The Natural Rate, Hysteresis, and the Duration Composition of Unemployment in the U.S.

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Abstract

This paper compares the natural rate and hysteresis accounts of equilibrium unemployment. The contrasting implications of the two hypotheses regarding the duration composition of unemployment are discussed, and cointegration tests are performed to see whether a tendency to converge on a unique ratio of long-term to total unemployment is evident in U.S. data 1959:I-1987:II. The results indicate that no such tendency is present, in violation of the natural rate hypothesis and in support of the hysteresis account of equilibrium unemployment.

Introduction

The natural rate hypothesis has come to dominate thought about what determines and what can be done about unemployment. This paper asks if confidence in the natural rate hypothesis is justified in light of evidence regarding the composition of long-term unemployment in total unemployment. The implications for long-term unemployment of the natural rate and hysteresis accounts of equilibrium unemployment are contrasted. Tests for the existence of a unique equilibrium relationship between long-term and total unemployment in the U.S. are conducted. The results suggest that such an equilibrium relationship does not exist, implying that there are evidential grounds for preferring the hysteresis to the natural rate account of equilibrium unemployment.

The Natural Rate

The natural rate was unveiled in Friedman [15], in an analogy to Wicksell's distinction between the natural and market rates of interest. The natural rate was

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termed U* in Phelps [29]. The natural rate of unemployment is, according to Friedman:

> the level that would be ground out by the Walrasian system of general equilibrium equations provided there is embedded 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 availability, the costs of mobility, and so on

The equilibrium rate of unemployment, the rate consistent with unchanging inflation, is determined by state variables and is independent of monetary forces that only can affect the market or actual rate of unemployment. The implication is that the natural rate is independent of the actual rate of unemployment and of the history of unemployment. The neutrality proposition involved in the natural rate hypothesis was restated formally in the new classical macroeconomics. Earlier work on Phillips relationships relied on the false inference that because:

> nominal prices and wages tend to rise more rapidly at the peak of the business cycle than they do in the trough . . . permanent inflation will therefore induce a permanent economic high [27, p. 19].

The irony is that the new classical macroeconomics, which claims that departures from the natural rate equilibrium are temporary and unsystematic, does not currently have a coherent theory of unemployment:

> there are no unemployed people in (the) Walrasian scenario, only unemployed hours of labor services . . . no one finds a job, or seeks one, or gets laid off from one . . . what we mean, in ordinary usage, by *unemployment* is exactly disruptions in, or difficulties in forming, employer-employee relationships . . . a Walrasian framework that assigns no role at all to such a relationship is not going to give us the understanding we want . . . if we are serious about obtaining a theory of unemployment, we want a theory about unemployed people, not unemployed "hours of labor services" [28, pp. 52-53].

Despite this curious history,

> in the United States at least, the validity of the natural rate hypothesis has not been an issue for a long time . . . the argument, instead, is over whether the convergence to the natural rate is rapid or glacial [3, p. 132].

Mainstream Keynesian economists have adopted the natural rate hypothesis as a long-run proposition, distinguishing themselves from the classical position by invoking nominal rigidities to explain why convergence to the natural rate is likely to be glacial rather than rapid. Apart from this controversy regarding the speed of adjustment to equilibrium, both Keynesian and classical economists have tended to focus on state variables such as unemployment insurance arrangements, the share of secondary workers in the labor force, and measurement problems with Bureau of Labor Statistics unemployment survey data when addressing questions such as why the steady inflation rate of unemployment appears to have remained at 6 percent to 7 percent in the U.S. in the mid-1980s (Summers [36] provides a critical review of such studies).

The features that distinguish the natural rate account of equilibrium unemployment are illustrated in Figure 1.

A contractionary shock ε(-ve) raises the actual rate of unemployment to U+; the actual rate of unemployment U exceeds the natural rate U*; inflation is overanticipated; the rate of inflation falls; and U returns to U* as the shock abates. An expansionary shock ε(+ve) reduces the actual rate of unemployment to U-; the actual is less than the natural rate of unemployment; inflation is underanticipated; the rate of inflation rises; and U returns to U* once the shock abates. This natural rate framework is shared by mainstream Keynesian and classical economists--the two camps differ on how quickly U returns to U*.

The noticeable absence from this framework is any influence of the time path of U on U*, the natural rate being invariant with regard to the experience of actual unemployment. This means that any change in the duration composition of unemployment that accompanies the movement of the actual rate of unemployment cannot affect the natural rate of unemployment. The natural rate, for any given vector of state variables, is assumed to be independent of the time path of actual unemployment and, hence, independent of any endogenous change in the duration composition of unemployment induced by variations in actual unemployment. For this implication to hold, the natural rate of unemployment would have to be characterized by a unique duration composition of unemployment. As far as long-term unemployment (durations in excess of a year) is concerned, the natural rate hypothesis requires that there is a tendency to converge on a unique natural rate ratio of long-term to total unemployment. If this property does not hold and if the long-term unemployed exert a different pressure on wage and price setting behavior than that exerted by the short-term unemployed, the experience of actual unemployment will lead to a change in the structural characteristics of the labor and commodity markets, thus changing the equilibrium rate of unemployment. This would constitute a direct violation of the natural rate hypothesis.

Hysteresis

The term hysteresis means that which comes after, or is behind, and was coined for application to phenomena of scientific interest in 1881 by the Scottish physicist-engineer James Alfred Ewing: " . . . these curves exhibit, in a striking manner, a persistence of previous state . . . to this action . . . the author now gives the term *Hysteresis* . . . " [12]. The epistemological difference between explanations of phenomena that rely on hysteresis and those that do not can be traced to the controversies that surrounded the notions of action at a temporal and spatial distance proposed by Descartes and Newton, respectively [9]. Leibniz objected to the conception of action at a distance:

> for since this command in the past no longer exists at present, it can accomplish nothing unless it has left some subsistent effect behind which has lasted and operated until now, and whoever thinks otherwise renounces any distinct explanation of things, if I am any judge, for if that which is remote in time and space can operate here and now without any intermediary, anything can be said to follow from anything else with equal right [9].

