

Natural Rate Hypothesis; A Review Article

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I. Introduction

The empirical negative relationship between inflation and unemployment was first examined by Phillips (1958). Using the long-term horizon annual data (1861 - 1957) of the United Kingdom, Phillips observed a negative relationship between the unemployment rate and the rate of wage inflation. Noting the very positive correlation between price inflation and wage inflation, modern Phillips curve substitutes price inflation for wage inflation.

During the 1960s, most of the American economists believe that there is a negative stable relationship between the inflation rate and the unemployment rate. The data on the inflation rate and the unemployment rate in the 1960s was coincident with that belief.

Against this view, Friedman (1968) and Phelps (1968) developed the concept of the natural rate of unemployment. Friedman (1968) argued that there is not a negative stable relationship between the inflation rate and the unemployment rate in the long run. The demand shock such as monetary expansion to reduce unemployment will lead to the accelerating price inflation, eventually not reducing

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the unemployment rate. This dynamic relationship between inflation and unemployment would be settled, as such a way that there exists a natural rate of unemployment consistent with the steady state level of inflation rate. This steady state level of unemployment has come to be recently known as the Non - Accelerating Inflation Rate of Unemployment (NAIRU).

If a unique NAIRU exists, there is not a long - run Phillips curve trade off. Once the unemployment rate deviates from the NAIRU, it tends to revert to the NAIRU with accelerating inflation. If the monetary authority succeeds in picking up the actual unemployment rate equal to the NAIRU, it can maintain the stable rate of inflation. The monetary authority could reduce the inflation rate to some other target which is lower, and not consistent with that of NAIRU if it keeps the actual unemployment rate above the NAIRU.

In this paper, we have reviewed the theoretical formulations to identify and quantify Friedman's vague (verbal) definition of the natural rate of unemployment.

Friedman (1968) has defined the natural rate of unemployment as follows ; "The natural rate of unemployment is the level which would be ground out by the Walrasian system of general equilibrium equations, provided that there is imbedded in them the actual structural characteristics for 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 cost of mobility, and so on".

We have also discussed the statistical implementation and its limits in finding the NAIRU. Given the existence of the NAIRU, We have explored the macroeconomic policy implication in utilizing the short - run Phillips curve trade off. Lastly concluding remarks follow.

II. The NAIRU as an Equilibrium Unemployment

1. The Steady - State Level of Unemployment

The state of the labor market in decentralized economies is constantly changing.

From firms' perspective, some of them are expanding employment, and others are reducing it. From workers' perspective, they quit their jobs in search of better ones, which forces firms to find replacements. This perpetual ebb and flow in the labor market may determine the fraction of the labor force that is unemployed.

Following Hall (1979), we derived the natural rate of unemployment in terms of the job separation rate (denoted by s) and the job finding rate (denoted by f). The labor force is divided into the employed workers and the unemployed ones in each period. That is, $L = E + U$, where L indicates the labor force, E indicates the number of employed workers, and U is the number of unemployed workers.

To clarify the flow mechanisms between workers and firms, suppose that in every end of period, a fraction s of the employed lose their jobs, and a fraction f of the unemployed find jobs. In steady state equilibrium, the number of people finding jobs (fU) should equal the number of people separated (sE). That is, $sE = fU$. Note that $E = L - U$. This implies that $fU = s(L - U)$. Dividing both sides of this equation by L yields $f(U/L) = s[1 - (U/L)]$. Then, solve for (U/L) to find $U/L = s/(s+f)$.

This equation says that the natural rate of unemployment (the steady state level of unemployment) U/L depends on the parameters s and f . The higher the job separation rate, the higher the natural rate of unemployment. The lower the job finding rate, the higher the natural rate of unemployment.

