# Modern Theory of Unemployment Fluctuations: Empirics and Policy Applications

*By* Robert E. Hall*

Strong and widely accepted evidence shows that the natural rate of unemployment varies over time with substantial amplitude. The frictions in the labor market that account for positive normal levels of unemployment are not simple and mechanical. Instead, as a rich modern body of theory demonstrates, the natural rate of unemployment is an equilibrium in which the volumes of job-seeking by workers and worker-seeking by employers reach a balance controlled by fundamental determinants of the relative prices of the two activities. In recessions, unemployment rises, and job vacancies fall. The natural explanation is an economy-wide fall in labor demand. But a compelling model that generates a fall in labor demand without a counterfactual fall in productivity has eluded theorists to date. Nonetheless, policymakers have appropriately adopted the view that the natural rate varies over time and is not a simple benchmark for setting monetary instruments.

## I. Friedman's Policy-Invariance Principle

Milton Friedman's (1968) famous presidential address at these meetings in this city 35 years ago laid out a view of unemployment and stabilization policy that retains a firm grip today on the profession and policymakers. Friedman saw the unemployment rate as a stable natural rate plus a component that responded to macroeconomic determinants, including monetary policy. His contribution was the principle that the second component was inevitably transitory. This conclusion became enormously influential among academic and practical macroeconomists and among policymakers. Stated in modern form, his conclusion was that the average level of unemployment was invariant to the monetary-policy rule. The average level was the same natural rate, no matter how much monetary policy tried to stimulate the economy. In particular, a regime of chronic inflation could not achieve a permanently lower unemployment rate.

Friedman's pronouncement, and Edmund Phelps's (1967) analysis along the same line, stimulated an outpouring of interesting and important research. The first important milestone was Thomas Sargent's (1971) formal analysis embedding Friedman's idea in a modern econometric framework—and refuting those who had thought they had refuted Friedman by fitting Phillips curves to data and showing that different rates of inflation seemed to imply different rates of unemployment. Sargent showed that the estimated regression combined information about the actual historical process of inflation and the response of current inflation to unemployment. Hence it could not be used to draw conclusions about what would have happened under alternative monetary regimes that generated processes of inflation different from the historical one. Robert Lucas (1972) followed a year later with a theoretical model showing that the transition period when real activity could be deflected by monetary policy lasted for the time that participants lacked full information about the sources of shocks.

It has become common to restate Friedman's ideas in terms of output rather than unemployment. *Potential output* is the level that would occur if unemployment were at the natural rate. The invariance principle in this framework holds that monetary policy cannot push actual output away from potential output except in the short run.

Friedman's policy-invariance proposition has withstood the test of the intervening 35 years. Nobody believes that the central bank can keep unemployment permanently lower by raising the permanent rate of inflation. Discussions of

* Hoover Institution and Department of Economics, Stanford University, Stanford, CA 94305 (e-mail: hall@hoover.stanford.edu). This research was supported by the National Science Foundation under grant SOC SBR-9730341 and is part of the research program on Economic Fluctuations and Growth of the NBER.

policy rules presume the desirability of keeping inflation at a low positive level. They focus on achieving the best trade-off between stabilization of inflation and of real activity in the short run, over the span of time when the latter is feasible—Friedman's short run. Scarcely any economists question that monetary policy does affect real variables in the short run of up to three years or perhaps more. Central bankers around the world have delivered low inflation in the past decade in part because they learned that there was little to gain from chronic inflation.

The second part of Friedman's canon has not achieved the same broad acceptance, especially in the past few years. The natural rate of unemployment now seems to be anything but stable. Friedman explained the natural rate in the following words: "The 'natural rate of unemployment' ... is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on" (p. 8). Although Friedman was clear that the natural rate was the product of an economic equilibrium and was not a physical constant of nature, he invited, and most commentators initially accepted, the view that it moved slowly and could be treated for most purposes as a constant.

George Perry (1970) suggested one source of variation over time in the natural rate: changes in the mix of the labor force between older workers with low normal rates and younger ones with high normal rates. The entry of the baby-boom generation to the labor market produced a modest bulge in the natural rate in the 1970's, but demographic variations in the rate since then have not appeared to be large.

