The Rise and Downward Trend of the Natural Rate

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The natural unemployment rate seems to have taken a wild ride. As late as 1970 the natural rate is thought to have been still low, perhaps 5.5 percent. Then unemployment rose in the mid-1970's, dipped, and rose again in the early 1980's. The impression formed that beneath this movement was a major rise of the natural rate—to about $6\frac{1}{2}$ percent at mid-decade in some estimates. Now the American unemployment rate has been back around its early-1970's level for two years without rising inflation. Many experts infer that the natural rate is likewise back to its early 1970's level.

These developments raise tough questions. If the natural rate really is near its 1970 level again, was the earlier rise real? If so, were its causes transitory? Their effects transient? If not for the most part, why the recent fall of the natural rate? Why at the same time is unemployment *within* every education group still elevated?

I. Tracking the Natural Rate

To infer the movement of the natural rate we have to understand something about how deviations from it arise and how to detect them. We therefore look at two expectational models generating a theoretical relation of unexpected wage inflation and price inflation to deviations from the natural rate.

One simple model is a version of the "shirking story" in Guillermo Calvo (1979) and Robert Solow (1979). The labor cost of producing one unit of output is proportional to the number of workers required, hence proportional to employees' propensity to shirk, slack, and so forth—their demand for on-the-job leisure. The latter is a function Υ of the tightness of the labor market (the expected waiting time in the unemployment pool), as proxied by the unemployment rate u, and of the firm's money wage W relative to the expected average wage W^e; some other factors (variables like wealth, s, and parameters like the overseas real interest rate, r^*) can shift the shirking demand curve and thus move the natural rate. The chosen wage minimizes expected unit labor cost, $W\Upsilon(W/W^e, u; s, \cdots; r^*, \cdots)$ and hence satisfies

$$(1)\quad \frac{-[\Upsilon_1(W/W^e, u; s, \cdots; r^*, \cdots)(W/W^e)]}{\Upsilon(W/W^e, u; s, \cdots; r^*, \cdots)} = 1$$

which is Solow's elasticity condition. W is decreasing in u and proportional to W^e.

By equilibrium we mean, following Alfred Marshall, Friedrich von Hayek, and others, self-fulfilling expectations. Thus, labor-market equilibrium means $W = W^e$, which implies

$$(2)\quad \frac{-[\Upsilon_1(1, u; s, \cdots; r^*, \cdots)]}{\Upsilon(1, u; s, \cdots; r^*, \cdots)} = 1.$$

Our "disequilibrium" includes random expectation "errors" (causing the vibrations of "rational-expectations equilibrium") as well as fundamental disequilibrium.

By the natural rate, though, we mean the *general*-equilibrium unemployment rate: equilibrium in the other markets too, and thus self-fulfilling expectations about current and future relative prices of goods and assets. Hence the current natural rate, $\hat{u}$, is the equilibrium unemployment rate in (2) corresponding to the current correct-expectations levels

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of wealth, human wealth, and so forth. It is given by

$$(3)\qquad \frac{-[\Upsilon_1(1, \hat{u}; \hat{s} \cdots ; r^*, \cdots)]}{\Upsilon(1, \hat{u}; \hat{s} \cdots ; r^*, \cdots)} = 1.$$

Suppose that, after firms have adjusted their work force to the desired level (following any shocks or expectation adjustments), the effectiveness of raising wages to reduce shirking is high (low) enough that firms set their W above (below) W^e, each trying to outpay the other firms. Then, by (1) and (3), it must be that u is below (above) $\hat{u}$—provided there is no other expectation error (say, an overestimate of wealth) operating to inflate (dampen) shirking, and thus inflate (dampen) the effectiveness of raising wages to reduce shirking (while not increasing the true natural rate). Hence we have

$$(4)\qquad W = W^e\Phi(u - \hat{u}; s - \hat{s}, \cdots ; r^*, \cdots)$$

$$\Phi'(u - \hat{u}; \cdots ; r^*, \cdots) < 0$$

$$\Phi(0; 0; r^*, \cdots) = 1$$

or, in logarithms,

$$(4')\qquad w - w_{-1} = \phi(u - \hat{u}; s - \hat{s}, \cdots ; r^*, \cdots) + w^e - w_{-1}$$

$$\phi(0; 0, \cdots ; r^*, \cdots) = 0$$

where ϕ denotes log Φ and w denotes log W. Departures from the natural rate are explicitly linked to *money-wage* misexpectations, and hence to unexpected *wage* inflation. *Price-level* misexpectations, thus unexpected *price* inflation, can create departures through background variables such as s.