Institutional factors such as unemployment insurance and legal restrictions on firms affect the natural rate of unemployment. The more generous the unemployment insurance if being separated from the job, the lower the job finding rate of the unemployed; This increases the natural rate of unemployment. This is because given the higher reservation wage the unemployed will not exert their best effort in locating a job.¹⁾

The stricter legal restrictions on firing workers will cost more in laying off the workers who are not necessary in firm's perspective. This yields the lower separation rate which results in the lower natural rate of unemployment. The current higher European unemployment can be partially explained within this framework. Many European countries have got the more generous unemployment insurance programs

1) The more generous unemployment insurance system makes the worker's reservation wages (the wage that makes worker indifferent to being employed or unemployed) higher.

than other advanced countries such as U.S. and Japan. This implies that the reservation wages are relatively higher in European economies, so that the job finding rate is relatively lower. It makes the natural rate of unemployment higher in Europe.

This framework for the natural rate of unemployment has some flaws in the theoretical point of view. It can't explain why there is unemployment in the first place. Furthermore the natural rate of unemployment suggested by this model would not be the efficient level of unemployment.

2. Wait Unemployment

Under the hypothetical competitive market environments, all homogenous workers receive the same equilibrium market wage. All workers who are willing to work at the given market wage are hired, and thus there is no involuntary unemployment. If a worker is fired on some reasons, he will be instantly rehired without the adjustment costs. In this situation, there is an incentive for an employed worker to shirk without any cost. To prevent the shirking behavior of a worker, the firm should pay more than the going wage in the market. Confronting with the same situation, all firms should raise their wages above the market clearing level. As all firms raise their wages, their demand for labor decreases. In this way, the wait (involuntary) unemployment occurs (Shapiro and Stiglitz (1984)).

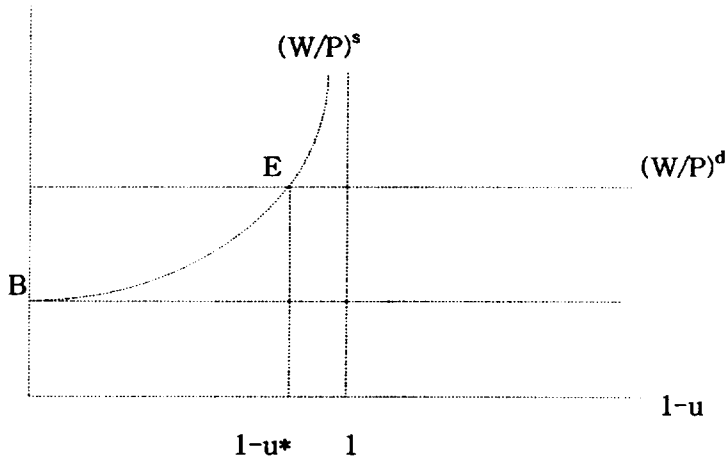
This argument is consistent with the efficiency wage hypothesis in the sense that reducing the shirking of workers will enhance the productivity of workers. Efficiency wage hypothesis is that productivity is affected by wages. According to this hypothesis (Katz (1986)), firms may want to pay workers more than the equilibrium market wage in order to get and keep better workers to economize on turnover costs, and to induce more effort and cooperation from their workforce.

Efficiency wage considerations does not play much of a role in poor labor market opportunities. The unskilled workers employed in the low wage industry have little or no bargaining power relative to the skilled workers. If the wage was set below the reservation wage in poor labor sector, the workers in that sector will prefer not to work, and yields the unemployment.

The wage setting above the equilibrium wage originates from the bargaining power of workers versus that of firms. Workers have some bargaining powers since they can't be costlessly and instantaneously replaced. The firm's bargaining power also arises because most workers can not find a job costlessly and instantaneously. In good times, the job finding rate of a worker will be higher as firms have greater incentive to post a vacancy. So the bargained wage will be higher. The bargained wage will be lower in bad times since it is not easier for workers to find a job.²⁾