The policy-invariance property yields general information about time variation in the natural rate. Friedman hypothesized a wage adjustment process of the following generic form:

$$\Delta w_t = -\phi(u_t - u_t^*) + \pi_t. \tag{1}$$

Here $w_t$ is the nominal wage, $u_t$ is the unemployment rate, $u_t^*$ is the natural rate, $\phi$ measures the response of wage inflation to excess unemployment, and $\pi_t$ is a shift in the relationship that occurs over time as the market adjusts to changes in the monetary-policy regime and the resulting underlying rate of inflation. The policy-invariance property requires that the unemployment rate converge to the natural rate after some period of time, $a$:

$$E_t(u_{t+a} - u_{t+a}^*) = 0 \tag{2}$$

where the expectation is over the alternative monetary policies that might be adopted. An immediate implication is that the adaptive shift obeys

$$E_t(\Delta w_{t+a} - \pi_{t+a}) = 0. \tag{3}$$

One specification that satisfies this condition is

$$\pi_t = E_{t-a}\Delta w_t. \tag{4}$$

Most authors in this literature have linked the adaptation term tightly to expected future inflation, but other specifications satisfying equation (3) would also deliver policy invariance.

Equation (2) implies that information about the natural rate is contained in the forecast of the actual unemployment rate made $a$ years in advance. To forecast the natural rate $a$ years in advance one uses the forecast of actual unemployment $a$ years in advance. Unemployment moves slowly—about 1.2 percent per month back to normal from a deflection. Consequently, its current value is a good forecast of its future value several years forward. Figure 1 shows the forecasts of unemployment since 1954 based on data 2, 3, 4, and 5 years old. This approach suggests large movements in the natural rate.

Douglas Staiger et al. (1997) and Laurence Ball and N. Gregory Mankiw (2002) reach similar conclusions using a related method. They characterize the adaptive shift, $\pi_t$, as a function of past actual wage inflation, with parameters to estimate, and they characterize $u_t^*$ as a flexible polynomial function of time, with the coefficients of the polynomial serving as parameters to estimate. They find similar, large movements in the natural rate.

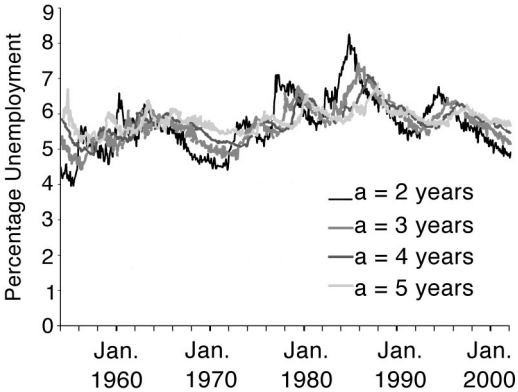


FIGURE 1. ESTIMATES OF THE NATURAL RATE OF UNEMPLOYMENT, BASED ON FORECASTS OF UNEMPLOYMENT USING DATA FROM 2–5 YEARS EARLIER

Robert Shimer (1999, 2001) has uncovered much more remarkable evidence of large shifts in the natural rate in data on unemployment by state. He finds that unemployment has a significant component forecasted by births in earlier decades. In a state with a high fraction of young workers, thanks to high births 20 years earlier, *all* age groups enjoy *lower* unemployment than in other states with low fractions of young workers.

Friedman's principle of policy invariance and the natural rate has two interpretations. One is that monetary policy should not try to influence real variables including unemployment in the longer run and should stick to stabilizing the price level. The other is that the natural rate is a monetary benchmark in the sense that the economy is overheated and inflation likely to rise when unemployment falls below the natural rate. Experience has shown that the first interpretation is the useful one and that trying to discern whether unemployment is dangerously low has almost no value. The Federal Reserve did not step on the monetary brake in 1995 when unemployment dropped below 5.5 percent. Rather, the Fed launched an investigation into what forces caused a decline in the natural rate.

Experience in the late 1990's confirmed that the natural rate was not a near-constant. The unemployment rate dipped to a low of 3.9 percent in 2000, well below the consensus natural rate of 5.5–6.0 percent, but inflation did not take off. Rather, as Figure 1 shows, the natural rate had fallen into the 4-percent range by that time. Had monetary policy taken the second view, that such low unemployment was dangerous, significant deflation would have taken place, it appears.

## II. Theory of the Natural Rate

Much the best-developed line of thought about the determinants of the natural rate springs from the work of Peter Diamond (1982) and Dale Mortensen and Christopher Pissarides (1994). I will discuss the basics of a simple version of their model from David Romer's (2001) excellent textbook. I use the following notation:

Exogenous determinants:
- $s$: separation rate—flow rate from employment to unemployment
- $r$: interest rate
- $z$: ratio of the value of the output produced by one worker to the flow cost of equipping the worker with capital, with $z > 1$

Endogenous variables:
- $u$: unemployment rate
- $v$: vacancy rate
- $x$: ratio of unemployed workers to vacant jobs, $u/v$

Matching technology:
- $\phi(x)$: job-finding rate for unemployed workers, decreasing in $x$, with corresponding job-filling rate $x\phi(x)$, increasing in $x$.

