment is at the NAIRU. But once these changes are made, the NAIRU idea loses its simplicity and, hence, much of its appeal. In addition, such procedures neglect an essential point: the bulk of the variation of inflation may be due to changes in expected inflation that are unrelated to the deviation of unemployment from the NAIRU. Consequently, modeling efforts should be directed toward understanding the other determinants of expected inflation.

To summarize, statistical analysis confirms that the value of the NAIRU is too elusive to be a reliable policy concept. In addition, the estimated NAIRU seems to move around, increasing uncertainty about its location and raising questions about the statistical assumptions that have to hold to estimate it.

Why Low Unemployment Is Not Always Followed by Higher Inflation

Perhaps the most compelling argument against using estimates of the NAIRU to predict inflation is a theoretical one. Most contemporary models of actual economies treat both inflation and unemployment as endogenous outcomes. These models treat movements in inflation and unemployment as simultaneously determined responses to more basic forces or “shocks,” which are typically modeled as random disturbances. In practice, shocks are of different kinds and hit actual economies all the time. Inflation and unemployment will move in opposite directions in response to some shocks and in the same direction in response to others. Hence, declines in unemployment will be associated with increasing inflation in some cases but with decreasing inflation in others. This relationship holds even if there is a well-defined Friedman-Phelps natural rate to which

unemployment must return in the long run and even if a NAIRU can be estimated. The relation between inflation, unemployment, the natural rate, and the NAIRU is not unambiguous but depends on the nature of the shocks hitting the system. It also follows that predictions of inflation should be based, if possible, on an assessment of these shocks rather than on unemployment movements alone.

As a consequence, in contemporary economic models it is incorrect in general to assume that the probability of an increase in inflation has gone up just because the unemployment rate has fallen below the estimated NAIRU. The correct inference depends on the kind of shock that has made the unemployment rate fall. It is clearly possible for some shocks to cause a fall in unemployment and to raise the likelihood of a decrease in inflation.

Is it possible to empirically identify the different shocks that affect the economy? The answer is yes, as shown recently by Sims (1986), Bernanke (1986), Gordon and Leeper (1994), Leeper (1995), and Sims and Zha (1996). These studies have shown how to identify the underlying causes of low unemployment and thereby to infer their expected effect on inflation. They present a promising alternative concept for inflation forecasting and policy formulation. If shocks can be identified, as this line of research demonstrates, knowledge of the NAIRU relative to the actual unemployment rate will add no new information for predicting inflation.

It may be helpful to illustrate these ideas in a particular and perhaps familiar context. As described by intermediate macroeconomic textbooks, the outcome of many macroeconomic models can be summarized by the intersection of two curves called aggregate demand (*AD*) and aggregate supply (*AS*). The *AD* and *AS* curves are not ordinary supply and demand curves. Rather, each summarizes the equilibriums of several markets, which can be kept in the background for this discussion.

The aggregate supply (*AS*) curve summarizes the combinations of output (*Y*) and price levels (*P*) such that the market for labor is in equilibrium. In Chart 3, an *AS* curve is shown with a positive slope, which is consistent with the traditional view that nominal wages adjust sluggishly. Under that view, an increase in the price level (*P*) reduces real wages and induces firms to increase hiring, thus resulting in a reduction in unemployment and a consequent increase in output (*Y*); hence *P* and *Y* must be positively related for labor market equilibrium. The Friedman-Phelps natural rate hypothesis implies, in this context, that the *AS* curve can only be upward-sloping in the short run because eventually nominal wages will adjust to fully incorporate the effect of unexpected inflation; hence the real wage, unemployment, and output will eventually return to their original, so-called natural levels. Given that our emphasis is on the short run, the distinction between the short and the long run is not

important for the purposes of this discussion. Accordingly, in Chart 3, the output level associated with the natural rate is denoted by Y^* , and the AS curve can be taken to be a short-run one.

The aggregate demand (AD) curve depicts combinations of output and price levels consistent with equilibria in the markets for output and money, which, again, need not be explicitly shown for the present purposes. It is typically assumed that the AD curve is downward-sloping. Given the nominal supply of money, an increase in the price level (P) causes a fall in the real quantity of money. The resulting excess demand for money is usually assumed to be eliminated by an increase in the interest rate, which reduces the demand for output (Y). Hence goods and money markets equilibria require a higher P to be associated with a larger Y or, in other words, the AD curve to slope down.

