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SUPPLY CONSTRAINTS ON EMPLOYMENT AND OUTPUT:  
NAIRU VERSUS NATURAL RATE

James Tobin

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International Conference in memory of Fausto Vicarelli,  
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"Theory, reality, and social commitment: the economist's stance"

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ABSTRACT

NAIRU and NATURAL RATE are not synonymous. NAIRU is a macro outcome of an economy with many labor markets in diverse states of excess demand and excess supply. NAIRU represents an overall balance between the inflation-increasing pressures from excess-demand markets and the inflation-decreasing pressures from excess-supply markets. The natural rate, as described by Friedman, is a feature of Walrasian market-clearing general equilibrium. While the NAIRU fits into a Keynesian model, the natural rate is an aspect of a New Classical model. The determinants of the two are theoretically different, and so are their implications for policy. The NAIRU varies from time to time as the relationships between unemployment, vacancies, and wage changes vary, and as the dispersion of excess demands and supplies across markets changes. In this decade, these developments appear to be reducing the NAIRU, in contrast to the unfavorable circumstances of the 1970s.

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"Potential output" and the two-regime model

Every macroeconomic theory needs a concept of the economy's productive capacity, the overall constraint on the effectiveness of increasing aggregate demand in increasing actual output and employment. This is not a technocratic physical limit, such as could be relevant to a wartime emergency. In the United States in World War II the entire population was working overtime, unemployment was 1 percent, plants were operating on shifts around the clock, and quantitative controls dictated by central government priorities displaced market prices and wages in allocating resources. This regime performed miracles. In 1944 nearly half the GNP was commandeered for war, and the remainder was greater than the entire prewar GNP. Clearly this kind of economy is infeasible in peacetime.

What we mean by potential GDP in peacetime is what a market economy, without rationing and other quantitative controls, with households and businesses making most of the decisions affecting prices and resource allocations, can produce. Accordingly capacity Net Domestic Product is sustainable GDP minus allowance

for the depreciation and depletion of productive resources. These are not unambiguous concepts, because there is generally no sharp dividing line beyond which additions to demand cease to induce response in increased production.

That is why it is natural to define the capacity constraint in terms of the effects of additional demand on prices (including nominal wage rates). In Keynes's General Theory (1936), potential output corresponds to full employment of labor, and the tell-tale symptom of excess demand is inflation. In the General Theory, any stable level of aggregate demand and output short of full employment will be accompanied by stable prices. However, moving closer to full employment would raise prices. That is, the stable price level will be higher at a higher stable aggregate demand level. The picture is asymmetrical. Deflationary gaps in demand show up in shortfalls of actual output from full employment output but not in prices, whereas inflationary gaps of demand affect prices but not output. The notion that the economy can be in either of these two regimes, demand-constrained or supply-constrained is, an important and useful doctrine, central to Keynes's thought and to the meaning of the word "general" in his title. Of course, he believed that mature capitalist economies are usually demand-constrained.

### **Cost-push, demand-pull, and Phillips**

In the middle 1950s American experience posed problems for this Keynesian model. Inflation arose and persisted at levels of GDP and employment that, on the basis of earlier observation, were thought to be well short of full employment. This inflation was dubbed **cost-push** in distinction to the inflation we economists thought we understood, **demand-pull**. Naming a phenomenon does not explain it, and there was no theory of cost-push inflation.<sup>1</sup>

Then came A.W. Phillips (1958) and his curve.<sup>2</sup> Stretched far beyond the author's intentions, this seemed to blur the distinction in a sensible way. The strength of cost-push depends on the pull of demand, as measured by the gap, positive or negative, between capacity output and actual output. That gap, in turn, is closely related to the unemployment rate, a relationship quantified by Arthur Okun for the Council of Economic Advisers in 1961. (Economic Report of the President 1962, 49-56; Okun 1962) The Phillips curve provided a continuous relationship of wage

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<sup>1</sup> Charles Schultze (1959) examined the supposed two kinds of inflation and concluded that the problem was the sensitivity of key industrial sectors to increases in demand when the economy as a whole was not at full employment, plus the asymmetrical insensitivity of prices and wages to decreases in demand.