The Shapiro - Stiglitz model(1984) leads to a wage relation that the lower the unemployment rate, the higher the real wages received by the workers.³⁾ Given the reservation wage, the relationship between the real wage and the unemployment is represented as the supply - wage relation $(w/p)^s$ in Figure 1. Note that the increase in the worker's reservation wage will shift the $(w/p)^s$ schedule upward. The demand wage $(w/p)^d$ that firms are willing to pay is represented by the horizontal line in Figure 1. The weak rationale for the horizontal representation of $(w/p)^d$ is that the real wage paid by firms is independent of the employment status.⁴⁾

Figure 1. The Determination of the Natural Rate
(w/p)



- 2) For more details along these lines, see for more recent example Mortensen and Pissarides (1994)'s matching model.
- 3) The lower the unemployment rate, the higher the exit rate from unemployment. This implies that when the unemployment rate decreases, the shirking behavior of workers increases. To stop the increasing shirking behavior of workers, the firms should raise the real wage.
- 4) For more details on this graphical representation, see the paper(Blachard and Katz(1997)).

The natural rate of unemployment is the rate at which supply and demand wage equals. The equilibrium point is given by point E, associated with the natural rate u^* . The institutional change in the labor market alters the level of the natural rate of unemployment. Some simple comparative statics analysis has been done to see how the natural rate of unemployment changes. Does the productivity growth decrease the natural rate of unemployment? The empirical answer to this question is that there is a long-run neutrality of the natural rate of unemployment due to the productivity growth (Layard, Nickell and Jackman (1991)). Theoretically, the growth in productivity will increase the demand wage. If the reservation wage is not affected by the productivity growth, the natural rate of unemployment will decrease. But the historical evidences were that the reservation wage moved in the same pace with the productivity growth. If this were true, the NAIRU will not change due to the productivity growth. Thus, the increase in the reservation wage will exactly offset employment effect induced by the productivity growth in the long run.

On the contrary to this fact, technological progress may be biased toward a skilled group of workers, rather than toward the unskilled workers. The biased technological progress may raise the natural rate of unemployment. To explain this, suppose that there are two markets in the economies, one for the skilled workers and the other one for the unskilled workers. If the technological progress is biased toward the skilled workers, the natural rate of unemployment in the labor market for the skilled may not change. The logic behind this argument is that the long-run neutrality of the natural rate of unemployment holds here. But the decrease in the demand for unskilled workers due to the technological bias may increase the level of natural rate of unemployment in the labor market for those workers. This is because supply wage curve shifts upward with the increasing reservation wage due to the technological progress, while the demand wage shifts downward by the relative regress in technology. Overall the natural rate of unemployment increases when the technological bias for skilled ones occurs in economies. The demand wage $(\frac{w}{p})^d$ may depend on the market structure of goods. In imperfectly competitive goods market, the firms will set the price over the marginal cost. The higher the markup, the higher the price of goods given the wage. Then the worker will receive the lower real wage. This implies that the more imperfectly competitive the goods markets, the higher the natural rate of unemployment.

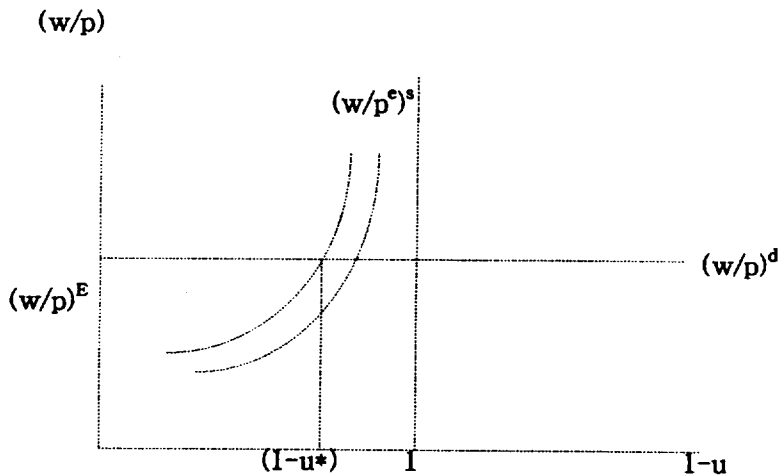
3. Cyclical unemployment as a monetary phenomenon

Unanticipated monetary shock may deviate the actual unemployment rate from the natural rate in the short run. As time passed, the worker expects the price increase exactly so that the actual unemployment rate returns to the natural rate.

