

# ECONOMIC REVIEW

## 1998 Quarter 3

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## An Introduction to the Search Theory of Unemployment 2

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The search theory approach to understanding unemployment flourished during the 1980s and 1990s. It has provided economists with a rich set of models for analyzing unemployment and labor market issues more generally. Unfortunately, while economists have found modern search theory to be an invaluable tool, the insights provided by this approach remain largely unfamiliar to noneconomists. This review is an attempt to reach out to those readers who are interested in acquiring a modern perspective by providing an introduction to the search theory of unemployment.

## What Labor Market Theory Tells Us About the "New Economy" 16

by Paul Gomme

"New economy" proponents claim that favorable supply-side shocks have permanently lowered the nonaccelerating inflation rate of unemployment (NAIRU). If true, this would explain why inflation has not risen over the past couple of years, despite unemployment rates that are well below most NAIRU estimates. What does economic theory have to say about such claims? This article shows that a simple search model of unemployment predicts no long-term change in the NAIRU, although favorable supply shocks may lower the NAIRU over the short term. The key to this result is that workers change their reservation wage (the lowest wage that they will accept) in response to favorable developments in the distribution of wages. The article then considers some extensions that may allow supply shocks to lower the NAIRU permanently.

## Unemployment and Economic Welfare 25

by David Andolfatto and Paul Gomme

The rates of employment and unemployment are measures of labor market activity that have long been used as indicators of economic performance and welfare. Comparisons of these measures across different regions are typically based on the idea that low levels of employment and high levels of unemployment are associated with low levels of economic performance and general well-being. But in the absence of information concerning the economic circumstances that determine individual labor market choices, such comparisons are not justified. In this article, the authors develop a simple model of labor market activity designed to illustrate the tenuous link that exists between labor market choices and economic well-being.

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# An Introduction to the Search Theory of Unemployment

by Terry J. Fitzgerald

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## Introduction

On any given day, during economic busts and economic booms alike, millions of Americans are unable to find desirable employment despite their best efforts. Understanding the reasons for this fact is a chief concern for economists and policymakers, since it is necessary for designing good labor market policies. Unemployment not only creates hardships for those it encompasses, but it also *seems* to represent a vast pool of idle economic resources.

Classical labor theory is not well suited to thinking about unemployment, for within this framework the amount of labor that workers supply is exactly equal to the amount of labor demanded by firms at the equilibrium wage—therefore, there is no unemployment. This feature of classical theory has contributed to the historical interpretation of unemployment, or at least a portion of unemployment, as a disequilibrium or an involuntary phenomena. While such terminology has permeated discussions of unemployment, it has done little to enhance our understanding of the underlying determinants of unemployment or its behavior through time and across countries.<sup>1</sup>

A different approach to the study of unemployment, which sought to directly explain the frequency and duration of unemployment spells, took root during the 1970s. The building block of this approach is the simple observation that finding a good job (or a good worker, in the case of a firm) is an uncertain process which requires both time and financial resources. This assumption stands in contrast to the classical model, in which workers and firms are assumed to have full information at no cost about job opportunities and workers. The alternative approach, referred to as the *search theory of unemployment*, seeks to understand unemployment in the context of a model in which the optimizing behavior of workers and firms gives rise to an *equilibrium* rate of unemployment. Furthermore, it has the potential to explain the striking fact that while millions of workers are unemployed, firms are simultaneously looking to fill millions of jobs.

■ 1 See Rogerson (1997) for an excellent discussion of the language used to discuss unemployment.

The search theory approach to understanding unemployment flourished during the 1980s and 1990s. Incorporating the simple observation that searching is costly into a theory of labor markets has resulted in a rich set of models which have helped us not only to understand how unemployment responds to various policies and regulations, but also to gain a better understanding of other labor market issues including job creation and destruction, business cycle characteristics, and the effects of labor market policies on the aggregate economy more generally.

Unfortunately, while economists have found modern search theory an invaluable tool for understanding unemployment (as well as numerous other issues), the insights provided by this approach remain largely unfamiliar to noneconomists. This is partly a reflection of the old language of unemployment—terminology such as “full employment” and the “natural rate of unemployment”—continuing to dominate discussions of unemployment in the media and politics. This review is an attempt to reach out to those readers who are interested in acquiring a modern perspective on unemployment by providing an introduction to the search theory of unemployment.

In this article I present a model of job search and analyze how an unemployed worker’s decision environment affects not only her employment decisions, but also the overall level of unemployment.<sup>2</sup> The model focuses on an unemployed worker’s decision to accept an offered job or to continue searching for a better job. This is one of the earliest search models used in labor market analysis; its virtue is that it provides a simple framework capturing many of the central ideas upon which labor search theory is based, as well as interesting economic insights. Far richer models which capture many additional characteristics of labor markets have been developed, but these models are much more complex and will not be discussed here.