<sup>2</sup> Irving Fisher (1925 and 1926) anticipated Phillips, showing with American data that the price changes and either the volume of trade or the volume of employment were negatively correlated. These articles were scarcely noticed, while Phillips's article came at a time when the subject was at the forefront of professional and political attention.

inflation to unemployment. Assuming that prices of value added are normal labor costs per unit output marked up to cover fixed costs and capital costs, price inflation mirrors wage inflation less the trend of productivity growth.

One trouble with this development was that it left full employment undefined. Should it correspond to the unemployment rate at which wage inflation would just equal productivity growth, so that price inflation would be zero? This definition just revived the original problem: GDP at that unemployment rate didn't look and feel like full employment. But if full employment was further up the Phillips curve, how far? And wouldn't the Keynesian hypothesis that prices are stable when demand falls below full employment GNP have to be abandoned? Or alternatively the notion of a sharp dividing line between the two regimes, demand-determined and supply-determined, could be discarded in favor of the idea of a zone of more and less full employment.

### **The Price-Wage Feedback**

Phillips himself, Lipsey (1960), Samuelson and Solow (1960), and many other economists who adopted the Phillips curve recognized that wage inflation, a determinant of price inflation, would itself be affected by price inflation. There are two reasons for this reverse effect: workers seek compensation for increases in consumer prices, and employers are more willing to pay higher nominal wages when product prices are higher. In the early 1960s statistical Phillips curve fits on American postwar

data were very good. When lagged price inflation was added as a regressor, its coefficient was significant but also significantly less than one. The notion of a long-run Phillips curve, the locus along which the dependent variable wage-change was the same as the independent variable price-change minus the productivity trend, was introduced. The long run curve was steeper than the short run Phillips curve, which assumed the inflation feedback term to be constant. As years passed and added observations in more inflationary environments, estimates of the feedback coefficient gravitated to one, making the long-run Phillips curve vertical and undermining the notion of a policy tradeoff between unemployment and inflation popularized by Samuelson and Solow (1964).

#### **The natural rate**

Came then the natural rate of unemployment. Phelps (1967) and Friedman (1968) maintained that rational behavior precluded any long-run tradeoff, a conclusion strengthened by regarding the inflation term on the right hand side of the Phillips wage equation as expectation rather than sluggish adjustment, and as rational rather than adaptive expectation. Thus was the sharp dividing line earlier provided by Keynes's concept of full employment restored, but in new guise with important differences. At Friedman's natural rate of unemployment, Friedman's full employment, it is not the price level but the inflation rate that is stable. The rate is determined by the growth in money supply

and in nominal aggregate demand, possibly but not necessarily zero. Friedman's price dynamics are, unlike Keynes's, symmetric: when monetary policy produces unemployment less than the natural rate, inflation increases without limit, and when monetary policy produces unemployment unnaturally high, inflation decreases indefinitely.

Friedman describes the natural rate of unemployment as "the level that would be ground out by the Walrasian system of general equilibrium equations, provided that 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 costs of getting information about job vacancies and labor availabilities, the costs of mobility, and so on." By characterizing the natural rate as Walrasian equilibrium, Friedman endows it with the usual optimal properties. The proviso is understandable, if not excusable. Without the non-Walrasian elements listed, the natural rate would be zero; if markets cleared, there would be no unemployment and no unfilled vacancies. But the proviso is a tall order. Generations of economists have not found an equilibrium system that embeds all those bothersome phenomena.

Keynes too recognized that there would be non-zero unemployment -- frictional unemployment -- at what he called full employment. He too finessed explanation of the size of frictional unemployment. He regarded full employment as optimal: "...I see no reason to suppose that the existing system seriously



misemploys the factors of production which are in use...It is in determining the volume, not the direction, of actual employment that the existing system has broken down." (Keynes, 1936. p. 379) Keynes identified full employment with the "classical" equilibrium of the aggregate labor market, defined as that volume of employment at which the marginal product of labor equals the real wage equals the marginal disutility of work. Unlike Friedman, of course, Keynes regarded involuntary unemployment, the demand-constrained regime, as the usual state of affairs.

Friedman was a short step away from the New Classical doctrine that markets are continuously clearing and grinding out optimal moving equilibria solving the Walrasian equations. That leads to the conclusion that actual unemployment, whatever it is, is natural or "full." I recall seeing in 1982 a message on the blackboard in the economics graduate students' lounge at Stanford saying "The Bureau of Labor Statistics announced this morning that the natural rate of unemployment is now 9.4 percent."