Departures from the natural rate, then, cause deviations of wages (and prices) from their expected levels, not necessarily their levels last period. One implication is that steadiness of the rate of wage inflation (no wage acceleration) is no assurance that unemployment is safely at its natural rate, that u is not below $\hat{u}$. The recent experience may be a case in point. If, as Paul Samuelson suggests, workers today are "cowed" by news of downsizing and wage sacrifices made to regain work, it could well be that anxious workers who have so far escaped downsizing overestimate how much their wage has risen relative to the casualties' wages, while the casualties do not overestimate (perhaps they deny) the decline of their relative wage. If workers on average believe that the mean wage of others in their reference group has fallen relative to their own, the average propensity to shirk would fall and with it the cost-effectiveness of raising the wage to reduce shirking; so wages would fall or unemployment would, or both. A reduction of the non-accelerating inflationary rate of unemployment (NAIRU) would be calculated, making it seem the natural rate had fallen, though no true fall of the natural rate had occurred—only an expectational disequilibrium.

Similarly, falling wage inflation (wage deceleration) is no guarantee that unexpected wage disinflation is occurring. Thus it need not be evidence that u is above $\hat{u}$. This, too, may apply to the recent past. Suppose that by its pronouncements the Fed has managed to "talk" the economy down an equilibrium glide path of disinflation. Then from mid-1994 to early 1996 u may have remained in the neighborhood of $\hat{u}$ while the rate of wage inflation was falling in tandem with a falling expected wage-inflation rate. NAIRU would be reduced, but not the natural rate.

These caveats notwithstanding, it is plausible that, *most* of the time, wage accelerations (decelerations) are a true sign that wage inflation has gone ahead of (fallen behind) expected wage inflation, and hence that the wage level is being underforecast (overforecast). Hence normal practice is to use inflation-rate changes as a proxy for misexpectations despite the risk of a false signal.

The "quitting story" of Phelps (1968), Steven C. Salop (1979), and Hian Teck Hoon and Phelps (1992) offers a richer model. Here firms drive up the wage in their attempt to dampen their employees' quitting. The wage balances wage costs against the costs of the firm-specific training of the new hires needed to offset quitting. Hiring is necessitated by quitting. The quit rate is a function ζ of W/W^e and of u. The growth rate of the firm's size (its stock of functioning employees) is the excess of the hiring rate, h, over quit rate plus mortality rate, θ. For least-discounted costs, the wage path minimizes the discounted integral of wage outlays subject to an analogous output integral and subject to the relation between the growth rate and the hiring and quitting rates. It follows that at each moment the wage minimizes the current-time expression $N\{W + q[\zeta(W/W^e, u; s, \cdots; r^*, \cdots) + \theta - h]\}$ where q is the current value of the co-state variable, the worth to the firm of another trained employee. At the optimal wage,

$$(5) \quad 1 = -\zeta_1(W/W^e, u; s, \cdots; r^*, \cdots) \times (1/W^e)q.$$

In the case of constant hiring costs, hiring quickly drives q down to its (constant) opportunity cost. Each unit increase of the annual hire rate (measured as a percentage of the firm's work force) requires a fraction β of employees to be used in firm-specific training of new hires rather than in production where each such employee would produce Λ units of output per year. If the money cost is figured at the price P^e the firm expected to get when that output would have been sold, so it is $P^e\Lambda\beta$, then

$$(6) \quad 1 = -\zeta_1(W/W^e, u; s, \cdots; r^*, \cdots) \times (1/W^e)P^e\Lambda\beta.$$

Suppose the marginal benefit from increasing W displays diminishing returns. Then increased P^e prompts an increase of W, given W^e and u; increased W^e also prompts a less-than-proportional increase of W. And, of course, increased u, in lowering the effectiveness of wage raises, lowers W.