## I. A Model of Job Search

Consider an unemployed worker who is searching for a job by visiting area firms, looking through help wanted ads, etc. Although the worker likely has many job opportunities, she has incomplete information as to the location of her best opportunities. Hence, she must spend time and resources searching, and she must hope she has luck finding one of her better

opportunities quickly. In any given week the worker may receive a job offer at some wage  $w$ . The decision she faces is whether to accept that offer and forego the possibility of finding a better job, or to continue searching and hope that she is fortunate enough to get a better offer in the near future.

This scenario is captured in a model of job search using the following assumptions. First, each week the worker receives one wage offer. In order to capture the uncertainty of job offers, I assume that this offer is drawn at random from an urn containing wage offers between  $\underline{w}$  and  $\bar{w}$ . Draws from this urn are independent from week to week, so the size of next week’s offer is not influenced by the size of this week’s offer. While I will interpret draws as weekly wage rates, they can be thought of more generally as capturing the total desirability of a job, which could depend on hours, location, prestige, and so on. For simplicity, assume that all jobs require the same number of hours and are of the same overall quality, so that jobs differ only in terms of the wage.

Each week the unemployed worker must decide whether to accept the wage offer  $w$ , or to reject the offer and wait for a better one. If she rejects the offer, the worker receives unemployment income of  $w^u$  dollars and draws a new wage offer the following week. For simplicity, wage offers from previous weeks cannot be recalled and accepted, an assumption which has no impact on the worker’s decision to accept or reject this week’s offer. While I will interpret unemployment income  $w^u$  as being unemployment compensation, it may also include factors such as the pecuniary value of leisure and home production activities less the cost of searching.

If the worker accepts the wage offer, she continues to work at that wage until she is fired (assume that the worker cannot search for a better job during this time). An employed worker faces a constant probability  $\alpha$  of being fired at the end of each week. When an employed worker is fired, she becomes unemployed and begins searching for a new job the following week. Because an employed worker would never choose to quit her job in this model, I have omitted that possibility. Workers in the model are either employed or unemployed and actively searching for employment. No worker is out of the labor force (that is, not seeking employment).

■ 2 The presentation of the model in this paper was largely drawn from chapter 2 of Sargent (1987), which provides a more advanced overview of search theory. Insights into the model were also drawn from lecture notes provided by Randy Wright.

Workers seek to maximize the expected present value of their lifetime wage income, which is written as

$$(1) \quad E \sum_{t=0}^{\infty} \beta^t y_t,$$

where  $\beta$  is a discount factor between 0 and 1, and  $y_t$  denotes the worker's income in period  $t$ .<sup>3</sup> Note that  $(y_t = w^u)$  if the worker is unemployed, and  $(y_t = w)$  if the worker is employed at wage  $w$ . The factor  $\beta$  determines the rate at which workers discount their future earnings and can also be written as  $1/(1+r)$ , where  $r$  is a real rate of interest. While workers in the model have the good fortune of living forever, this assumption can be thought of as an approximation of the case where workers have many periods left to live.

Now consider the unemployed worker's decision problem in more detail. In evaluating a wage offer  $w$ , her decision will depend on how the current offer compares to other offers which she may receive. If the chances of receiving a substantially better offer next period are good, then the worker may choose to reject the current offer with the expectation of receiving a better one in the near future. A worker who rejects an offer foregoes income this week in the amount of the offer wage  $w$ , less the amount of unemployment compensation  $w^u$ . That loss must be balanced against the potential gain from receiving a higher wage offer next week, which the worker would receive in all future weeks until she is fired. In other words, the worker must compare the expected present value of her income if she rejects the offer with the expected present value of her income if she accepts the wage offer. As we will see, just how high the wage offer must be for the worker to accept depends on the exact shape of the wage offer distribution, the probability of being fired, the level of unemployment compensation, and the rate at which the worker discounts future earnings.

The specific mathematical structure of an unemployed worker's decision problem is laid out in the appendix, along with the description of a solution strategy. While the formulation of this problem makes use of mathematical techniques that are likely to be unfamiliar to non-economists, the underlying intuition of the problem is relatively straightforward and will be highlighted here. Recall that in making her decision, the unemployed worker must compare the expected lifetime incomes of accepting or rejecting a particular offer. I describe the unemployed worker's decision problem using

the following notation. Let  $v^{wait}(w)$  be the expected present value of lifetime income if she rejects a wage offer  $w$  and waits for a better offer; let  $v^{accept}(w)$  be the expected present value of lifetime income if she accepts  $w$ ; and let  $v^{offer}(w)$  be the expected present value of lifetime income upon drawing a wage offer  $w$ . Each of these three functions assumes that the unemployed worker will behave optimally (that is, makes the best decisions) in future periods so as to maximize expected lifetime income as given by (1).

First consider the value of rejecting an offer and waiting for a better offer:

$$(2) \quad v^{wait}(w) = w^u + \beta E v^{offer},$$

where  $E v^{offer}$  is the expected value of  $v^{offer}(w)$ . The value of waiting includes the unemployment compensation which the worker receives this week, plus the discounted expected value of drawing a new wage offer next week. Notice that  $v^{wait}(w)$  is a constant, which I will write as  $v^{wait}$ , since  $E v^{offer}$  does not vary with  $w$ . This reflects the fact that next week's wage offer is independent of this week's offer, so the value of rejecting an offer and waiting for a new offer is the same regardless of this week's offer.