Newtonian theory came to dominate the explanation of physical phenomena, despite the objections of Leibniz.

Ewing first applied the concept of hysteresis to his discovery that when iron and steel are stressed, the thermoelectric effects on the properties of the metals lag behind the stress applied [11]. He coined the term when describing a similar lag that arose when investigating the transient electric currents produced by twisting magnetized wires [12]. Ewing's most celebrated application of the hysteresis effect was to the behavior of magnetic fields in ferric metals. Maxwell's field continua equations that do not exhibit hysteresis and do not explain the behavior of electromagnetic fields in ferric metals. Ewing explained this anomaly by invoking hysteresis, noting the tendency on the part of the metal to persist in any magnetic state it might have acquired:

> when there are two qualities M and N such that the cyclic variations of N cause cyclic variations of M, then if the changes of M lag behind those of N, we may say that there is hysteresis in the relation of M to N . . . the value of M at any point of the operation depends not only on the actual value of N, but on all the preceding changes (and particularly on the immediately preceding changes) of N, and by properly manipulating those changes, any value of M within more or less wide limits may be found associated with a given value of N [13, p. 524].

In economics, the issue of whether equilibria are ahysteretic (i.e., determined by state variables alone and independent of the history of the economic system) or hysteretic (i.e., dependent on the history of the system as well as state variables) can be traced to the equilibrium debate of the 1930s. It is interesting that the immediate context of this debate was Wicksell's concept of a natural rate of interest:

> a discussion arose regarding Wicksell's concept of the "natural" interest rate . . . the discussion subsequently extended to the question of what in general was to be understood by a "natural" or "equilibrium" position of a certain set of economic variables [16, p. 100].

Frisch's celebrated article defined what emerged as the standard ahysteretic account of equilibrium in economic systems. An awareness was displayed, however, of the alternative hysteretic account of equilibrium:

> equilibrium will be determinate . . . even if it is only gradually established, so long as the position of equilibrium is independent of the actual path followed . . . indeterminateness can only arise through the disturbing influence of intermediary situations [22, pp. 126-127].

Until the 1980s, mainstream analysis in economics, both classical and Keynesian, excluded hysteresis from the conception of equilibrium employment. The natural rate equilibrium is part of this tradition. Outside the mainstream, economists such as Schumpeter [35] and his one-time student Georgescu-Roegen [17] persistently have argued that hysteresis is necessary in understanding the behavior of economic systems. At the formal level of analysis, economic theorists have been reluctant to introduce hysteresis phenomena into their models:

> for, if we . . . go back to a detailed picturing of the colliding billiard balls, we realize that at best all we can observe is that the present position of the system is in a determinate relationship to all of its past behavior . . . the behavior of an effect Y at time t depends upon the whole shape of behavior at all previous times of its cause X . . . when the equilibrium of a system depends on (and is dictated) by its path toward equilibrium, the scientist has an uncomfortable feeling [33, pp. 440-441].

This uncomfortable feeling in introducing hysteresis into formal analytical systems, however, has been accompanied by a tendency to take hysteresis seriously: " . . . in our more realistic moods, we tacitly used models involving hysteresis" [33, p. 541].

During the 1980s, however, there have been increasing signs of a willingness to undertake the fundamental departure from the received ahysteretic analytical systems employed in mainstream classical and Keynesian theory. A strong incentive to investigate the properties of economic systems in which there is a continuum of equilibria, each haunted by hysteresis, is provided by dissatisfaction with the ability of ahysteretic classical and Keynesian theories to provide a coherent account of the empirical characteristics of unemployment [36]. Accounts of general equilibrium systems characterized by hysteresis can be found in search equilibrium models, where the number of advantageous trades exploited depends on the levels of stocks held by traders [6] and in bootstrap or sunspot versions of rational expectations equilibria in which

> the state of the economy which we single out as an equilibrium depends on our theory of the behavior of agents out of that equilibrium . . . (the) theory must turn on the information available to agents and on the manner in which they learn from such information . . . (implying) that equilibrium will not be independent of the history of the economy [20, p. 1].

A good part of this increased willingness to depart from ahysteretic analytic systems can be traced to the observed tendency of output and unemployment deviations from the ahysteretic equilibrium assumed to persist. According to conventional equilibrium analysis, demand and supply shocks of the once-off type should not have effects that persist over time. Yet it is difficult to explain the evolution of output and unemployment in many countries during the 1980s and earlier episodes without invoking strong persistence effects. Hysteretic systems of analysis offer a means of explaining persistence as a general characteristic of economic systems without having to resort to *ad hoc* explanations of why the degree of persistence of deviations from ahysteretic equilibria appears to have been anomalously high during particular episodes such as the 1980s.

Hysteresis Accounts of Equilibrium Unemployment

Phelps was the first to suggest, using the hysteresis terminology, that the equilibrium rate of unemployment could be haunted by history:

> the transition from one equilibrium to the other tends to have long lingering effects on the labor force, and those effects may be discernible in the equilibrium rate for a long time . . . the natural unemployment rate at any future date will depend on the course of history in the

> interim . . . such a property is sometimes called hysteresis [30, p. xxiii].

It is plausible to interpret the analysis of unemployment equilibrium contained in Keynes' *General Theory* as constituting a continuum of unemployment equilibria contingent on the history of beliefs and expectations formed within the framework of a beauty contest:

> competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not the faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors . . . it is not a case of choosing those which, to the best of one's judgment, are really the prettiest, not even those which average opinion genuinely thinks the prettiest . . . we have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be . . . and there are some . . . who practice the fourth, fifth, and higher degrees [23, p. 156].