In labor-market equilibrium (i.e., $W = W^e$) we have the "wage curve,"

$$(7) \quad 1 = -\zeta_1(1, u; s, \cdots; r^*, \cdots)(\Lambda/v^e)\beta$$

$$v^e \equiv W/P^e.$$

The equilibrium product wage, v^e, required by incentives is decreasing in u.

To obtain the natural rate and see how expectations errors induce deviations from it, we need a price equation. Take pure competition. Suppose the price, P, covers normal cost. Then

$$(8) \quad P = W/\{\Lambda[1 - f(u; s, \cdots; \beta, \theta, \cdots)]\}$$

$$0 < f(u; s, \cdots; \cdots) < 1, \; f'(u) < 0$$

where $1 - f$ gives the fraction of Λ left for hourly labor cost in order for interest and depreciation on investment in employees to be covered (so that q covers opportunity cost). P makes $(W/P)/[1 - f(u; \cdots)]$ always equal to Λ. Substituting that result for Λ in (6) yields

$$(9) \quad 1 = -\zeta_1(W/W^e, u; s, \cdots; r^*, \cdots) \times (W/W^e)(P^e/P)\beta/[1 - f(u; \beta, \theta, \cdots)].$$

Here W is increasing (and u decreasing) both in $(W/P)/[1 - f(u)]$, proxying for Λ, and in P^e/W^e. As before, the current natural rate, $\hat{u}$, is the u given by (9) when expectations are correct in all markets:

$$(10) \quad 1 = \frac{-\zeta_1(1, \hat{u}; \hat{s}, \cdots; r^*, \cdots)\beta}{[1 - f(\hat{u}; \hat{s}, \cdots; \beta, \theta, \cdots)]}.$$

Taking logs and combining (9) and (10), we have

$$(11) \quad w - w_{-1} - (w^e - w_{-1}) = Y(u - \hat{u}; \hat{s} - s, \cdots; \beta, \theta, \cdots) + (1/\eta)\{[w - w_{-1} - (w^e - w_{-1})] - [p - p_{-1} - (p^e - p_{-1})]\}$$

where $Y'(u) < 0$, η (>0) is the negative of the elasticity of the propensity to quit with respect to a firm's relative wage, and p denotes log P. The message is that $W > W^e$ will result if $u < \hat{u}$, or if $P^e > P$, or if misperceptions of some background variable (s, etc.) has that effect.

II. Accounting for the Rise and Fall of the Natural Rate

Our main thesis, for which we will provide empirical support, is that, for decades now, a strong underlying downward trend has been imparted by the change in the educational composition of the American labor force. Every year there are fewer who drop out of high school and also fewer who stop with the high-school diploma. The proportion who are high-school dropouts fell from 42.5 percent in 1965 to 10.8 percent in 1995. Estimates in our recent paper (Phelps and Zoega, 1996) pooling data from the G-7 imply that this process has little effect on within-group unemployment rates. The climb by some up the educational ladder evidently does not worsen the unemployment of the others. The net aggregate effect, then, is to reduce considerably the general unemployment rate in countries where, as in the United States, higher educational attainment is associated with lower unemployment. We confirm these results here using only annual U.S. data for the period 1965–1996 for workers between 25 and 64 years of age:

$$(12)\quad \log(u_{1t}) = \underset{(1.22)}{0.225} + \underset{(26.34)}{0.963}\log(u_t) + \underset{(0.51)}{0.002}\ell_{1t} + \underset{(5.14)}{0.020}t,$$

$$(13)\quad \log(u_{2t}) = \underset{(-7.26)}{-0.618} + \underset{(48.30)}{1.093}\log(u_t) + \underset{(3.75)}{0.009}\ell_{2t} + \underset{(15.08)}{0.009}t,$$

$$(14)\quad \log(u_{3t}) = \underset{(-2.59)}{-0.309} + \underset{(18.27)}{0.978}\log(u_t) + \underset{(1.17)}{0.010}\ell_{3t} - \underset{(-0.48)}{0.002}t,$$

$$(15)\quad \log(u_{4t}) = \underset{(-4.64)}{-1.369} + \underset{(5.34)}{0.809}\log(u_t) + \underset{(1.47)}{0.046}\ell_{4t} - \underset{(-0.65)}{0.011}t.$$