The supply wage relation $(w/p)^s$ is replaced with the expected supply wage relation $(w/p^e)^s$ in uncertain world.⁵⁾ The expected supply wage relation $(w/p^e)^s$ is rewritten as follows; $(w/p^e)^s = (w/p)^s (p/p^e)$. In perfect foresight world, workers expects the actual price exactly. Then $p=p^e$. In this case, the supply wage relation coincides with the expected supply wage relation.

In Figure 2, we explained the cyclical unemployment around the natural rate. Suppose the point E in Figure 2 is the initial equilibrium point when workers expects the price level exactly; the natural rate of unemployment is u^* and the real wage is $(w/p)^E$. If the monetary authority fools workers such that $p > p^e$ by expanding money, then the expected supply wage relation shifts to the right as in Figure 2. In response to the monetary shock, the new equilibrium is that the actual unemployment rate decreases below the natural rate.

Figure 2. The Cyclical Unemployment Rate around the Natural Rate



5) We assume that the schedule for the demand wage relation is not changed by the monetary shock. That is, the firms would not confuse real and nominal wages. But the supply wage relation is changed. The key assumption is that workers confuse real and nominal wages.

As workers become to expect the price level, the expected real wage relation shifts to the left so that the actual unemployment rate reverses to the initial natural rate. Thus the cyclical unemployment around the natural rate occurs in responding to the monetary shock

III. The Estimation Method of the NAIRU

1. The Standard Model

The standard macroeconomic models(Blanchard and Katz(1997)) determine the natural rate through two equations ; the equation for demand wage relation, and the equation for supply wage relation. These equations can be written as

$$\Delta p_t = \alpha_p + \Delta w_t + \gamma x_t + \varepsilon_{pt} \quad : \text{demand wage relation}$$

$$\Delta w_t = \alpha_w + \Delta p_{t-1} + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \varepsilon_{wt} \quad : \text{supply wage relation}$$

where p is the logarithm of the price index, w is the logarithm of the wage index, so that Δp and Δw are price and wage inflation respectively, u is the unemployment rate, α_p and α_w are constants, ε_p and ε_w are error terms, x denotes additional control variables such as supply shocks.

Substituting Δw_t in the supply wage relation into the demand wage relation yields the so-called "Phillips curve" equation;

$$\Delta p_t = \alpha + \Delta p_{t-1} - \beta_1 u_{t-1} + \beta_2 u_{t-2} + \gamma x_t + \varepsilon_t$$

where $\alpha = \alpha_p + \alpha_w$, and $\varepsilon_t = \varepsilon_{pt} + \varepsilon_{wt}$.

To derive the natural rate of unemployment, we set $\Delta p_t = \Delta p_{t-1}$, $u_{t-1} = u_{t-2} = u^*$ and $x_t = x^*$. Then the natural rate of unemployment consistent with the nonaccelerating inflation can be expressed as $u^* = (\alpha + \gamma x^*) / (\beta_1 + \beta_2)$

Note that the NAIRU is a nonlinear function of regression coefficients β_1 , β_2 , α and γ . Thus the statistical precision of the NAIRU depends on that of the regression coefficients. Using Fieller(1954)'s method in constructing a confidence interval, Staiger Stock and Watson(1997) showed that the 95% of confidence interval for the NAIRU is so large that the precision of the NAIRU is dubious. This implies

that the monetary authority should be cautious in performing monetary policy based on the estimate of the NAIRU. Other leading indicators of inflation may be better in predicting the inflation rate than the unemployment.