An account of Keynes' struggle to escape from received doctrine could be elaborated in terms of an attempt to break free from the straitjacket of unique ahysteretic equilibria and reconstruct economic analysis in terms of equilibria shaped by hysteresis. The notion of hysteresis appears to be implicit in the objections of certain Keynesian economists to classical doctrine (Tobin [39], for example).

There are a wide variety of channels whereby hysteresis effects can help shape the equilibrium rate of unemployment (see the contributions in Cross [5], for example). To date, two main sources of hysteresis have been investigated. In the insider-outsider account insiders, those with a pattern of regular employment that yields on-the-job training and acquisition of skills conducive to future employment, are distinguished from outsiders, who have the opposite characteristics. Insiders are postulated to care about their expected real wages and the probability that they will remain in employment and to have greater influence in determining wages during negotiations with employers. If insiders do not care about the interests of outsiders, those who remain employed as insiders after a contractionary shock that reduces employment will have no incentive to accept lower wages once the shock abates. If outsiders are disenfranchised in the sense that they have little or no influence on wage and price setting behavior, those who have become outsiders as a result of the contractionary shock will have no power to exert downward pressure on wages once the shock abates [25]. Thus, the time path of actual unemployment shapes the balance of insiders and outsiders in the labor force, providing an endogenous source of variation in the structural characteristics of the labor and commodity markets. In the case of the contractionary shock discussed above, the effects of the lower employment engendered by the temporary shock persist in the form of, *mutatis mutandis*, a permanently larger pool of outsiders and a higher rate of equilibrium unemployment and vice versa for the case of an expansionary shock. In the case where insiders lose insider status immediately when they lose employment and where outsiders are powerless to exert any influence on wages, the implication can be that the equilibrium rate of unemployment follows a random walk (this result arises in the Blanchard and Summers model [2]).

Of more direct relevance to the tests contained in this paper is the long-term unemployment account of hysteresis effects. The argument is similar to the insider-outsider account--the long-term unemployed are postulated to cease to participate or be allowed to participate actively in labor markets. This could arise through a deskilling effect or an atrophying of the capacity to work or search for work [31] or through a screening process whereby employers see the long-term unemployed as being unsuitable for work [40]. The evidence is that statistics on the average duration of completed spells of unemployment

> seriously underestimate the unemployment experience of all groups of persons . . . persons with single spells, because on average single spells are longer than multiple spells . . . persons with multiple spells, because the unemployment experience of these persons includes the multiplicity of their spells [1].

The implication is that if an increase in actual unemployment leaves in its wake a larger number of persons scarred by the experience of a long spell of unemployment, a higher equilibrium rate of unemployment will ensue and vice versa for the case of a fall in actual unemployment. Thus the history of actual unemployment will shape the structural characteristics of the labor force in terms of the balance between the long- and short-term unemployed and hence provide an endogenous source of change in the equilibrium rate of unemployment.

For the U.K., the long-term unemployment account of hysteresis effects has been used to explain why the equilibrium rate of unemployment has increased during the 1980s, despite the fact that state variables such as unemployment benefits, trades union power, and payroll taxes have indicated a downward movement in the equilibrium rate [24]. Without this invocation of hysteresis, the natural rate hypothesis is inconsistent with the fact that the U.K. inflation rate has been steady in the mid-1980s, instead of falling. The link between the long-term duration composition of unemployment and total unemployment is provided by the following equation [24, p. 15]:

$$(1)\quad RM_t = 0.054 + 0.61\, RM_{t-1} - 2.41\, U_t + 5.58\, U_{t-1} - 2.18 U_{t-2}$$
$$\qquad (2.1) \quad (3.7) \qquad (5.6) \quad (6.5) \quad (2.4)$$

OLS estimation U.K. 1956-1983, $\bar{R}^2 = 0.84$, s.e. = 0.023

RM = proportion of unemployed males who have been out of work for longer than a year;
U = unemployment rate among males.

t-statistics are indicated in brackets. This equation indicates that " . . . as unemployment rises, the long-term unemployed proportion falls initially, since historically increases in unemployment come about because the inflow rises . . . in the long run, however, the long-term proportion tends to rise with unemployment . . . " [24, p. 15].

The earlier analysis of long-term unemployment in the U.S. deals with quarterly data 1959-1987. To check whether changes in actual unemployment provide an endogenous source of variation in the long-term composition of unemployment in the U.S. along the lines suggested for the U.K., equation (1) was estimated for the U.S. on similar annual data, yielding:

$$(2)\quad RA_t = -0.016 + 0.882\, RA_{t-1} + 0.005\, U_t + 0.011 U_{t-1} - 0.012 U_{t-2}$$
$$\qquad (2.1) \quad (6.54) \qquad (2.84) \quad (4.78) \quad (4.95)$$

OLS estimation, U.S. 1962-1986, $\bar{R}^2 = 0.95$, s.e. = 0.0076
LM autocorrelation test of F (3, 17) = 1.95 compared with 5 percent critical value of 3.20.

RA = proportion of unemployed males and females who have been out of work for 52 weeks or more;
U = unemployment rate for males and females.

t-statistics are indicated in brackets. The main difference between equations (1) and (2) is that the coefficient on U_t is positive in equation (2), indicating that in the U.S. both the short- and long-run effect of an increase in actual unemployment is a rise in the proportion of long-term unemployment. The endogenous source of variation in long-term unemployment in the U.S. can be seen by rewriting equation (2) as:

$$(3)\quad \Delta RA_t = a_0 + a_1 U_t + a_2 \Delta U_{t-1} \quad a_1, a_2 > 0$$

Thus, the long-term unemployment characteristics of the labor force change in response to the level of unemployment and to the change in unemployment.