Next consider the value of accepting a wage offer  $w$ :

$$(3) \quad v^{accept}(w) = w + \beta \alpha E v^{offer} + \beta (1 - \alpha) v^{accept}(w).$$

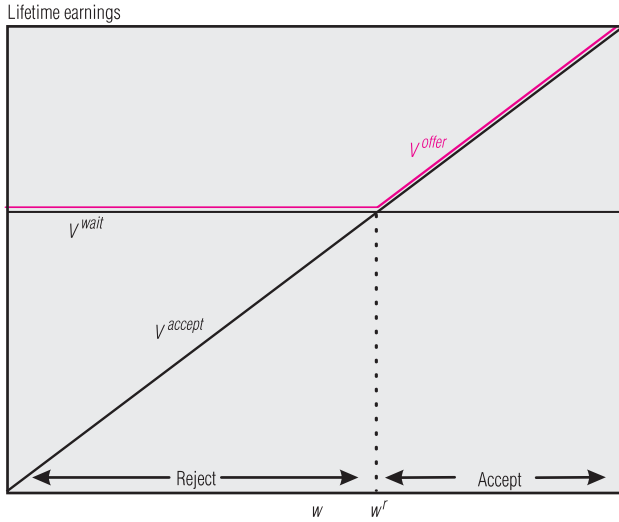
If the worker accepts a wage offer  $w$ , she receives income  $w$  this week. At the end of the week she is fired with probability  $\alpha$ , in which case she receives the discounted expected value of receiving a new offer next week,  $\beta E v^{offer}$ , or she continues on the job with probability  $(1 - \alpha)$ , in which case she receives the discounted value of accepting the same wage offer next week,  $\beta v^{accept}(w)$ . This equation can be rewritten

$$(4) \quad v^{accept}(w) = \frac{w + \beta \alpha E v^{offer}}{1 - \beta (1 - \alpha)}.$$

■ 3 The assumption that workers maximize expected lifetime income can be interpreted in several ways: 1) workers are risk-neutral, so they do not care about smoothing consumption; 2) workers are able to perfectly insure themselves against any idiosyncratic income risk, so the worker first maximizes expected income and then arranges her consumption stream so as to maximize utility; or 3)  $c$  and  $w$  can be reinterpreted as being the utility value of being unemployed and of working at a job with wage  $w$  respectively, in which case equation (1) can be reinterpreted as expected, discounted utility.

FIGURE 1

## Expected Lifetime Earnings



Notice that  $v^{accept}(w)$  increases linearly with  $w$ .

The problem for a worker with an offer  $w$  in hand is deciding whether to accept the offer, which has value  $v^{accept}$ , or reject the offer, which has value  $v^{wait}$ . The value of having an offer  $w$  in hand is given by

$$(5) \quad v^{offer}(w) = \max \{v^{accept}(w), v^{wait}\},$$

which takes into account that offers will be accepted only when accepting is more beneficial than waiting.

A solution to this problem is characterized by functions  $v^{offer}(w)$  and  $v^{accept}(w)$ , and a constant  $v^{wait}$ , that satisfy equations (2), (4), and (5). Associated with the function  $v^{offer}(w)$  is a decision rule which indicates whether the worker accepts or rejects each wage offer  $w$  between  $\underline{w}$  and  $\bar{w}$ . Unfortunately, computing these functions is not as straightforward as it might first appear. The function  $v^{accept}(w)$  and the constant  $v^{wait}$  which define  $v^{offer}(w)$  depend themselves on  $v^{offer}(w)$  through the term  $Ev^{offer}$ . None of these elements can be solved for independently.

To gain insight into the nature of the solution to the unemployed worker's job decision, it is helpful to graph  $v^{accept}(w)$  and  $v^{wait}$  against the value of the wage offer  $w$  (figure 1). The decision to accept or reject each wage offer  $w$  depends on whether  $v^{wait}$  is greater than or less than  $v^{accept}(w)$ . The figure shows that this decision takes a particularly simple form. For values

of  $w$  less than  $w^r$ ,  $v^{wait}$  is greater than  $v^{accept}(w)$ , so the worker is better off rejecting the offer. For  $w$  greater than  $w^r$ ,  $v^{wait}$  is less than  $v^{accept}(w)$ , so the worker is better off accepting the offer. The function  $v^{offer}(w)$  is defined by the maximum of these two functions, and is illustrated in blue. Notice that  $w^r$  will depend on the specific value of  $v^{wait}$  and the function  $v^{accept}(w)$ , which themselves depend on  $v^{offer}(w)$  through the term  $Ev^{offer}$ . Furthermore,  $Ev^{offer}$  depends on the value of  $w^r$ , and it will be helpful to make this dependence explicit by writing  $Ev^{offer}(w^r)$ .