Here u_{it} is the rate of unemployment in education group i at time t, ℓ_{it} is the share of the labor force belonging to this group, both written as percentages, and allowance is made for a time trend; t statistics are in parentheses. Group 1 has the least-educated workers, those having less than a high-school diploma; group 2 has workers who have completed high school only; group 3 has workers with some college education; and group 4 has workers with a college degree. All the coefficients of the labor-force shares are insignificant at the 5-percent level, except that for the second group. The size of that coefficient is very small: a huge 10-point (1,000 basis-point) increase in the percentage share belonging to the second group would raise the group's unemployment rate by only 9 percent of itself.

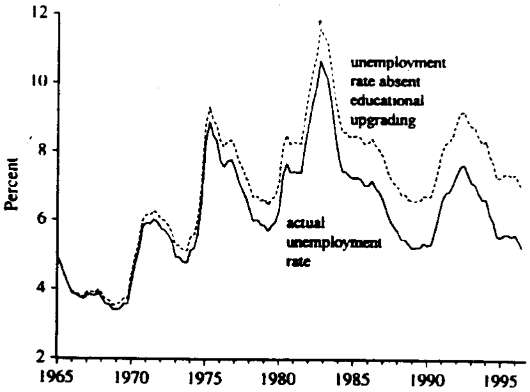

FIGURE 1. THE GENERAL UNEMPLOYMENT RATE

Is the effect of the change in the educational composition really large? We calculate that unemployment would be some 170 basis points above the actual unemployment rate in 1996 had the educational composition been unchanging. In Figure 1 we display the adjusted general unemployment rate, year by year, calculated in the same way alongside the actual one.

If this correction is accurate enough, it is no longer a puzzle why the natural level of the general unemployment rate is now again around $5\frac{1}{2}$ percent after having been around $6\frac{1}{2}$ percent in the mid-1980's. And the rise in unemployment to be explained in the 1970's and the first half of the 1980's is now much bigger.

A counterargument is that such a thesis singles out a demographic shift that happens to work that way while some others might do as well, and still others might be offsetting. Changes in the proportion of teenagers among the unemployed has been described as a likely cause of the apparent rise in the natural rate in the 1970's and the fall in the 1990's. Using an analogous procedure, we find that the changes in the teenage share are not sufficiently big to explain the broad movements in the unemployment rate. The

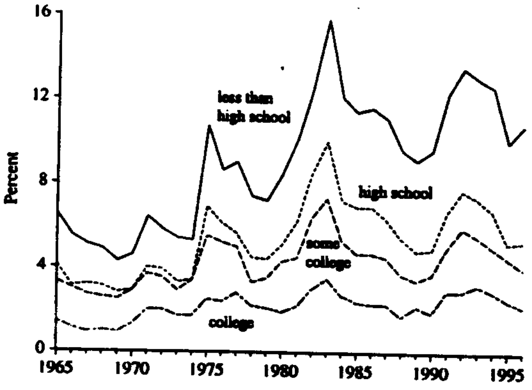

FIGURE 2. THE RATE OF UNEMPLOYMENT FOR FOUR EDUCATION GROUPS

entry of the "baby boom" generation into the labor force in the late 1960's and 1970's *never* raises the general unemployment rate by more than 27 basis points, and the fall in the share of teenagers in the last few years has not exerted a downward effect on the natural rate in excess of 20 basis points.

In our interpretation, then, the downward trend imparted by educational upgrading and to a far lesser extent by the shrinkage of the teenage share have masked other forces that, on balance, have shifted up the downward-trending path of the natural rate. The evidence is that unemployment rates within groups have risen steadily, most strongly among the bottom groups, whose attachment to work and community hung by a thread to begin with. This is visible in Figure 2. The increases are not unlike those recorded in Europe. Continued exit from the lower rungs of the education ladder, in reducing further the proportion of the population exposed to the worst conditions, will continue to impart a downward slope to the natural-rate path. But the worst conditions, and hence the unemployment rates of dropouts and those without any college, will not be improved by that development.