The implications of the hysteresis account of equilibrium unemployment can be seen in Figure 2, which is a modification of the hysteresis loop diagram invented by Ewing [14]. A contractionary shock ε(-ve) raises the actual rate of unemployment to U_1; inflation is overanticipated; the rate of inflation falls. The equilibrium rate of unemployment remains higher at U_1^* once the shock abates, however, because of more outsiders or long-term unemployed individuals. A subsequent expansionary shock ε(+ve) only can be evaluated in relation to the new equilibrium rate of unemployment U_1^*. The actual rate of unemployment falls to U_2; inflation is underanticipated; the rate of inflation rises. The equilibrium rate of unemployment remains lower once the shock abates, however, because of fewer insiders or long-term unemployed persons. Thus, the equilibrium rate of unemployment is changed by the experience of actual unemployment instead of remaining unchanged as in the natural rate hypothesis. There is no reason why a subsequent cycle of contraction and expansion should replicate the experience sketched in Figure 2. The equilibrium rate of unemployment is a palimpsest on which is written the history of different shocks to actual unemployment--the initial conditions will not be the same, other than by chance.

Cointegration and the Existence of Equilibrium Relationships

The natural rate hypothesis suggests that there will be a tendency to converge on a unique duration composition of total unemployment. The hysteresis hypothesis suggests that no such convergence will occur. The cointegration approach in econometrics treats the existence of equilibrium relationships as a statistical property of time series for which tests can be conducted. This method of time series analysis has been developed only recently, so it is worthwhile to outline the salient features of the approach.

The general problem that the cointegration approach addresses is that of distinguishing spurious from nonspurious systematic comovements of time series variables in economics [21]. The approach specifies two necessary conditions for a relationship to be nonspurious: the variables involved need to be integrated on the same order. That is, the same degree of differencing is required in order to introduce stationarity and there has to be a relationship between the variables such that the system converges on the equilibrium postulated [19].

The point of departure is that many economic time series are nonstationary and require differencing to introduce stationarity. The most basic example is the random walk:

$$(4)\quad X_t = a + bX_{t-1} + \varepsilon_t \quad a = 0, b = 1, \text{or}$$

$$(5)\quad X_t = \sum_{i=0}^{t-1} \varepsilon_{t-1}, \quad X_0 = 0$$

where

$\varepsilon_t \sim$ IN $(0, \sigma^2_\varepsilon$, i.e., independently normally distributed disturbances with zero mean and constant variance).

This is a nonstationary process with indefinitely long memory; the moments of the distribution are not defined; the variance of X_t is $t\,\sigma^2_\varepsilon$. (See Dickey and Fuller [7].) Hence, the usual statistical properties of the moments of the sample distribution converging on those of the population do not hold. In order that such properties hold, first differencing, i.e., $\Delta X_t = \varepsilon_t$, is required to induce stationarity.

A detailed outline of the cointegration approach is found in Engle and Granger [10]. A time series that is stationary is termed I(0), integrated of order zero. If first differencing is required to induce stationarity, the series is I(1) and so on. The first necessary condition for two series X_t and Y_t to be cointegrated is that they are integrated of the same order, e.g., $X_t, Y_t \sim I(1)$. Otherwise, the two series will tend to drift apart over time.[1] The second necessary condition is that there exists an α cointegration factor in

$$(6)\quad X_t = k + \alpha\, Y_t + Z_t \quad Z_t \sim \text{IN}\,(0, \sigma^2_Z)$$

such that $Z_t \sim I(0)$. If the latter condition holds, the two series will tend to converge on an equilibrium relationship. If $Z \sim I(1)$, however, the behavior of

[1] In relation to the tests reported in this paper, for example, long-term and total employment being integrated of the same order is necessary but not sufficient for the existence of an equilibrium relationship between the two. The two variables may display no systematic tendency to drift apart over time, but will not tend to converge onto an equilibrium relationship unless the second necessary condition holds.

X_t and Y_t in relation to the equilibrium postulated is random, and there is no support for the existence of an equilibrium relationship.

One problem in testing for cointegration concerns tests for unit roots in nonstationary series. An OLS estimate of b from equation (4), for example, would be grossly misleading because the moments of the distribution are not defined under the null b = 1. A second problem concerns the power of tests for unit roots against alternative hypotheses in which the roots lie just within the unit circle (b = 0.9 in equation (4), for example). These problems mean that the limit distributions of the estimators need to be defined on a case by case basis to yield estimators that have the size and power claimed. Engle and Granger [10] provide a classification and comparison of such test statistics. The two most powerful test statistics are those suggested by Sargan and Bhargava [34] and Dickey and Fuller [7, 8].

The Sargan-Bhargava test for order of integration uses the Durbin-Watson (DW) statistic and involves running the regression:

$$(7) \quad X_t = k + \varepsilon_t$$

where
k = constant.
The null hypothesis that $X_t \sim I(1)$ is equivalent to the $\rho = 1$ null in:

$$(8) \quad \varepsilon_t = \rho\varepsilon_{t-1} + \mu_t \quad \mu_t \sim IN(0, \sigma_\mu^2)$$

in which case ε_t, and hence X_t follow a random walk, given that $X_t - X_{t-1} = \varepsilon_t - \varepsilon_{t-1}$. Using a 5 percent size test for 101 observations (as is approximately the case with the tests reported earlier), the $X_t \sim I(1)$ null cannot be rejected if the DW for equation (7) is less than 0.259 [34]. As far as the cointegration equation (6) is concerned, the Sargan-Bhargava test uses the cointegration Durbin-Watson (CRDW) test statistic on the Z residuals in equation (6). Taking the case of a 5 percent size test and 100 observations, the $Z_t \sim I(1)$ null cannot be rejected if the CRDW for equation (6) is less than 0.386. This test has a power of 19.9 percent against the alternative hypothesis that the root of Z_t is 0.9 [10].