The wage  $w^r$  is called the *reservation wage* and represents the lowest wage offer that an unemployed worker will accept. As I will show in the next section, the exact value of the reservation wage depends on the wage offer distribution, the firing rate  $\alpha$ , unemployment compensation  $w^u$ , and the discount factor  $\beta$ .

### Solving for the Reservation Wage

Next I briefly describe how to solve for the value of the reservation wage. As shown in figure 1, the reservation wage  $w^r$  is the value of  $w$  which satisfies

$$(6) \quad v^{accept}(w^r) = v^{wait}$$

or, using equations (2) and (4),

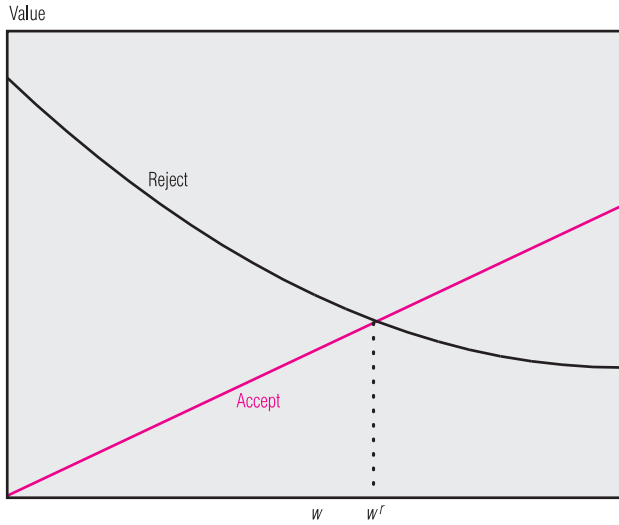
$$(7) \quad \frac{w^r + \beta\alpha Ev^{offer}(w^r)}{1 - \beta(1 - \alpha)} = w^u + \beta\alpha Ev^{offer}(w^r)$$

This expression says that the reservation wage is the wage at which the value of accepting the wage offer (the left side) is equal to the value of rejecting the offer (the right side). That is, the reservation wage is the wage at which the worker is just indifferent between accepting or rejecting the offer. Before we can solve this equation for  $w^r$ , we must first provide an explicit expression for  $Ev^{offer}(w^r)$ .

Obtaining an expression for  $Ev^{offer}(w^r)$  requires that I be explicit about the distribution of wage offers that are contained in the wage offer urn. Assume that these offers are uniformly distributed between  $\underline{w}$  and  $\bar{w}$ . This implies that all wages between  $\underline{w}$  and  $\bar{w}$  are equally likely to be drawn and makes the computation of  $Ev^{offer}(w^r)$  straightforward. It is proportional to the area under the  $v^{offer}$  curve between  $\underline{w}$  and  $\bar{w}$ . After doing some algebra, one finds that

FIGURE 2

### Determination of the Reservation Wage



$$(8) \quad Ev^{offer}(w^r) = \left( \frac{1}{1-\beta} \right) \left[ \frac{w^u + s(\bar{w} - w^r)^2}{2(\bar{w} - \underline{w})} \right]$$

where  $s = 1/(1 - \beta(1 - \alpha))$ .

Using equation (8) to substitute  $Ev^{offer}$  out of equation (7), one obtains a single equation containing  $w^r$ :

$$(9) \quad w^r = w^u + \left[ \frac{\beta(1-\alpha)}{1-\beta(1-\alpha)} \right] \frac{(\bar{w} - w^r)^2}{2(\bar{w} - \underline{w})}$$

However,  $w^r$  appears on both sides of this equation, so a little more work is needed.

To simplify notation in what follows, define a new function,

$$(10) \quad \varphi(w^r) \equiv \left[ \frac{\beta(1-\alpha)}{1-\beta(1-\alpha)} \right] \frac{(\bar{w} - w^r)^2}{2(\bar{w} - \underline{w})},$$

which is the second term on the right side of equation (9). This function can be interpreted as the expected benefit of drawing a new wage when the unemployed worker has an offer  $w^r$  in hand. Notice that this function is decreasing in  $w^r$ , which indicates that the expected gains from drawing a new wage diminish as  $w^r$  increases. If  $w^r$  is set to  $\bar{w}$ , this function is 0, reflecting the fact there can be no gain from drawing a new offer since  $\bar{w}$  is the highest possible wage. Equation (9) can be rewritten

$$(11) \quad w^r = w^u + \varphi(w^r).$$

I have arrived at a single equation, (11), which determines the value of the reservation wage  $w^r$  given values for all the parameters in the model. The left side can be regarded as the benefit of accepting a wage offer at the reservation wage. The more selective a person is (e.g., the higher her reservation wage), the higher the value of accepting a job offer at the reservation wage. Hence the left side of the equation is increasing in  $w^r$ . The right side can be regarded as the value of rejecting the offer and waiting. It includes the value of unemployment compensation  $w^u$  plus the expected gain from drawing a new age. The expected gain from receiving additional wage offers again depends on how selective the person is. The pickier she is, the lower the chances of getting such an offer and the lower the value of waiting. Thus the right side is decreasing in  $w^r$ . The equilibrium reservation wage is the wage at which the benefit of accepting is equal to the benefit of rejecting.