To complete our work at understanding unemployment we need to relate unemployment to those other forces as well. To test our hypotheses, we estimate an expanded natural-rate equation. The unemployment rate in this equation is now the rate adding back to the actual rate the cumulative reduction estimated to have been contributed by education upgrading and shrinkage of the teenage share. This regression equation is based on (11) with certain background variables and moving parameters made explicit. Thus we are testing here for the significance of some forces theorized to affect the demand wage (through the function f) or the incentive wage (through the function ζ). After some log-linearizing we have

$$(16) \quad \Delta\pi_W = c_1 + c_2\log(u) + c_3\Delta\log(u) + c_4[\Delta\pi_W - \Delta\pi_P] + c_5\Delta\pi_{\text{fae}} + c_6\Delta\pi_{\text{mc}} + \beta\mathbf{X}$$

where c_n are coefficients, $\mathbf{X}$ is a vector of variables affecting the position of the labor demand curve and of the wage curve, π_{fae} is the difference between the rate of price inflation measured by the CPI with and without food and energy, and π_{mc} is the rate of inflation of the cost of medical care. The following hypotheses suggest variables to include in the vector $\mathbf{X}$.

(i) Our first hypothesis (see Phelps, 1968; Hoon and Phelps, 1992) attributes some of the rise and fall of the natural rate to a coincident speedup and slowdown of the labor force. In steady state, faster labor-force growth necessitates a higher hiring rate, and that can only be brought about by a lower real wage, hence a higher unemployment rate. We therefore include the rate of change of the labor force from the current quarter to the same quarter next year, $\Delta\log(L)$.

(ii) We have long maintained that the steep climb of global real interest rates to a new plateau in the early 1980's is a factor in the secular rise of the natural rate; and by the same reasoning, so is the slowdown in productivity. Our recent work (e.g., Phelps, 1994) models firms' hiring as an investment in employees. As a result the hiring rate (and in steady state the rate of unemployment) is a function of the expected rate of productivity growth as well as the real rate of interest. A fall in the former or a rise in the latter lowers the shadow price of labor and leads to an immediate drop in hiring, and thus a gradual rise in unemployment toward a higher steady-state level. We include, lagged four quarters, the long-term real rate of interest, r, where inflation expectations in each quarter are measured as the simple average of inflation in the past and the following year. To test for the effect of changes in the rate of growth of productivity, we allow the constant term to change between the periods before and after the first quarter of 1974.

(iii) We have also argued that social-welfare programs, many of them added or expanded in the late 1960's and 1970's, have raised the natural rate. A key factor in the propensity to quit, shirk, and so forth is the ratio of net-of-tax wage to nonwage income, both private and social. Both the financing via payroll tax and the welfare entitlements themselves can be shown to raise unemployment in the quit model of Section I. In that model, workers' behavior is also a function of other forms of nonwage income. A rise in the nonwage-to-wage ratio has an effect similar, though less strong, to entitlements. Workers now have to rely less on their wage income and require higher wages to deter quitting, shirking, and so forth. We include a variable that is the sum of the log of the ratio of nonwage to total personal income, Y_{nw}/Y_p, and the rate of payroll tax, pt, in the vector **X** —that is, $\log(Y_{nw}/Y_p)$ + pt. Nonwage income is defined as the sum of rental, interest, dividend, and transfer income. We also test for their independent effects.

(iv) Finally, we hypothesize that downsizing may reduce the natural rate by reducing workers' gains from quitting and thus reducing the incentive wage required to combat employee turnover. (The expected gain from having the preferred job falls because all jobs are not expected to last as long.)

(v) We also acknowledge the important hypothesis of Chinhui Juhn et al. (1991) that the upward trend in unemployment between 1967 and 1989 can largely be explained by a fall in the relative demand for unskilled labor. We notice in Figure 2, tracing the path of the unemployment rate among workers in the four educational groups, that the *relative* unemployment rate rises only among high-school dropouts. Actually, this relative rate rose little in the 1970's, when the natural rate supposedly peaked for the first time, and the suspected recent fall in the natural rate does not coincide with a fall in their relative unemployment.