The analysis of the effects of a particular shock to the economy proceeds by comparing the outcomes before and after the shock. In Chart 3, the aggregate supply curve and the aggregate demand curve in the absence of economic shocks are displayed as AS and AD_0 , respectively. The intersection of AS and AD_0 , the point E_0 , gives the outcome of this model in the absence of shocks: if output is Y^* and the price level is P^* , all markets are in equilibrium. Now, consider a shock in either the output or the money market that displaces the aggregate demand curve to the right, say, to AD_1 . An example of such an “ AD shock” is an unexpected decrease in the demand for money. For any given price level P , and assuming that the nominal supply of money has not changed, the real supply of money must increase. Equilibrium in the money market then requires a matching increase in the real demand for money. This increase is brought about, in turn, by a fall in the interest rate and an increase in income and output (Y). Hence Y must be larger for each P , or the AD curve must shift to the right, if the markets of money and goods are to be in equilibrium.

For all markets to be in equilibrium after the AD shock, the new price level must be P_1 and output Y_1 , as given by the intersection of AD_1 and AS . The upshot is that prices and output both increase. The increase in output must be, in turn, associated with lower unemployment. Hence as a result of an AD shock unemployment falls below the natural rate and inflation increases.

Chart 4 illustrates the effects of a different kind of shock, one that affects supply. Initially, aggregate demand and supply are given by AD and AS_0 , respectively. Suppose there is a shock that shifts the aggregate supply curve to the right, say, to AS_1 . An example is an unexpected increase in labor productivity that, given prices, induces firms to increase employment and production. Given all prices, and hence P , labor market equilibrium thus requires increased output (Y), and the AS must move to the right.

CHART 4
Short-run Effect of an
Aggregate Supply Shock

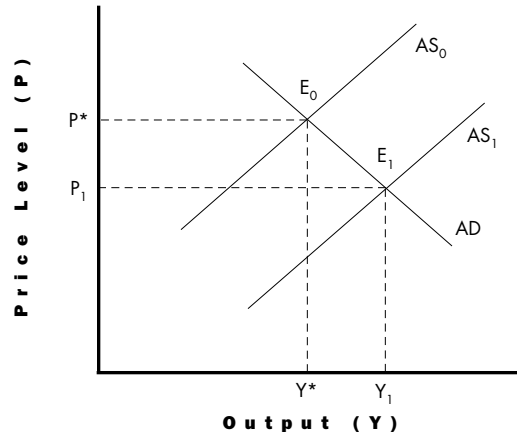


Chart 4 shows that after the AS shock, the model's equilibrium moves from E_0 to E_1 . Since Y is above Y^* , unemployment must fall below the natural rate. On the other hand, inflation must fall. Hence unemployment and inflation respond in the same direction to an AS shock.

In this simple context it is possible that the natural rate is such that “when unemployment is above it, inflation is expected to decline,” at least on average; in other words, the natural rate and the NAIRU may coincide. This would be the case if the economy were mostly affected by AD shocks, which move unemployment and inflation in the opposite direction. Note that, from this perspective, the imprecision in the econometric estimation of equations such as (2) or (3) may be attributable to the existence of significant AS shocks.

Whether the estimation of the NAIRU yields precise estimates is, however, beside the point. The reason to estimate the NAIRU is, clearly, to forecast the direction of prospective changes in inflation. But if the economy is subject to AD and AS shocks, one should be able to make better predictions by relying on all available information, not only on the comparison between the NAIRU and observed unemployment. To see why, suppose that one observes prices only with a delay and observes that unemployment falls below the natural rate. Is it a good idea to bet that inflation will increase? Clearly not, if one knows that the fall in unemployment has been caused by an AS shock. In such a case blind adherence to the concept that “unemployment below the NAIRU is likely to be associated with increased inflation” would lead to a mistaken inference.

These considerations are, of course, consequential for economic policy. The effect of contractionary monetary policy changes, such as increases in the federal funds rate, in the AD - AS model is to shift the AD curve toward the origin. Suppose, as in the previous paragraph, that

unemployment falls below the natural rate. If the Federal Reserve's objective is to keep a stable price level, should it adopt a contractionary monetary policy? The answer is positive only if the cause of low unemployment is an *AD* shock, as in Chart 3. If unemployment is instead low because of a favorable *AS* shock, as in Chart 4, contractionary monetary policy will have the undesired effect of exacerbating the fall in the price level.

Note that this simple example illustrates that it is not necessary to deny the existence of a stable negative correlation between unemployment and inflation to assert that the NAIRU concept is of little use in predicting inflation. In the example, such a Phillips curve-type correlation and perhaps even a stable NAIRU could be observable if most shocks to the economy came from the demand side. It is noteworthy that the NAIRU concept was developed during an era in which it was widely believed that demand shocks were responsible for the bulk of economic fluctuations. Beliefs have since changed due to two developments. The first is that since 1973 oil prices have become a main source of concern for the U.S. economy. The second is the emergence of a school of thought, called real business cycle theory, that asserts that macroeconomic fluctuations are mostly caused by shocks to the aggregate production function, which affect the supply side. While many of the implications of real business cycle theory are controversial, it is safe to say that the evidence presented by its proponents has changed the beliefs of most macroeconomists toward assigning supply shocks a more important role in explaining fluctuations.