The next question to consider is whether a unique value of  $w^r$  exists which satisfies equation (11). Figure 2 graphs both sides of this equation. Denote the left side,  $w$ , the “accept curve,” and the right side,  $w^u + \varphi(w)$ , the “reject curve.” Since the accept curve is increasing in  $w$  and the reject curve is decreasing in  $w$ , the intersection of the two curves, if one exists, will be unique. However, there may not exist such a value. In this case the solution to the problem will correspond to a reservation wage of  $\underline{w}$  (or lower) or to a reservation wage of  $\bar{w}$  (or higher). In any case, the functions  $v^{offer}(\cdot)$  and  $v^{accept}(\cdot)$  and the constant  $v^{wait}$  which solve the problem are unique, as is the decision rule for accepting and rejecting wage offers within the set of possible wage offers. Figure 2 will be useful later when we discuss how changes in various parameter values impact the reservation wage.<sup>4</sup>

It is interesting to note that the reservation wage behavior of the unemployed worker in this model is observable in “real world” behavior. Each week many unemployed workers choose to continue their job searches even though they could accept low-paying jobs at, for instance, a local fast food restaurant. They obviously do so with the expectation that they will find a better job in the near future.

■ 4 Equation (9) is quadratic in  $w^r$ , and the quadratic formula can be used to directly solve for  $w^r$ .



## Unemployment Duration and Unemployment Rates

Although this model abstracts from the behavior of firms and the process by which the wage distribution is determined, unemployment durations and unemployment rates can be constructed nonetheless. First, assume that there are many identical workers in the model who act independently and have independent wage offer draws when unemployed. Also assume that the firing of employed workers occurs at the end of each week. At the beginning of the next week, each unemployed worker arrives at a firm, receives a wage offer  $w$ , and decides whether to accept or to reject that offer.

By setting the reservation wage  $w^r$  relatively high, the worker is less likely to receive an acceptable wage offer and will, on average, spend more time waiting for an acceptable offer than if she set  $w^r$  lower. The probability of accepting a wage offer, called the *job-acceptance rate* or the *hazard rate*, is simply equal to the fraction of offers greater than or equal to  $w^r$ . Let  $\psi$  denote the job-acceptance rate. Because the wage offer distribution is uniform,  $\psi$  is computed as

$$(12) \quad \psi = \frac{\bar{w} - w^r}{\bar{w} - \underline{w}}.$$

The average number of weeks it takes to receive an acceptable offer, referred to as the average waiting time, is given by  $(1/\psi)$ . Notice that if  $w^r$  is equal to  $\bar{w}$ , the job-acceptance rate is 0 and the average waiting time is infinity since there is zero chance of drawing  $\bar{w}$  from the uniform distribution. If  $w^r$  is equal to  $\underline{w}$ , the job acceptance rate is 1 and the average waiting time is one week. That is, a job is always accepted in the first week upon becoming unemployed.

Given the assumptions on the transition between employment and unemployment, the average duration of unemployment is the average waiting time less one week,  $[(1/\psi) - 1]$ . So, for example, if the job-acceptance rate is 1, then the average duration of unemployment is 0 weeks since all unemployed workers except a job offer at the beginning of the week. If the job-acceptance rate is 0.10, or one out of 10, then the average waiting time is 10 weeks and the average duration of unemployment is nine weeks.

The path of the unemployment rate through time can be computed for any given initial unemployment rate  $u_1$  as follows. Let  $u_t$  be the

fraction of workers who are unemployed during week  $t$  (the unemployment rate), and let  $L$  denote the total population. Total unemployment is thus  $(Lu_t)$ , while total employment is  $(L - Lu_t)$ . Given  $u_t$ , we can compute  $u_{t+1}$  by keeping track of how many workers enter and exit unemployment each week. This is expressed as

$$(13) \quad Lu_{t+1} = Lu_t(1 - \psi) + [(L - Lu_t)\alpha(1 - \psi)].$$

This equation says that total unemployment next week  $(Lu_{t+1})$  is equal to the number of unemployed workers this week who do not accept a job at the start of next week  $[Lu_t(1 - \psi)]$ , plus the total number of employed workers this week who are fired and do not accept a job at the start of next week  $[(L - Lu_t)\alpha(1 - \psi)]$ . This equation can be rewritten by dividing through by  $L$  and rearranging terms to get a simpler expression for  $u_{t+1}$ , referred to as the *law of motion* for  $u_t$ :

$$(14) \quad u_{t+1} = \alpha(1 - \psi) + [(1 - \psi)(1 - \alpha)]u_t.$$

Given any unemployment rate  $u_1$ , equation (14) can be used to compute the path of the unemployment rate through time. One property of this law of motion for  $u_t$  is that the unemployment rate converges to the same level for any given initial unemployment rate  $u_1$ . The unemployment rate to which these paths converge can be computed from equation (14) by setting  $u_{t+1} = u_t = u_s$ . Solving for  $u_s$  produces