The model embodies the following principles:

(i) *Nash wage bargain:* Workers and employers divide the surplus from a job match equally.
(ii) *Zero profit:* Recruiting costs exhaust the benefit to an employer of engaging a worker.
(iii) *Stochastic equilibrium:* Flows into and out of unemployment are equal.

The first two principles result in the following equilibrium condition (see Romer [2001 pp. 446–48] for details):

$$[(z-1)x-1]\phi(x) = 2(s+r). \tag{5}$$

TABLE 1—DATA FROM HOUSEHOLD AND VACANCY SURVEYS, AVERAGES FOR DECEMBER 2000–SEPTEMBER 2002

| Symbol | Concept | Value |
|---|---|---|
| $s$ | separation rate | 0.034 per month |
| $\phi$ | job-finding rate | 0.62 per month |
| $v$ | vacancy rate | 0.028 |
| $u$ | unemployment rate | 0.051 |
| $r$ | real interest rate | 0.0042 per month |

*Source:* Bureau of Labor Statistics' JOLTS survey.

From this, it is immediate that the unemployment/vacancy ratio, $x$, is an increasing function of the turnover rate, $s$, and the interest rate, $r$. Increases in these factors reduce the benefit of employment and cause substitution away from vacancies and toward unemployment. The unemployment/vacancy ratio is a decreasing function of the output/rental ratio, $z$. A higher value of the ratio increases the benefit of employment and results in substitution toward vacancies and away from unemployment.

The unemployment/vacancy ratio, $x$, is the unique root of equation (5). The principle of stochastic equilibrium yields the corresponding unemployment rate:

$$u = \frac{s}{s + \phi(x)}. \tag{6}$$

The unemployment rate is an increasing function of the unemployment/vacancy ratio, $x$, and it shares the same responses to the exogenous determinants listed above. Notice that the separation rate, $s$, makes a direct contribution to unemployment in addition to its contribution through $x$. Actual turnover rates are sufficiently high that stochastic equilibrium should be achieved in only a few months after a disturbance.

## III. Interpretation of Recent Events in the Labor Market

Following are averages over the period December 2000 through September 2002 taken from the Bureau of Labor Statistics' household and vacancy surveys (the JOLTS survey reporting vacancies and turnover began in December 2000): Equation (6), describing the equality of inflows to and outflows from unemployment, holds quite closely here, although it is not an identity in the data (see Table 1). The value of the product/rental ratio, $z$, that solves equation (5) is 1.60.

TABLE 2—RESPONSES OF KEY LABOR-MARKET VARIABLES

| Variable | Derivative with respect to $s$ | Derivative with respect to log $z$ |
|---|---|---|
| Unemployment/vacancy ratio, $x$ | 5.7 | −10.0 |
| Unemployment rate, $u$ | 1.5 | −0.13 |
| Vacancy rate, $v$ | 0.7 | 0.08 |

To determine the response of the labor market to changes in fundamentals, I need to assign a functional form to the job-finding function, $\phi(x)$. I make the assumption that is standard in the literature: $\phi(x) = \phi_0 x^{-0.5}$. My discussion draws extensively from Shimer (2002). The responses of the key variables to the determinants are shown in Table 2.

An increase in the separation rate, $s$, is a reallocation shock. Naturally, it increases the unemployment rate. But it also increases the vacancy rate, $v$. With more workers available, it pays for employers to recruit new workers more energetically. On the other hand, an increase in the product/rental ratio, $z$, is an increase in the demand for labor. It results in a tighter labor market, with lower unemployment and higher vacancies. Such a change is a movement along the labor market's Beveridge curve. A stylized fact of the labor market is that it sees large movements *along* the Beveridge curve (induced by demand shocks) and relatively small movements *of* the Beveridge curve (induced by reallocation shocks). Shimer (2002) and others conclude that demand shocks are a bigger factor in perturbing the labor market than are reallocation shocks.

The economy sustained an important shock between early 2001 and early 2002; a recession began in March 2001, the peak month for national employment. Unemployment rose by 1.3 percentage points from December 2000–September 2001 to the same months a year later (this choice of months is chosen to fit the available data from JOLTS). Vacancies fell by 0.7 percentage points. This turns out to be close to a pure movement along the Beveridge curve.

From Table 2, the slope of the curve is the ratio of the derivatives of $u$ and $v$ with respect to log $z$, $-1.7$. The ratio of the actual changes is $-1.9$. In spite of the fact that the recession began as a focused contraction in equipment investment, which might seem to be a reallocation shock, the response of the labor market looks like a general negative demand shock. The decline in vacancies occurred in almost every industry, further supporting the demand over the reallocation interpretation.