2. The Estimation of a Time - Varying NAIRU

The basic framework for the estimation of the time - varying NAIRU suggested by Gordon (1997) is as follows;

$$\pi_t = \alpha(L) \pi_{t-1} + b(L) (U_t - U_t^N) + c(L) z_t + e_t$$

$$U_t^N = U_{t-1}^N + \varepsilon_t$$

Here, the dependent variable π_t is the inflation rate. Price inertia is conveyed by the lagged rate of inflation π_{t-1} . U_t is a unemployment rate (U_t^N is a natural rate). z_t is a supply shock variable (when a supply shock is absent, $z_t = 0$). L is a polynomial in the lag operator. e_t is a serially uncorrelated error. ε_t is a stochastic variable with a mean of zero and a standard deviation of σ_ε .

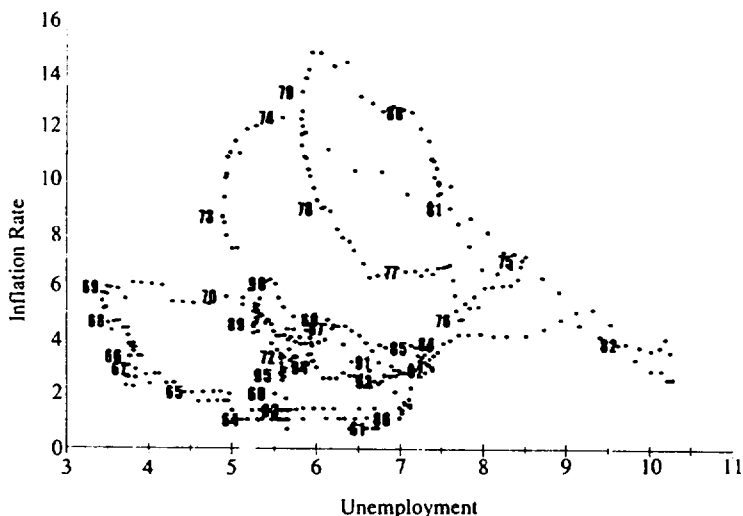
Above framework is simply to combine the traditional "Phillips curve" reduced form with the natural rate which follows the first order markov process. Note that when the standard error $\sigma_\varepsilon = 0$, the natural rate is constant. The more variability of the NAIRU is generated when the standard deviation is large. If the NAIRU could vary without limit, the time - varying NAIRU would fluctuate up and down and absorb all the residual variability in the inflation equation. This standard "stochastic time - varying parameter regression model" can be estimated using maximum likelihood methods described by Hamilton (1994). Similar approach to estimate the NAIRU was found in King, Stock and Watson (1995), and Staiger, Stock and Watson (1996).

Gordon (1997) ruled out the highly zig - zags time varying NAIRU by assuming appropriate standard error.⁶⁾ Of course, this is based on the sense of economics rather than the statistical sense.

6) He argues that the zig - zags in the series of the NAIRU assuming a standard deviation of 0.4 seem implausible. Instead of a large standard error (0.4), he has chosen the smaller standard of 0.2 which generates the smooth zig - zags in the movements in the NAIRU. His smoothness prior in estimating the timevarying NAIRU is based on the definition of the natural rate : To paraphrase Friedman, if the natural rate is viewed as "ground out" by the labor market institutions, it should shift slowly.

IV. The NAIRU and Macroeconomic Policy

Figure 3. Inflation and Unemployment
(12-month moving averages, 1960-1996)



Source : Galbraith James K., *Journal of Economic Perspectives*, Winter 1997, 11 - 1, pp. 93 - 108.

The mainpoint of Friedman's argument on the vertical long-run Phillips curve is that even though short-run trade off between the inflation and the unemployment is possible by the aggregate demand shock, this trade off disappears, eventually resulting in the accelerating inflation. Obviously this long-run situation induced by the aggregate demand control has become worse than the original situation in welfare sense; Given the Natural Rate, the higher level of inflation yields the higher loss in the society's welfare.