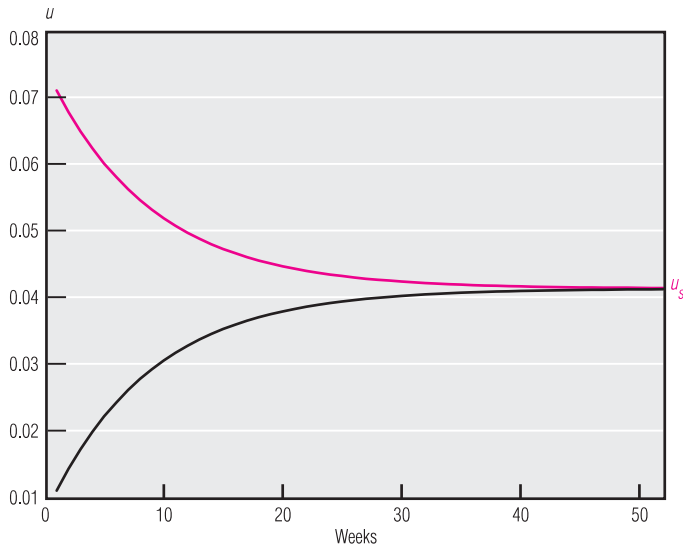
$$(15) \quad u_s = \frac{\alpha(1 - \psi)}{\alpha(1 - \psi) + \psi}.$$

The value  $u_s$  is the *steady state unemployment rate*. It is the point at which the flow of people into unemployment equals the flow of workers out of unemployment, so that the unemployment rate remains constant through time.

Notice that steady state unemployment depends only upon the firing rate  $\alpha$  and the job-acceptance rate  $\psi$ . It is easy to show that higher firing rates and lower job-acceptance rates each imply higher unemployment rates, results which match one's intuition. Remember that while the firing rate  $\alpha$  was exogenously given (that is, given as a parameter and not part of the solution), the job-acceptance rate  $\psi$  is endogenously determined (that is, not given as a parameter but part of the solution) and depends on all the parameters in the model. Thus, through  $\psi$  the steady state unemployment depends on all the parameters in the model.

FIGURE 3

## Unemployment Paths



At this point let me briefly return to two points raised in the introduction. First, notice that unemployment in this model arises solely from incomplete information about wages and jobs that is costly to acquire; unemployment here is not a disequilibrium phenomena. Unemployment occurs even though all workers behave optimally and results from the costly but socially beneficial activity of achieving good matches between workers and jobs. Second, the model illustrates that distinctions between voluntary and involuntary unemployment are unclear and not useful. Here unemployment is voluntary in the sense that workers choose to reject wage offers. But unemployment is involuntary in the sense that any unemployed worker (whom we know has only received wage offers less than  $w^r$ ) would prefer to switch places with any employed worker (who is receiving a wage of  $w^r$  or larger).

## II. A Numerical Example

In order to make the insights provided by this model concrete, it is helpful to work with a numerical example. Consider a distribution of wage offers that is uniform between 200 and 800. This means that an unemployed worker is equally likely to receive any wage offer between \$200 and \$800 per week, and implies an average wage offer of \$500. Let the firing rate

$\alpha$  be 0.005, or 1/2 percent per week, and the discount rate  $\beta$  equal 0.999, which corresponds to a 5 percent annual real interest rate. Lastly, set unemployment compensation  $w^u$  to \$200. After solving the model for these parameter values, I will discuss how the reservation wage, the average duration of unemployment, and the unemployment rate respond to changes in these values.

Take a guess at what the reservation wage is for this example. Will the worker hold out for a wage greater than \$500, the average wage offer? The answer is yes. In fact, the reservation wage  $w^r$  is \$737.62. If you think this number is surprisingly large, consider the fact that with a firing rate  $\alpha$  of 0.005, the average length of employment, which is given by  $1/\alpha$ , is 200 weeks or almost four years. This means that once a wage offer is accepted, the worker expects to receive that wage for the next four years—thus providing an incentive to hold out for a relatively high wage. Of course, every week an offer is rejected is a week with foregone wage income, so the worker doesn't hold out for \$800.

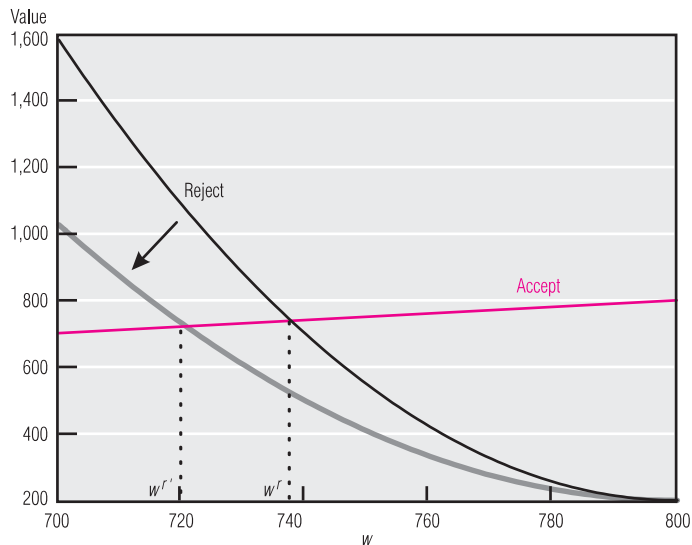
The job-acceptance rate for this example is equal to 0.104. This says that each week there is a 10.4 percent chance of receiving an acceptable wage offer—which is any wage greater than or equal to \$737.62. This job-acceptance rate implies an average duration of unemployment of 8.6 weeks.