The motivation for the augmented Dickey-Fuller test can be seen by: (See Taylor [38].)

$$(9) \quad X_t = \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + \gamma_3 X_{t-3} + \ldots \quad \text{as}$$

$$(10)\ \Delta X_t = \left[\sum_{i=1}^{n-1} \gamma_i - 1\right] X_{t-1} - \sum_{i=1}^{n-1} \gamma_i \Delta X_{t-1} - \ldots \quad \text{or}$$

$$(11)\ \Delta X_t = \beta_0 X_{t-1} + \sum_{i=1}^{n} \beta_i \Delta X_{t-i} + \varepsilon_t$$

where n is chosen so that $\varepsilon_t \sim IN(0, \sigma_\varepsilon^2)$. Thus, a test for $X_t \sim I(1)$ is that $\beta_0 = 0$ in equation (11). In the random walk case, this would imply that $\gamma_1 = 1$. Given 5 percent size and 100 observations, the Dickey-Fuller (DF) test involves $n = 0$ for $\varepsilon_t \sim IN(0, \sigma_\varepsilon^2)$ and requires the t-statistics on β_0 in equation (11) to be more negative than -3.37 in order to reject the $X_t \sim I(1)$ null hypothesis. The power of this DF test is 15.4 percent against the alternative hypothesis that $\gamma_1 = 0.9$ in equation (9) [10]. The augmented Dickey-Fuller (ADF) test is employed when $n > 0$ is required for $\varepsilon_t \sim IN(0, \sigma_\varepsilon^2)$ in equation (11). For 5 percent size and 100 observations, the ADF test requires the t-statistic on β_0 in equation (11) to be more negative than -3.17 in order to reject the $X_t \sim I(1)$ null. The power of this test against the $\gamma_1 = 0.9$ alternative is 11.0 percent [10]. In the tests reported in the next section, the critical values mentioned above are used. For the DF and ADF tests, the t-statistics always are reported as positive. A word of warning is necessary here; there is no general theory of optimality in tests for unit roots; " . . . nevertheless, it appears that the critical values for ADF . . . can be used as a rough guide in applied studies at this point . . . " [10, p. 270].

Long-Term Unemployment in the U.S. 1959-1987

The following tests are designed to see if there is a tendency to converge on a unique duration composition of long-term unemployment in total employment in the U.S. In cointegration terms, this means testing for cointegration between long-term and total unemployment. Data on long-term unemployment, defined as those without work for 52 weeks and over, were made available by the Bureau of Labor Statistics. The notation is as follows:

ULA	= males and females unemployed for 52 weeks or more;
UTA	= total male and female unemployment;
RA	= ULA/UTA;
ULM	= males unemployed for 52 weeks or more;
UTM	= total male unemployment;
RM	= ULM/UTM;

ULF = females unemployed for 52 weeks or more;
UTF = total female unemployment;
RF = ULF/UTF.

The data were available quarterly 1959:I-1987:II. Figures 3, 4, and 5 graph the time series for RA, RM, and RF.

In order to test for cointegration between UL and UT and convergence on some R* = (UL/UT)* ratio, the first step is to ascertain the order of integration of the variables.

The DW statistics were derived from the regression $X_t = k + \varepsilon_t$; the ADF t-statistics are reported in brackets and test whether β_0 is significantly different from zero in the regression

$$\Delta X_t = k + \beta_0 X_{t-1} + \sum_{i=1}^{\beta} \beta_i \Delta X_{t-i} + \varepsilon_t;$$

and the LM statistic is the Lagrange multiplier test for ninth order autocorrelation in the ADF regression (the 5 percent critical value for this F-test is 1.99).

The Lagrange multiplier (LM) test is an asymptotically optimal test for the existence of autocorrelation between the contemporaneous residual and the previous residuals. The test was developed by Rao [32] and is based on making optimal use of the information contained in the log likelihood function for the estimators. For recent developments and applications of this test for higher order autocorrelation, see Godfrey [18].

Using the critical values outlined above, it is clear that the null hypothesis of unit roots cannot be rejected for all six variables. Thus, there is no support for the hypothesis that the variables are I(0). The next stage in ascertaining the order of integration is to first difference the variables and ask whether the null hypothesis that the variables are I(2) can be rejected.

The DW statistics were derived from the regression $\Delta X_t = k + \varepsilon_t$ and the ADF statistics from the regression

$$\Delta^2 X_t = k + \beta_0 \Delta X_{t-1} + \sum_{i=1}^{\beta} \beta_i \Delta^2 X_{t-i} + \varepsilon_t.$$

All the tests reject the null that there are unit roots in the first differences of the variables. Thus, the first necessary condition for cointegration is satisfied. It is not possible to reject the hypothesis that ULA, UTA, ULM, UTM, ULF, and UTF ~ I(1). The implication is that long-term and total unemployment follow a random walk. Unemployment, both in terms of the long-term unemployed and total unemployed, shows no tendency to return to a fixed value.[2] The evidence fits more easily with hysteresis than with the natural rate account of equilibrium unemployment. The evidence does not necessarily refute the natural rate hypothesis, which would be violated if there was no tendency to converge to an equilibrium composition of long-term to total unemployment.

The CRDW tests relate to the ZA, ZM, and ZF residuals in equations (12), (13), and (14) and have a 5 percent critical value of 0.386. The ADF test in equation (12) is derived from the regression

$$\Delta ZA_t = k + \beta_0 ZA_{t-1} + \sum_{i=1}^{\beta} \Delta ZA_{t-i} + \varepsilon_t,$$

the 5 percent critical value for the t-statistic is 3.17. The DF tests in equations (13) and (14) were derived from the regressions

$$\Delta ZM_t = k + \beta_0 ZM_{t-1} + \varepsilon_t \text{ and } \Delta ZF_t = k + \beta_0 ZF_{t-1} + \varepsilon_t.$$

There were no signs of significant autocorrelation and, hence, no need to use the ADF test. The 5 percent critical value for the t-statistic is 3.37 (critical values are taken from Engle and Granger [10]).