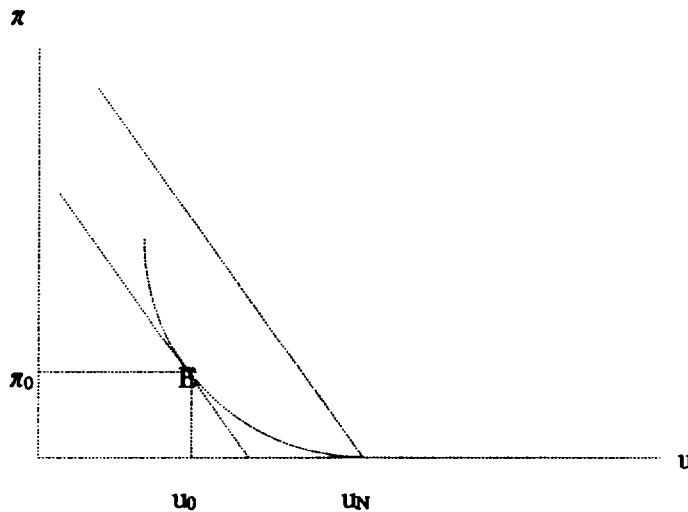
Contrary to this accelerationist view, the evidence was that the economy experience a slight dose of inflation, not the ever-increasing levels of inflation, and that the magnitude by which inflation rises does not increase when the unemployment rate is held down for a prolonged period of time. In short, this evidence does not preclude the stable "Phillips curve".

In the 1960s, the Phillips curve in the United States was convex as shown in Figure 3. The convexity of the Phillips curve is that the costs of employment in

terms of inflation will increase as expansions policy is continuously pursued. In this environment, if the government contracts the economy to increase the unemployment rate closer to the NAIRU, the economy confronts the larger unemployment rate with the smaller decrease in the inflation rate. Conversely if the government continues to expand the economy below the natural rate, the cost of expansions in terms of the resulted inflation will be larger. Then the risk-neutral policy maker would be averse to exploiting the Phillips curve.

Figure 4. illustrates the case for the convexity of the "Phillips curve". In Figure 4, the convex curve is the Phillips curve, and the straight line is the level line with the loss function being constant; we can define the loss function in terms of unemployment rate (u) and the inflation rate (π). If a policy maker is risk neutral, then the level curve should be a straight line in (u, π) plane.

Figure 4. The Convex Phillips curve and Macroeconomic implication



Suppose that the economy's initial situation is in that of the natural rate and zero level of inflation. Then there is an incentive for a risk-neutral policy maker to move to the other point (such as the point E) on the convex Phillips curve. By doing that, the economy reduces the loss in welfare sense. Once the economy reaches the desirable point such as the point E, there is no incentive for a policy maker to pursue any expansion or contraction policy. In Contrast to this, if the

Phillips curve is linear, a risk-neutral policy maker can exploit the Phillips curve trade-off to locate the inflation and the unemployment rate which are different from the current combination without any cost.

Stiglitz(1997) and others argued that there are some evidences that the Phillips curve might be concave. The concavity of the Phillips curve is that the employment cost in terms of the inflation becomes smaller as the expansion policy is pursued. This concavity is consistent with the costly price adjustment in New Keynesian literature. In monopolistically competitive market, facing with the kinked demand curve, firms are reluctant to raise prices even in the face of rising prices. In case of concavity of Phillips curve, even risk-averse policy makers might want to lower the unemployment rate without relatively much higher increase in the rate of inflation.

V. Conclusion

We have reviewed some theoretical developments to identify and quantify the determinants of the NAIRU since Friedman(1968). Hall(1979)'s focus on the flow mechanisms in the labor market has clarified the determinants of the NAIRU; Labor market institutions (such as legal restrictions, or unemployment insurance system) determine the job-finding rate and the job-separation rate which generates the natural rate. The institutional change in labor markets may change the level of the NAIRU. But Hall's framework for the natural rate has some flaws in the theoretical point of view. It can't explain why there is unemployment in the first place. Furthermore, this kind of the natural rate would not be the efficient level of unemployment.