Finally, the steady state unemployment rate is 0.041, or 4.1 percent. Figure 3 illustrates the time paths for two different initial unemployment rates, 7.1 percent and 1.1 percent. Each of these paths converges to the steady state rate of 0.041. As discussed in the previous section, this convergence to steady state occurs for any initial unemployment rate.

What causes the unemployment rate to be above or below the steady rate in the first period? Loosely speaking, one could imagine that a one-time unexpected shock hits the economy which changes the unemployment rate. For example, this could reflect a temporary increase (decrease) in the wage offer distribution, perhaps due to a productivity shock, which implies that more (fewer) wage offers are above (below) the reservation wage and thereby lowering (increasing) unemployment. After this temporary shift, the wage offer distribution returns to its original form, and the unemployment rate steadily returns to its steady state value. Throughout the remainder of this paper, I will focus on the determinants of the steady state unemployment rate.

FIGURE 4A

## Effect of Higher Real Interest Rate



## The Effects of Changes in the Environment

While the model presented here is relatively stark and simple, it nonetheless provides interesting insights on how elements of the economic environment influence the unemployment rate. In the following subsections I explore how changes in the discount rate, firing rate, wage offer distribution, and unemployment compensation each influence the solution to the numerical example. For each of these elements I first examine the effect on the reservation wage, then trace the effects on the average duration of unemployment and the steady state unemployment rate.

## Changes in the Discount Rate

First consider the effect of an increase in the real interest rate, which implies a lower value for the discount factor  $\beta$  (recall that  $\beta = 1/(1+r)$ ). It is not immediately obvious how this change will effect the reservation wage or the unemployment rate. However, intuition suggests that because a higher interest rate implies discounting future earnings more rapidly, an increase in the real interest rate lowers the benefits of waiting for a higher wage. This suggests that the reservation wage will decrease. Indeed, figure 4a shows that a higher interest rate causes the reject curve to shift inward, resulting in a lower reservation wage.

The lower reservation wage implies a higher job-acceptance rate, lower unemployment duration, and lower steady state unemployment. That is, higher real interest rates lead to lower steady state unemployment. It is informative to consider extreme cases to gain insight into the underlying logic of the model. For example, consider setting the real interest rate infinitely large, which corresponds to setting  $\beta$  to 0. In this case the worker completely discounts future earnings. Thus, she sets her reservation wage to \$200, accepts any job offer, and the unemployment rate is 0. Unemployment in the model is due, in part, to workers' willingness to wait for a high wage offer.

Figure 4b shows how the reservation wage and unemployment rate vary with the real interest rate. Both are steadily decreasing in the interest rate. As the interest rate approaches 0 (the case in which workers do not discount the future at all), the reservation wage and the unemployment rate increase to \$743 and 4.5 percent, respectively.

FIGURE 4B

## Effect of Changes in the Real Interest Rate

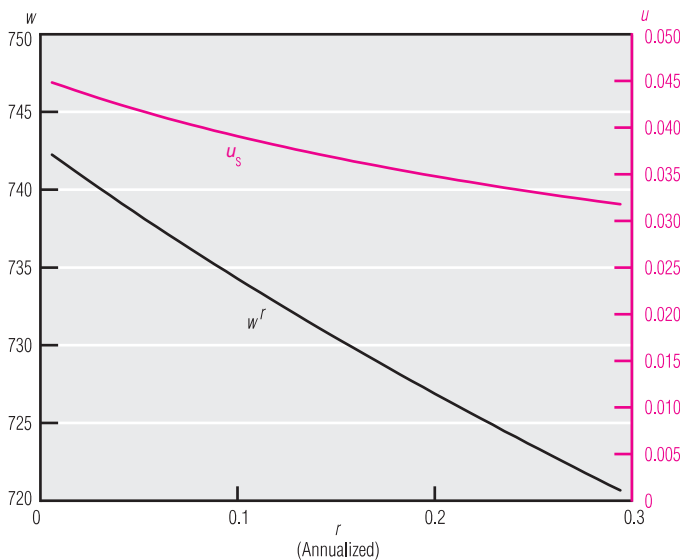
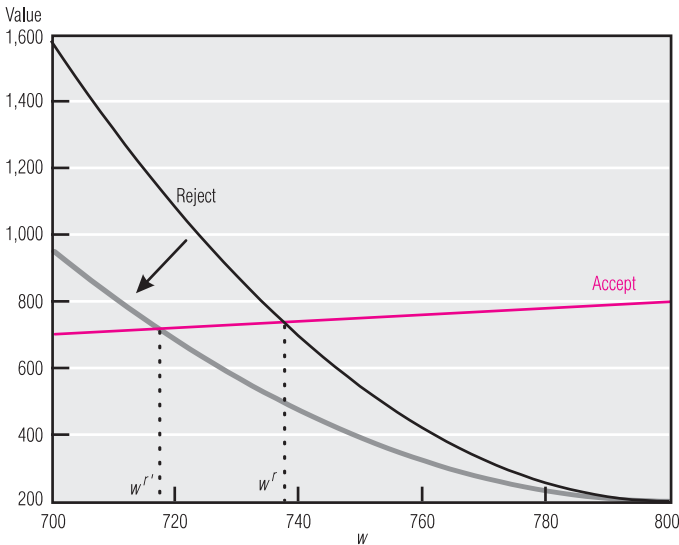