#### **The NAIRU**

Franco Modigliani, I believe, originated the NAIRU concept -- Non-Accelerating-Inflation Rate of Unemployment. (Modigliani and Papademos 1976) At first he called it simply NIRU, Non-Inflationary Rate of Unemployment. Somehow it got changed in common usage, presumably to reflect better the "accelerationist" theory. I believe that the whole purpose of the concept was to escape the normative equilibrium connotations of the natural

rate. The NAIRU is, like full employment, a barrier to expansion of demand and in some sense a boundary between regimes. But it need not be the best of all possible worlds, and departures from it need not have Friedman's dynamic consequences. It is a mistake, I think to regard NIRU or NAIRU just as neutral synonyms of natural rate.

My own interpretation of the difference between NAIRU and natural rate is as follows:

The NAIRU does not assume a Walrasian equilibrium, in which markets, in particular labor markets, are being cleared by existing prices and wages. Instead it assumes an economy in which at any time most markets are characterized by excess demand or excess supply at prevailing prices. Applied to labor markets, excess demand means a preponderance of job vacancies over unemployment, and excess supply means the opposite. The distribution of markets, weighted by the number of workers or jobs in them, depends systematically on the strength of aggregate demand relative to potential GDP. That is, the weighted number of excess demand markets, relative to excess supply markets, will be greater the higher is aggregate demand.

The NAIRU is the unemployment rate at which the inflation-increasing effects of the excess-demand markets just balances the inflation-decreasing impacts of the excess-supply markets. Unlike the natural rate, this is a balance among disequilibrium markets, a stand-off between those in excess demand and those in excess supply. The existence of markets in diverse circumstances is

essential for the NAIRU. Unlike the natural rate, the NAIRU could not be modelled as a single economy-wide market or representative agent.

The distribution of these markets as function of aggregate real demand I take to be a characteristic of an economy that remains fairly constant within the time span of a business cycle and indeed changes only slowly from cycle to cycle. However, this does not mean that the identities of the markets within the distribution is constant or slow-changing. Markets are always interchanging places, as a result of never-ceasing inter-sectoral flux of microeconomic demands and supplies. This flux is quite consistent with the maintenance of a fairly stable macroeconomic environment.

### **The Beveridge Curve**

A Beveridge curve plots, for the economy as a whole, Vacancies against Unemployment, both as percentages of labor force. Observed Beveridge curves can be thought to be generated by the multi-market disequilibrium model just described, in the following way. It is convenient to think of each market at a given time as characterized by either vacancies or unemployment (or by neither) but not by both at the same time. Indeed that might be the definition of an atomic market. Then for the economy as a whole vacancies are the sum of excess-demands over all excess-demand markets, and unemployment is the sum of excess supplies over all excess supply-markets. As aggregate demand is

hypothetically raised from low to high, relative to potential output, excess supplies fall, excess demands rise, and markets move from excess-supply to excess-demand status. Consequently total vacancies increase and total unemployment decreases. The resulting Beveridge Curve is downward sloping, and in practice concave. (Figure 1).

The coexistence of unemployment and vacancies is a sign of frictional unemployment, which could be measured in principle as the amount of unemployment at the point on the curve where  $V=U$ . Beveridge (1945) didn't invent the curve that bears his name, but he did define full employment as a situation in which unemployment is less than vacancies.

A movement along a Beveridge curve up and left arises from expansion of aggregate demand. An outward and upward shift of the curve increases frictional unemployment and raises the rate of vacancies associated with any given rate of unemployment. This might come about from an increase in the dispersion of excess demands and supplies across the markets, because of less efficient matching by labor markets or because of slower response of workers in moving from weak to strong markets. "Structural unemployment," the label frequently given to unemployment not remediable by aggregate demand, might be an extreme case of frictional unemployment.