There are several approaches in explaining the wait unemployment in the first place : The efficiency wage hypothesis, matching approach, and etc. Among them, efficiency wage hypothesis is that firms may want to pay workers more than the market equilibrium wage to increase the productivity. Thus, involuntary unemployment occurs. Along these lines, Shapiro-Stiglitz's model(1984) was striking. Under the competitive labor market, all homogenous workers who are going to accept the

given equilibrium market wage are always hired. If a worker is fired for some reasons, he will be rehired without any adjustment costs.

To prevent the shirking behavior of a worker, the firm should pay more than the going wage. Facing with the same situations, all firms should pay above the market clearing wage. The equilibrium level of unemployment occurs in this way.

Following Blanchard and Katz(1997)'s exposition for the determination of the NAIRU, we have done some simple comparative static analysis.

We have also reviewed some statistical implementation to estimate the level of the NAIRU. Even though there are some problems in estimating the precise NAIRU, we can not desert the usefulness of Phillips curve trade off in performing monetary policy. Of course, policy makers should consider other leading indicators besides unemployment in predicting inflation rate.

Given the curvature of the Phillips curve, we have discussed the macroeconomic policy implication. For example, if the Phillips curve is concave, even risk - averse policy maker might want to lower the unemployment rate without much higher increase in inflation.

References

- Blanchard, Olivier, and Lawrence Karz, "What We Know and Do Not Know About the Natural Rate of Unemployment," *Journal of Economic Perspectives*, Winter 1997, 11-1, pp.51-72.
- Fieller, E. C., "Some Problems in Interval Estimation," *Journal of the Royal Statistical Society*, 1954, 16:2, pp.175-85.
- Friedman, Milton, "The Role of Monetary Policy," *American Economic Review*, March 1968, 68, pp.1-17.
- Gorden, Robert J., "The Time - Varying NAIRU and its Implications for Economic Policy," *Journal of Economic Perspectives*, Winter 1997, 11-1, pp.11-31.
- Hall, Robert E., "A Theory of the Natural Rate of Unemployment and the Duration of Unemployment," *Journal of Monetary Economics*, April 1979, 5, pp.153-69.
- Katz, Lawrence, "Efficiency Wage Theories : A partial Evaluation," *NBER Macroeconomics Annual*, 1986, 1, pp.235-76.
- King, Robert G., James H. Stock, and Mark W. Watson, "Temporal Instability of the Unemployment - Inflation Relationship," *Economic Perspectives of the Federal Reserve Bank of Chicago*, May/June 1995, 19, pp.1-12.
- Layard, Richard, Stephen Nickell, and Richard Jackman, *unemployment : Macronomic Performance and the Labor Market*. New York : Oxford University Press, 1991.
- Mortensen, Dale, and Christopher Pissarides, "Job Creation and Job Destruction in the theory of Unemployment," *Review of Economic Studies*, July 1994, 61:3, pp.397-416.
- Phelps, Edmund, "Money - Wage Dynamics and Labor - Market Equilibrium," *Journal of Political Economy*, July/August 1968, 76, part 2, pp.678-7121.
- Phillips, A. W., "The Relation Between Unemployment and the Rate of Change of Money Wages in the United Kingdom, 1861-1957," *Economica*, November 1958, 25, pp.283-99.

Shapiro, Carl, and Joseph Stiglitz, "Equilibrium Unemployment as a Discipline Device," *American Economic Review*, June 1984, 74, pp.433-44.

Staiger, Douglas, James H. Stock, and Mark W. Watson, "The NAIRU, Unemployment and Monetary Policy," *Journal of Economic Perspectives*, Winter 1997, 11-1, pp.33-49.

Stiglitz, Joseph, "Reflections on the Natural Rate Hypothesis," *Journal of Economic Perspectives*, Winter 1997, 11-1, pp.3-10.