Table 3 reports results on whether the second necessary condition for cointegration is satisfied. For long-term and total unemployment to be cointegrated, it would have to be possible to reject the hypothesis that the ZA, ZM, and ZF residuals in the auxiliary equations (12), (13), and (14) are I(1). This is not possible, given that the CRDW, DF, and ADF tests do not reject the I(1) null hypothesis at the 5 percent level. The results for aggregate and female long-term unemployment are further within the critical values than those for male long-term unemployment. It is worth adding the caveat that the power of

[2]The tests reported here relate to the numbers unemployed, not to the rates of unemployment. Thus, the tests relate directly to the issue of whether there is a tendency to return to a natural level of unemployment rather than to a natural rate.

the CRDW test for a unit root against the alternative hypothesis of a 0.9 root is only 20 percent.[3]

The implication of the tests reported above is that long-term unemployment is not cointegrated with total unemployment. The time series for long-term and total unemployment are integrated of the same order, but there is no tendency to converge on an equilibrium ratio of long-term to total unemployment. The data do not allow the hypothesis that the behavior of the long-term unemployment ratio in relation to the equilibrium value postulated by the natural rate hypothesis is random to be refuted. The claims about the duration composition of unemployment made by the hysteresis account of equilibrium unemployment are consistent with the evidence; the claims made by the natural rate hypothesis are not.

It is important to note that the tests concern whether there is a tendency to converge to an ahysteretic equilibrium of the type postulated by the natural rate hypothesis; the tests suggest that there is no systematic tendency to converge onto such an equilibrium. Once hysteresis is introduced, however, the time path of actual unemployment helps to determine or pin down the long-term unemployment ratio, as indicated by the regression equations reported earlier. Thus, what appears to be a failure of long-term and total unemployment to converge onto an equilibrium relationship when seen through ahysteretic spectacles appears as the evolution of a path dependent equilibrium relationship when viewed through hysteretic spectacles.

Conclusion

The natural rate account of equilibrium unemployment continues to dominate thought about what determines and what can be done about unemployment. In this account, there is no role for the history of actual unemployment in shaping the characteristics of the labor force and the equilibrium rate of unemployment. The evidence above suggests that the actual rate of unemployment does shape the long-term unemployment characteristics of the labor force. The results further indicate that there is no tendency to converge on a unique proportion of long-term to total unemployment. These two pieces of evidence suggest that the natural rate account of equilibrium unemployment is flawed seriously.

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[3] It is worth underlining the point that tests for unit roots tend to have low power against alternative hypotheses involving roots that lie just within the unit circle. This means that it is difficult to discriminate between hypotheses that imply no mean reversion and hypotheses involving slow mean reversion.

In the hysteresis account, the equilibrium rate of unemployment is shaped by the history of actual unemployment. There are plausible reasons why this should be the case. The empirical tests reported in this paper lend strong support to the existence of hysteresis effects on long-term unemployment. In this account, there is a continuum of equilibrium rates of unemployment, each with its own legacy of long-term unemployment or other characteristics modified by the experience of actual unemployment. It is time to escape from the straitjacket of the natural rate hypothesis and think about unemployment in terms of equilibria haunted by hysteresis.

The analytical challenge is to construct accounts of equilibrium in economic systems in which the path toward equilibrium helps shape the characteristics of equilibrium. Orthodox equilibrium analysis tends to treat demand and supply shocks as being random in nature, capable of generating only temporary deviations from the equilibrium postulated. In terms of the hysteresis research agenda, by direct contrast, such shocks do not not have merely temporary effects, but become consolidated in equilibria which evolve in a manner determined by the cumulation of past shocks. The policy implication is that once-off policy measures have permanent effects. Thus, the Keynesian claim that aggregate demand policies can have lasting effects on output and unemployment is reinstated.

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Table 1
Testing for I(0)

Variable	DW	ADF
ULA	0.044	-0.032 (1.683)
LM Autocorrelation Test F(9,85)		1.44
UTA	0.071	-0.021 (1.310)
LM Autocorrelation Test F(9,85)		1.67
ULM	0.045	-0.030 (1.598)
LM Autocorrelation Test F(9,85)		0.33
UTM	0.137	-0.035 (1.684)
LM Autocorrelation Test F(9,85)		2.50
ULF	0.057	-0.042 (1.692)
LM Autocorrelation Test F(9,85)		1.19
UTF	0.047	-0.014 (0.933)
LM Autocorrelation Test F(9,85)		1.08
Critical Value for DW (5 percent)	0.259	
Critical Value for ADF (5 percent)		(3.17)
Critical Value for LM (5 percent)		1.99

Table 2
Testing for I(1)

Variable	DW	ADF
ΔULA	0.818	-0.552 (3.496)
LM Autocorrelation Test F(9,84)		1.60
ΔUTA	2.347	-0.586 (5.311)
LM Autocorrelation Test F(9,84)		1.37
ΔULM	0.855	-0.474 (4.641)
LM Autocorrelation Test F(9,84)		0.59
ΔUTM	2.159	-0.752 (6.967)
LM Autocorrelation Test F(9,84)		1.73
ΔULF	1.240	-0.607 (5.153)
LM Autocorrelation Test F(9,84)		1.17
ΔUTF	2.617	-0.735 (5.849)
LM Autocorrelation Test F(9,84)		1.83
Critical Value for DW (5 percent)	0.259	
Critical Value for ADF (5 percent)		(3.17)
Critical Value for LM (5 percent)		1.99

Table 3
Cointegration Tests for the Long-Term Composition of Unemployment

(12) ULA = -282.262 + 0.118 UTA + ZA
(6.84) (17.73)

Sargan-Bhargava Test:	CRDW = 0.216 - Critical Value 0.386
Augmented Dickey-Fuller Test:	ADF = -0.115 (2.710) - Critical Value (3.17)
	$R^2 = 0.74$

(13) ULM = -182.450 + 0.141 UTM + ZM
(6.59) (17.69)

Sargan-Bhargava Test:	CRDW = 0.330 - Critical Value 0.386
Dickey-Fuller Test:	DF = 0.165 (3.157) - Critical Value (3.37)
	$R^2 = 0.74$