### **The NAIRU and the Phillips Curve**

A Phillips curve plots, for the economy as a whole,

percentage increase in average wage rates against the economy-wide unemployment rate. Observed Phillips curves can be regarded as having been generated by the same model that generates the Beveridge curve. For each market there is a function that translates excess demand or supply into a market-specific wage change to which is added the common ongoing average wage change. (Figure 2 shows wage change in a single market as a function of excess demand or supply in that market. For each level of aggregate demand there is a point on the Beveridge curve and also a corresponding average wage change, which can be plotted either against the aggregate unemployment rate, as does the Phillips curve, or against aggregate vacancies. Since vacancies and unemployment are symmetric indicators of disequilibrium, it is logical to associate wage pressures with both of them. Just as unemployment might be expected to induce workers, individually or collectively, to moderate the terms on which they are willing to work, so vacancies might be expected to induce employers to bid higher for labor. See Baily and Tobin (1977) for statistical wage-change regressions on both vacancies and unemployment. An upward shift in the Beveridge curve, signifying an increase in frictional unemployment, should mean an increase in the wage inflation associated with a given rate of unemployment.

The old-fashioned neoclassical view of the mechanics of adjustment to excess supply or demand in individual markets was simply that prices would rise or fall as a positive function of excess demand (regarding excess supply as negative excess

demand). Traditionally, this was just assumed to be a plausible characteristic of competitive markets, but it is also a likely implication of models of optimal price and quantity adjustments by individual market participants. In any case, the average wage increase would be greater the more the distribution of labor markets was weighted in favor of excess-demand markets. Phillips (1928) and Lipsey (1960) took this approach as the obvious logic of the Phillips curve.

In addition, there would usually be in each market a non-zero wage increase or decrease related to the growth of productivity in that market and to the ongoing economy-wide pattern and expectation of wage and price inflation or deflation. This would occur in the absence of excess demand or supply.

The NAIRU is the rate of unemployment that generates no change in the average wage change. At the NAIRU the excess-demand and excess-supply markets' components of wage change average to zero. Does this model imply that the "long-run" Phillips curve is vertical at the NAIRU, just as it is vertical at the natural rate in the Friedman-Phelps model? The answer is "not always." The multi-market stochastic macro-equilibrium model allows for a different possibility, about to be explained.

#### **Nominal wage stickiness and the costs of zero inflation.**

An important difference of Keynesian from neoclassical economics is that Keynes was explicitly describing a monetary economy, in which markets set nominal prices. Neoclassical

economics is a theory of real or relative prices, essentially multilateral barter. Dudley Dillard (1988) convicted it of "barter illusion." Keynes considered it likely that adjustments of money wages to excess demand or supply would be sluggish, especially downward wage adjustments to excess supply of labor. This should not be considered as money illusion or as a characteristic of market-clearing equilibrium in any individual market or of Walrasian equilibrium in the whole economy.

Empirical evidence for downward wage stickiness is overwhelming. Availability of replacement workers outside the factory gate is almost never an occasion for employers to cut wages. At the same time, there is evidence that nominal wages will give way to save insiders' jobs when the employing company can convincingly claim financial distress and can threaten imminent shutdown. Perhaps the Phillips curve is a reclining "S", with a long fairly flat middle, between sharp rises in inflation at low unemployment and falls at very high unemployment.

In Tobin (1972) I set forth a model of temporary downward nominal wage rigidity, namely that a market's wage change would be the maximum of 0 and  $w^*$ , where  $w^*$  is calculated from the formula above, shown in Figure 2, the sum of the change related to excess supply or demand and the common economy-wide pattern, but could be zero continuously for only a finite time. Thus if a market remained in a situation of large excess supply and  $w^*$  negative, eventually the money wage would fall and this source of unemployment-inflation trade-off would cease. However, if

microeconomic flux always puts another market into a similar excess-supply situation, some element of downward rigidity is always there, enabling an increment of aggregate demand to reduce unemployment permanently while increasing inflation permanently, or making a permanent increase of unemployment a cost of lowering the ongoing inflation trend.

This curvature in the long-run Phillips curve exists only at low inflation rates. If the economy's average wage inflation is high enough, there will never be any real wage adjustments in any markets that cannot be made without negative wage change, simply by falling behind the general pattern.

A recent paper at the Brookings Institution (Akerlof, Dickens, and Perry, 1996) presents a similar model, and estimates and tests it empirically, finding that the model even explains the combination of rising unemployment and galloping deflation in the Great Depression in the United States. The authors estimate that at present pushing the price inflation trend in the United States to zero from three percent would cost an additional full point of unemployment every year. By Okun's law, this is a permanent 2 or 2.5 percent loss of GDP. This Brookings paper seems to be tempering the enthusiasm for literal price stability in the United States.