TABLE 1—SELECTED RESULTS FROM THE SUCCESSIVE ESTIMATION OF EQUATION (16)

$\Delta \log(L)$	r	$\log(Y_{tr}/Y_p)$ + pt	P
0.160 (1.12)			0.08
0.105 (0.65)	0.106 (2.23)		0.02
0.384 (1.77)	0.133 (2.68)	0.037 (1.73)	0.05

Note: Numbers in parentheses are t ratios. Y_{tr} denotes transfer income. For the other coefficients, see footnote 1.

However, this factor may prove important along with other factors.

The estimation results, using quarterly data (1965–1996), are in Table 1, where the last column has the results of an F test for equality of the constant term before and after the first quarter of 1974.[1] Space limitations permit only the briefest commentary on the findings.

The growth rate of the labor force has a positive and a mildly significant coefficient. Thus the slowdown of the labor force since the 1970's and early 1980's is a force that has operated to shift down the (downward-trending) path of the natural rate.

There is good news on our real-interest and expected-productivity-growth hypotheses. The coefficient of the real rate of interest, r, has the right sign and is significant. Of course, since real rates were negative in the middle of the 1970's they could not have played a part in the apparent elevation of the natural rate in that period, but they are badly needed to explain the high plateau of unemployment rates reached in the mid-1980's. Regarding expected productivity growth, we find that the constant term in the late period (starting with the slowdown in 1974) is significantly higher than the con-

[1] The coefficients c_1, c_2, c_3, c_4, c_5, and c_6 have the expected sign and are statistically significant. Before introduction of the variables in Table 1, they take the values 0.029, −0.015, −0.026, 0.661, 0.555, and 0.242, respectively. The sign and statistical significance of these coefficients are not altered by the inclusion of the remaining variables.

stant term in the early period (before 1974). Equality of the constant terms is rejected at the 5-percent level in the last two regressions. Thus there is new evidence that slower growth since the mid-1970's has raised the natural rate.

The new hypothesis, that workers react to a rise in anticipated separation rates from corporate restructuring by quitting less, which lowers wages and unemployment, did not receive much support. While it is true that layoffs have remained high in the past three years despite the recovery of employment, and quitting appears to be unusually low, we were unable to find an effect of these developments on wage inflation in equation (16).

The news on the importance of wealth, private and social, is mixed. Only one form of nonwage income turned out to have a significant coefficient: transfers received by households. Interest, dividend, and rental income all had insignificant coefficients. The failure of private nonwage income to matter is theoretically unfortunate since one wants models in which certain things like productivity and wages figure in behavior only as ratios to private and social wealth. Our continued success with a welfare-state variable is obviously of some importance for social policy.

REFERENCES

Calvo, Guillermo A. "Quasi-Walrasian Models of Unemployment." *American Economic Review*, May 1979 (*Papers and Proceedings*), *69*(2), pp. 102–7.

Hoon, Hian Teck and Phelps, Edmund S. "Macroeconomic Shocks in a Dynamized Model of the Natural Rate of Unemployment." *American Economic Review*, September 1992, *82*(4), pp. 889–900.

Juhn, Chinhui; Murphy, Kevin M. and Topel, Robert H. "Unemployment, Nonemployment and Wages: Why Has the Natural Rate Increased through Time?" *Brookings Papers on Economic Activity*, 1991, (2), pp. 75–142.

Phelps, Edmund S. "Money-Wage Dynamics and Labor-Market Equilibrium." *Journal of Political Economy*, August 1968, *76*(4), Part 2, pp. 678–711.

———. *Structural slumps: The modern equilibrium theory of unemployment, interest, and assets*. Cambridge, MA: Harvard University Press, 1994.

Phelps, Edmund S. and Zoega, Gylfi. "The Incidence of Increased Unemployment in the Group of Seven, 1970–1994." Birkbeck College (London) Discussion Paper No. 21/96, 1996.

Salop, Steven C. "A Model of the Natural Rate of Unemployment." *American Economic Review*, March 1979, *69*(1), pp. 117–25.

Solow, Robert M. "Another Possible Source of Wage Stickiness." *Journal of Macroeconomics*, January 1979, *1*(1), pp. 79–82.