One might be tempted to declare victory in the quest for a theory of unemployment that accords with the actual movements of the labor market, and some authors have. But that declaration would be quite premature. The increase in unemployment of 1.3 percentage points corresponds to a decline in output per worker of 10 percent (1.3 divided by the derivative, $-0.13$). No such decline in productivity actually occurred. Moreover, real wages should have declined substantially during the period, according to the model. In fact, real wages rose slightly.

In short, the modern model of the labor market encounters the same barrier that impedes the development of a credible general-equilibrium model of aggregate fluctuations: Among the various plausible driving forces, the one that fits a number of facts well is shifts in labor demand. But the most basic labor-demand function is just the marginal product of labor, so labor demand cannot shift except by movements of productivity. Observed movements of productivity are nowhere near large enough nor sufficiently correlated with fluctuations to serve as the primary driving force of the aggregate economy.

## IV. Concluding Remarks

Modern unemployment theory has come a long way. We have moved from a mechanical to an economic model of friction. This progress equips economists to understand movements in the natural rate of unemployment. Given the strong evidence that these movements are large, this understanding is critical for economic policymaking. Modern thinking supports the Federal Reserve Board's decision to disregard the earlier belief that the natural rate was 5.5 percent and thus to formulate intelligent policy during the boom of the late 1990's, which might have been deflationary if the Fed had interpreted 4-percent unemployment as calling for more restrictive policy. And the same understanding permitted the Fed to turn expansionary in 2001 and 2002, even when the unemployment rate was below 5.5 percent.

There is far from a complete understanding, however. The recession that began in 2001 shows every sign of being a softening of the entire labor market (with the sole exception of home-building). An economy-wide unfavorable shift in technology is the obvious explanation of that phenomenon, but it is contradicted by direct measures of productivity. One active line of thought generates economy-wide shifts in labor demand from higher market power (Julio Rotemberg and Michael Woodford, 1992). Another revives the old idea of wage rigidity—almost forgotten in modern theory where wages are continuously updated through a Nash bargain.

## REFERENCES

**Ball, Laurence and Mankiw, N. Gregory.** "The NAIRU in Theory and Practice." *Journal of Economic Perspectives*, Fall 2002, *16*(4), pp. 115–36.

**Diamond, Peter A.** "Aggregate Demand Management in Search Equilibrium." *Journal of Political Economy*, October 1982, *90*(5), pp. 881–94.

**Friedman, Milton.** "The Role of Monetary Policy." *American Economic Review*, March 1968, *58*(1), pp. 1–17.

**Lucas, Robert E., Jr.** "Expectations and the Neutrality of Money." *Journal of Economic Theory*, April 1972, *4*(2), pp. 103–24.

**Mortensen, Dale and Pissarides, Christopher.** "Job Creation and Job Destruction in the Theory of Unemployment." *Review of Economic Studies*, July 1994, *61*(3), pp. 397–415.

**Perry, George.** "Changing Labor Markets and Inflation." *Brookings Papers on Economic Activity*, 1970, (3), pp. 411–41.

**Phelps, Edmund.** "Phillips Curves, Expectations of Inflation, and Optimal Unemployment over Time." *Economica*, August 1967, *34*(135), pp. 254–81.

**Romer, David.** *Advanced macroeconomics*, 2nd Ed. New York: McGraw-Hill, 2001.

**Rotemberg, Julio J. and Woodford, Michael.** "Oligopolistic Pricing and the Effects of

Aggregate Demand on Economic Activity." *Journal of Political Economy*, December 1992, *100*(6), pp. 1153–1207.

**Sargent, Thomas J.** "A Note on the 'Accelerationist' Controversy." *Journal of Money, Credit, and Banking*, August 1971, *3*(3), pp. 721–25.

**Shimer, Robert.** "Why Is the U.S. Unemployment Rate So Much Lower?" in Ben Bernanke and Julio J. Rotemberg, eds., *NBER macroeconomics annual 1998*, Vol. 13. Cambridge, MA: MIT Press, 1999, pp. 11–61.

_____. "The Impact of Young Workers on the Aggregate Labor Market." *Quarterly Journal of Economics*, August 2001, *116*(3), pp. 969–1007.

_____. "The Cyclical Behavior of Equilibrium Unemployment, Vacancies, and Wages: Evidence and Theory." Mimeo, Princeton University, October 2002.

**Staiger, Douglas; Stock, James H. and Watson, Mark W.** "How Precise Are Estimates of the Natural Rate of Unemployment," in Christina D. Romer and David H. Romer, eds., *Reducing inflation: Motivation and strategy*. Chicago: University of Chicago Press, 1997, pp. 195–246.