#### **Uncertainty about NAIRU and Policy Tradeoffs**

Where the NAIRU is at any given time is quite uncertain. Evidently it rose in the United States after the 1960s, when 4



percent seemed a good guess. NAIRU was widely estimated as 6 percent at the beginning of the 1990s. This was the Federal Reserve's belief. But the Fed has allowed unemployment to decline almost to 5 percent during the present recovery without hitting the monetary brakes. No significant inflationary consequences have followed. It seems that NAIRU has declined. Other indicators of labor market tightness -- a low help wanted index, a proxy for vacancies, and a low ratio of job leavers to job losers -- suggest that the current environment is like the 1960s, when the NAIRU was 5 percent or less. Figures 3 and 4,

Natural rate theory implied that there is no durable policy tradeoff between unemployment and inflation. New Classical Macroeconomics and Real Business Cycle Theory went one step further, asserting there is no temporary tradeoff either. Nominal stickiness is, as argued above, a reason for curvature of the long-run Phillips curve at low rates of inflation. In any case, the uncertainty of the location of the NAIRU, whether it is a constant or a function of the unemployment rate, is an independent source of policy tradeoff.

This tradeoff is between two risks. Associated with any actual unemployment rate and thus indirectly with the monetary policy that supports it, are a range of possible discrepancies of actual unemployment from the unknown NAIRU. If the NAIRU is higher than the actual rate, the cost is higher inflation. If the NAIRU is lower than the actual rate, the costs are the jobs and output unnecessarily forgone. The lower the actual unemployment

rate chosen, the more likely the first kind of error and the less likely the second kind. The central bank has to balance the probability-weighted disutilities of the two kinds of errors.

Events will provide information for a new policy decision. If, for example, more inflation occurs than the central bank bargained for, the policy-makers will presumably decide to aim for a higher unemployment rate. Some commentators appear to regard NAIRU as a threshold to a burst of wage-price spiral exceedingly difficult and costly to reverse. Worse yet, it may be like the virus of a dread disease, which doesn't break out for a long time. Accordingly they counsel a very conservative policy. But there is no convincing evidence of that kind of asymmetric discontinuity as between the two types of error.

#### **The need for active macro policy**

Do we need policy to stay at the NAIRU, that is to return to it promptly whenever an aggregate demand shock pushes the economy away from it? Or, if you prefer, is the natural rate equilibrium stable without the help of active monetary or fiscal policy? This is the big issue of macroeconomics, the debate between Keynes and Pigou, carried on by their followers. Does flexibility of nominal prices and wages guarantee that enough aggregate real demand is automatically restored to return the economy to full employment?

Much of the profession nowadays believes that years ago the Pigou effect or real balance effect settled that issue once and for all. However, I think Irving Fisher (1933) was right. I would

recast his argument in Keynesian terms. The propensity to spend from wealth is systematically greater for debtors than for creditors, enough so to overcome the small amount by which nominal creditor positions exceed nominal private debts, the monetary base plus part of other government debt. Moreover, Fisher was right too that the process of deflation is like an increase in the real rate of interest and is devastating for demand for goods and services. The dynamics of the relation of aggregate demand to disinflation and inflation may well be destabilizing. As Keynes argued, there are good reasons for stickiness of nominal wages; it is not money illusion. At the same time, he argued, more flexibility of nominal wages may be ineffectual or even counterproductive.

No wonder that exponents of New Classical Macroeconomics and Real Business Cycle Theory evade the problem by assuming perfect flexibility in the sense of continuous instantaneous market clearing, so that excess demands and supplies never occur for even a second of real time. Actual is always Potential. Real demand shocks never occur; that is, incipient shocks are instantaneously absorbed by market-clearing price settings.

Since 1982 the Federal Reserve has fine-tuned its monetary policy, expressed in the Federal Funds rate on base money. As a result the U.S. economy recovered from the deep 1981-82 recession and a shallow 1990-91 setback, and achieved virtually full employment with low inflation, a macroeconomic performance much superior to that of Europe or Japan, where monetary policies are

much less activist and much more subservient to monetarism and New Classical theories, and much more dedicated to price stability to the exclusion of high employment and output. Actually the United States passes all the Maastricht tests, which no EU member save Luxembourg can meet.