(14) ULF = -85.439 + 0.083 + ZF
(6.44) (17.22)

Sargan-Bhargava Test:	CRDW = 0.234 - Critical Value 0.386
Dickey-Fuller Test:	DF = 0.121 (2.73) - Critical Value (3.37)
	$R^2 = 0.73$

Figure 1
The Natural Rate

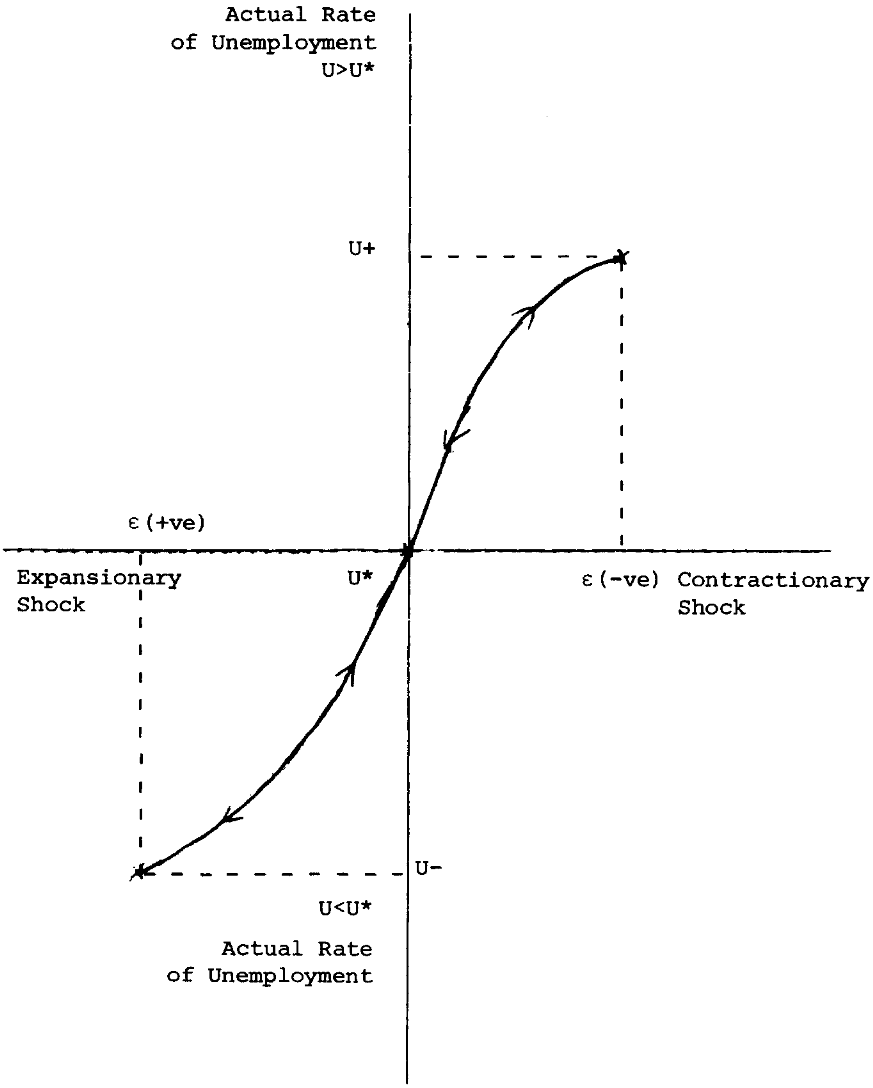


Figure 2
Hysteresis in Equilibrium Unemployment

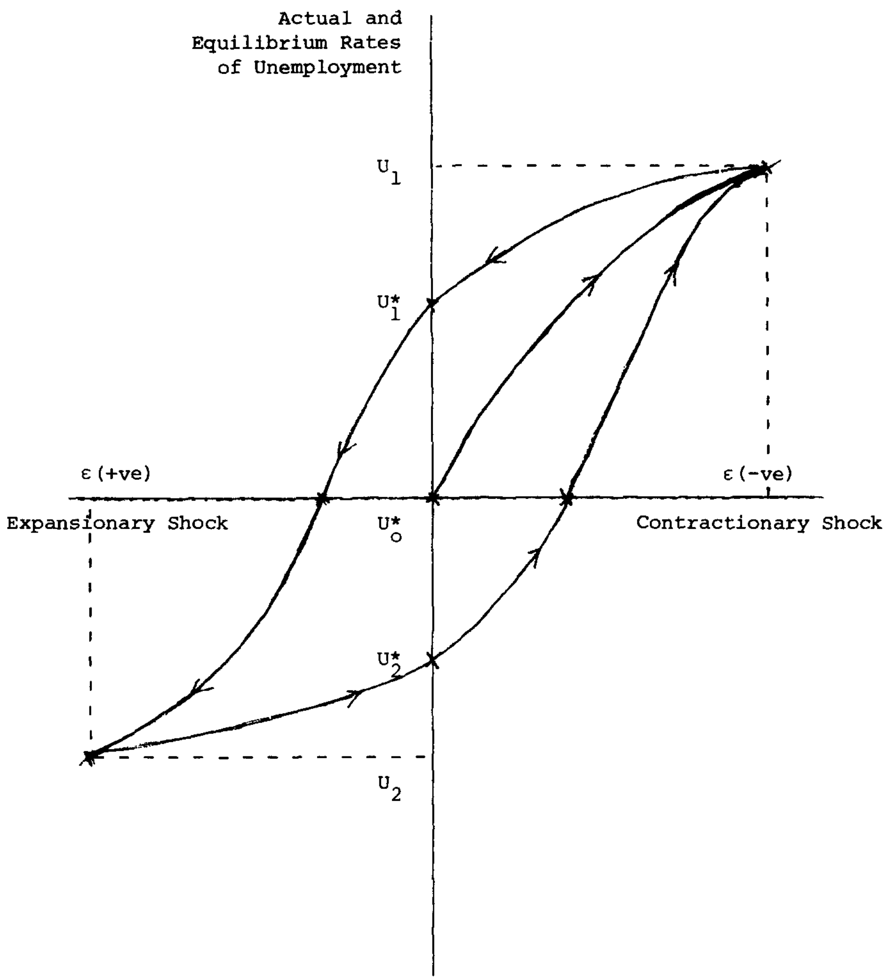
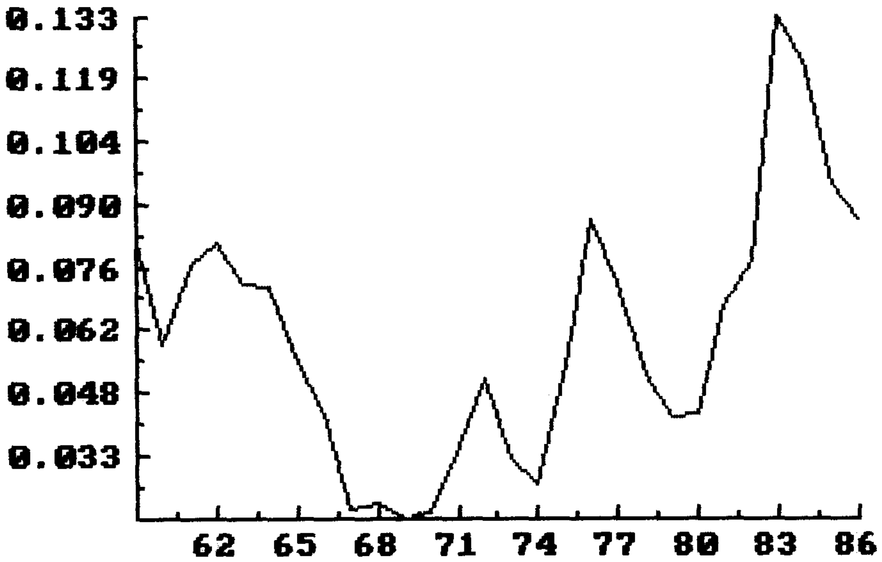
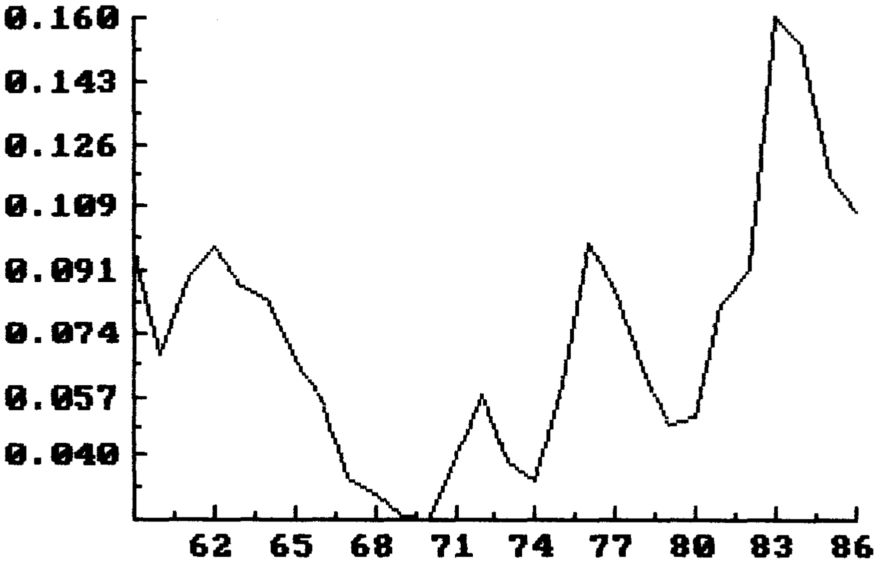


Figure 3
Long-Term Unemployment/Total Unemployment Ratio