It is not difficult to find examples of favorable aggregate supply shocks that may help explain why recent unemployment has remained low without accelerating inflation. Oil prices are one example: except for short-lived episodes mostly related to the U.S. conflict with Iraq, the real price of oil has been surprisingly low for many years. Another example is the furious pace of technological innovation in computers and communications. While the quantitative effect of these shocks remains to be determined, the point is that the recent performance of the U.S. economy may be explained to a large extent by good luck on the supply side.

This discussion has assumed that it is possible to observe shocks to aggregate demand and aggregate supply or, more generally, the fundamental shocks that affect actual economies. This is in fact a valid assumption in view of the existence of a large literature devoted to identifying the sources of macroeconomic fluctuations. Recent studies, in particular, have followed the lead of Bernanke (1986) and Sims (1986) in trying to decompose the sources of fluctuations by imposing mild theoretical conditions on estimated vector autoregressions (VARs).¹⁰ Using the Bernanke-Sims methodology, subsequent papers have analyzed the nature of the shocks that

ultimately cause fluctuations in the U.S. economy and elsewhere. For example, Gali (1992) showed that an *AD-AS* model similar to that described above can successfully explain the U.S. data. More recent studies have refined estimates and proposed alternative models; a good exposition of technical details and recent developments is the article by Leeper (1995). For present purposes, the point to be noted is that isolating the fundamental shocks hitting actual economies is feasible and has been done in practice.

The arguments just advanced can be summarized and rephrased in a perhaps more appropriate way: concluding that inflation is likely to increase just because the unemployment rate has fallen below the NAIRU ignores useful and available information. Techniques are available for identifying the different shocks that impinge on the economy and cause unemployment to fall. Once these shocks are identified, the deviation of the unemployment rate from the NAIRU provides no additional information for the prediction of changes in inflation.

Conclusion: There Are Better Ways

This article has advanced theoretical and empirical reasons to show that, in practice, the concept of a noninflation accelerating rate of unemployment is not useful for policy purposes. To make this point, the discussion has focused on three facts. First, the NAIRU moves around. Second, uncertainty about where the NAIRU is at any point of time is considerable. Third, even if we knew where the NAIRU were, it would be suboptimal to predict inflation solely on the basis of the comparison of unemployment against the NAIRU.

It is not hard to find additional justification for the views expressed here. A policy of raising the fed funds rate when unemployment falls below the NAIRU may be ineffective, for example, even if the NAIRU were constant, its location were known, and all shocks to the economy were to come from the demand side. Implementing such policy would likely induce changes in the expectations and behavior of the private sector, a point made forcefully many years ago by Lucas (1976). Because the "Lucas critique" has been emphasized in past discussions of the NAIRU and the Phillips curve, this article has not elaborated on it. However, the Lucas critique is an important additional reason to be skeptical about using the NAIRU for policy.

This article's position has been critical of the NAIRU concept, but economists remain divided about the policy relevance of the NAIRU.¹¹ The arguments discussed above highlight the need to further develop models in which the fundamental forces behind macroeconomic fluctuations can be identified and analyzed. Fortunately, a body of outstanding research in that direction is already in progress.

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10. As the name suggests, a VAR model is one in which a vector of variables is "regressed" against its own lags. Thus, for example, one may define the vector $x(t)$ to be the triple of output, inflation, and a short interest rate and estimate the system $x(t) = A(1)x(t-1) + A(2)x(t-2) + \dots + A(n)x(t-n) + e(t)$, where $e(t)$ is a (three-dimensional) disturbance, n is the number of lags, and $A(1), \dots, A(n)$ are 3×3 matrices of coefficients to be estimated from the data. Typically, the estimates of the $e(t)$'s will not directly yield the fundamental shocks hitting the economy but, rather, linear functions of such shocks. However, Bernanke and Sims showed how one can recover the fundamental shocks by imposing a priori restrictions drawn from economic theory.

11. The curious reader is encouraged to read the Winter 1997 issue of the *Journal of Economic Perspectives*, which includes several recent papers on the subject. Of these, the studies by Staiger, Stock, and Watson (1997) and Rogerson (1997) are particularly critical of the NAIRU. More sympathetic views are developed by Stiglitz (1997) and Gordon (1997).