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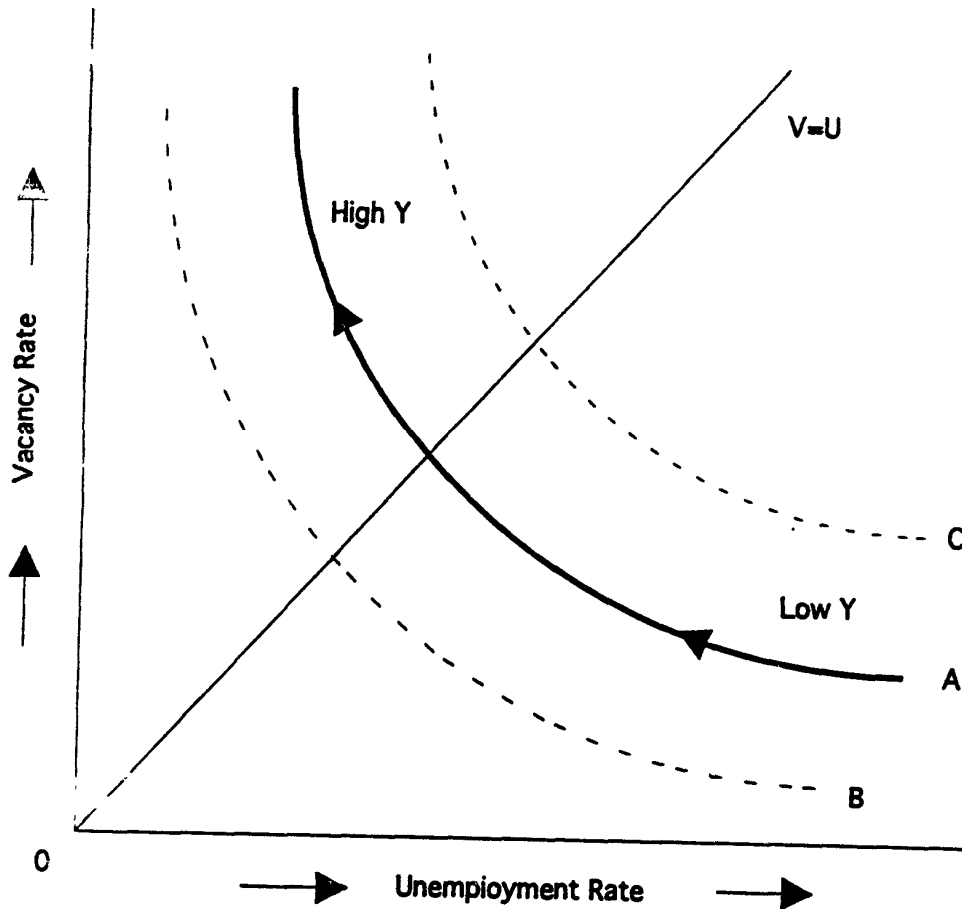
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Figure 1  
 BEVERIDGE CURVES IN THEORY



Points above the  $U=V$  line are full employment by Beveridge's criterion. (In practice, however, empirical measures of  $U$  and  $V$  are not commensurate. Indicated movement along curve A from low  $Y$  to high  $Y$  represents increase in aggregate real demand. Shift to curve C represents deterioration of labor market, leading to greater frictional or structural unemployment, likely also to an adverse shift in Phillips curve and NAIRU. Shift to curve A is benign.

Figure 2

Wage change as function of Excess Demand or Supply

$w$  is the ongoing average nominal wage change of the economy. To this is added or subtracted  $w_i^*$ , a function of Excess Demand or Supply in market  $i$ . As average wage-change rises or falls, point  $B$  moves with it. The function depicted is a broken line with a steeper slope for Excess Demand than for Excess Supply. This is realistic but inessential. Temporary resistance to negative  $w_i$  is indicated by substitution of  $ABCD$  for  $ABCE$  as the wage-change function.