Males and Females
1959-1986



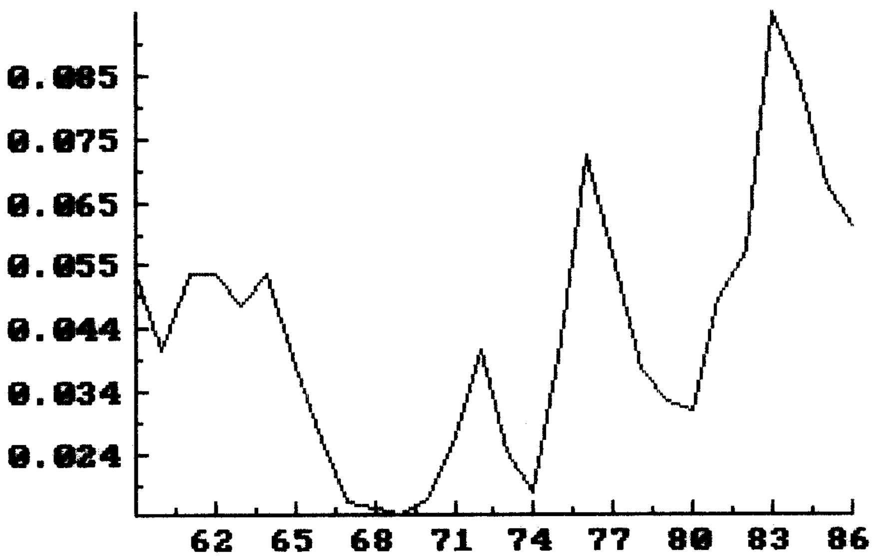
RA= Males and females unemployed for 52 weeks or more divided by total male and female unemployment

Figure 4
Long-Term Unemployment/Total Unemployment Ratio
Males
1959-1986



RM= Males unemployed for 52 weeks or more divided by total male unemployment

Figure 5
Long-Term Unemployment/Total Unemployment Ratio
Females
1959-1986



RF= Females unemployed for 52 weeks or more divided by total female unemployment