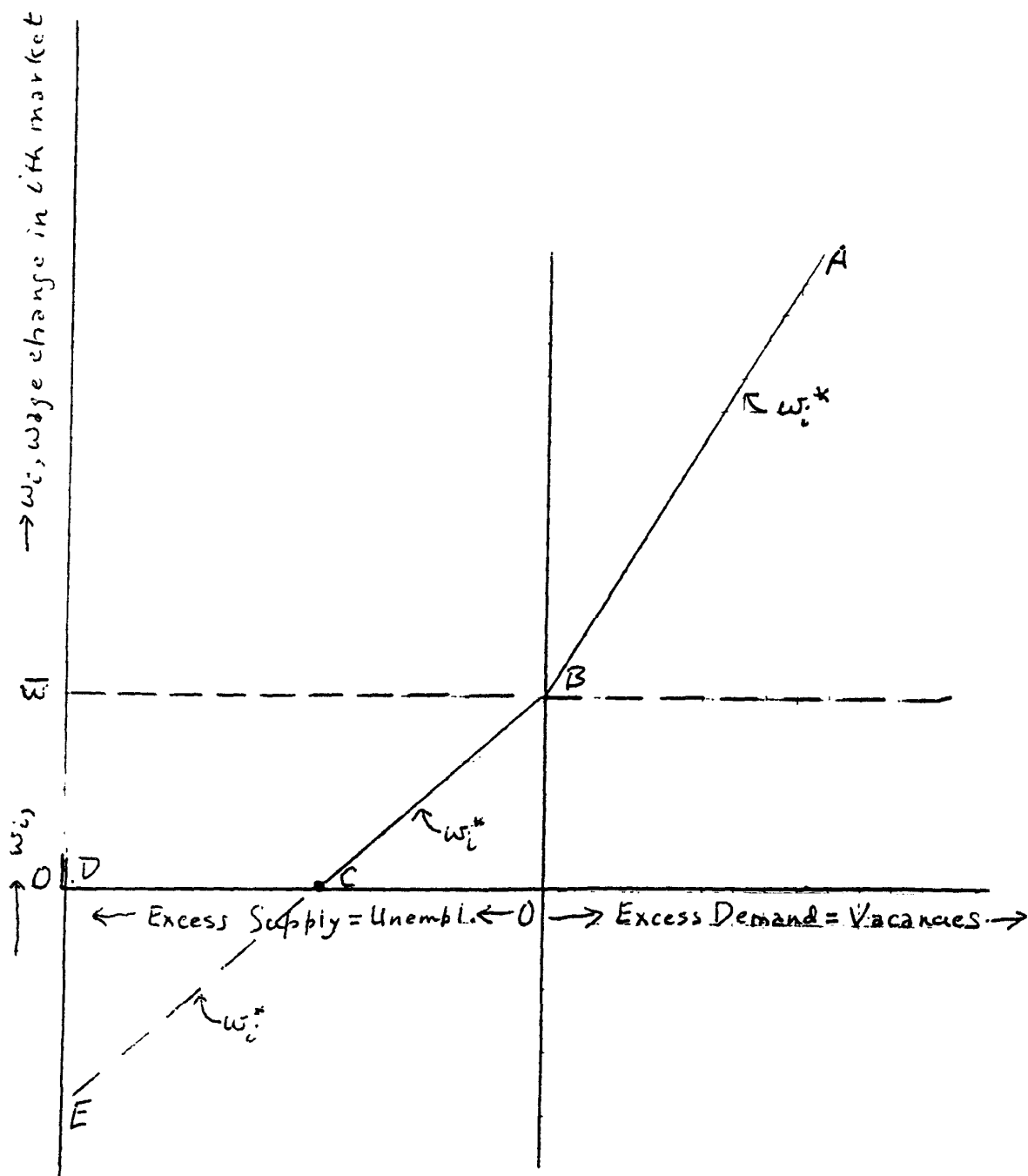




Figure 3

Empirical Beveridge Curve Points: U.S. 1956-95

The proxy for vacancies is the Help-wanted index relative to the labor force. The curve for the 1950s and 1960s was favorable for combining low vacancies with low unemployment and low inflation. The situation deteriorate in the 1970s, and the curve for the 1980s was unfavorable. However, in the 90s the curve appears to have shifted back to the benign curve of the 1960s.

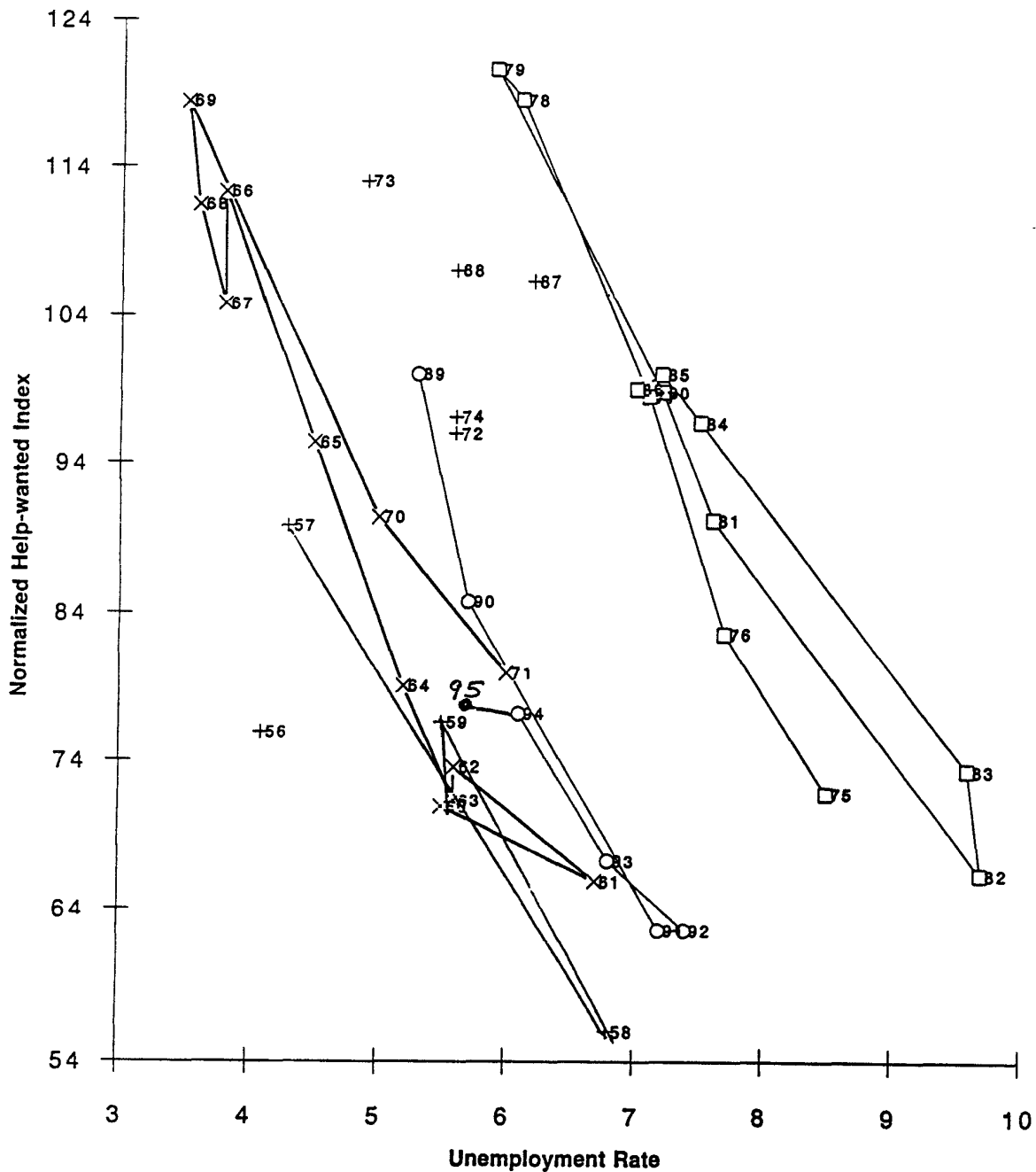


Figure 4

Job Leavers/Losers Ratio and Help-wanted Index, U.S. 1967-95

Unemployed workers are either leavers, who quit jobs voluntarily, or losers, who were laid off. When labor markets are tight, the leavers/losers ratio could be expected to be high because workers can quit with reasonable expectation of finding another job. The figure shows that this ratio confirms the message of Figure 3. The ratio has recently been rising but it is still in 1995 quite low considering how low unemployment is.