FIGURE 5A

Effect of Higher Firing Rate



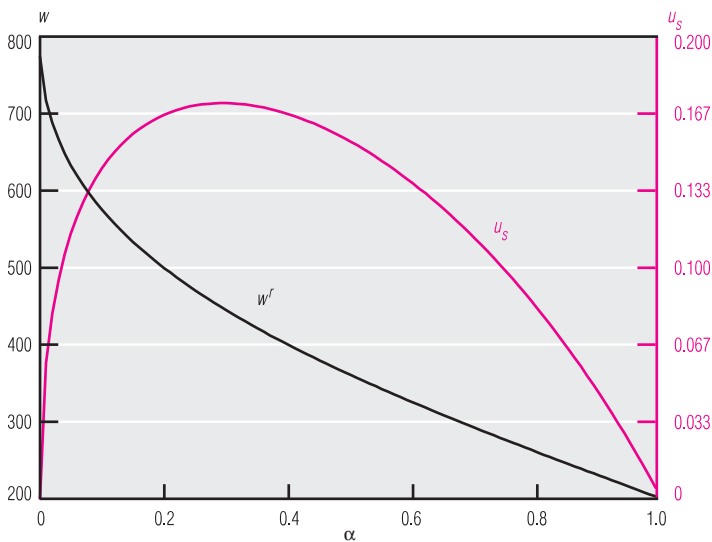
Changes in the Firing Rate

Next suppose there is an exogenous increase in the firing rate  $\alpha$ , perhaps resulting from a change in government regulations. While the effect on the reservation wage may not be apparent in this case, it seems obvious that an increase in the firing rate must result in an increase in the unemployment rate. Figure 5a illustrates that an increase in  $\alpha$  causes the reject curve to shift inward toward 0. This results in a decrease in the reservation wage and a corresponding increase in the job-acceptance rate. This finding is not particularly surprising since, all things being equal, an increase in the firing rate reduces the expected length of time at a given job, and thus reduces the benefit of waiting for a relatively high wage offer. For example, if you are likely to hold the same job for only a few months, then it is not worth spending a long time searching for a high wage job.

Surprisingly, the effect of an increase in the firing rate on the unemployment rate is ambiguous and depends on the size of the increase. Figure 5b shows that the unemployment rate increases steadily as the firing rate rises to roughly 0.30, but then declines for higher firing rates. To understand why this occurs, note that the reservation wage falls as the firing rate rises. This implies that the job-acceptance rate is *increasing* with  $\alpha$  and the average duration of unemployment is *falling*.

FIGURE 5B

Effect of Changes in the Firing Rate

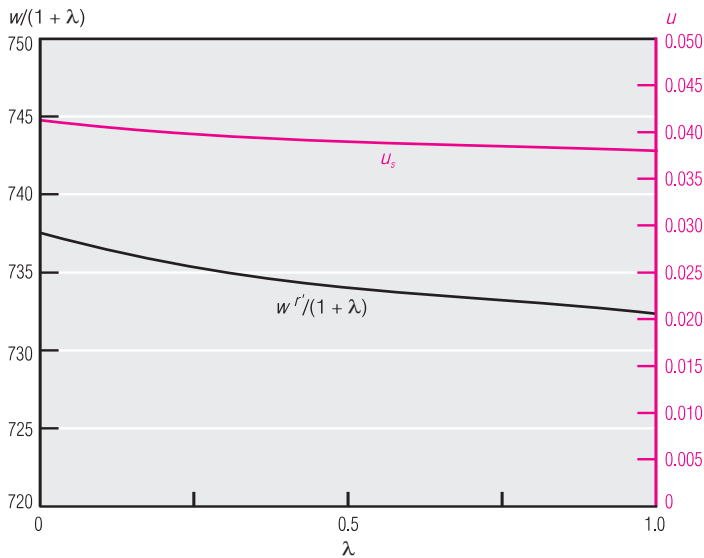


Thus there are two competing effects on the steady state unemployment rate. The increase in the firing rate raises unemployment, while the increase in the job-acceptance rate lowers unemployment. Which effect dominates depends upon the specific numerical values used in the example and the magnitude of the increase in the firing rate. In the extreme case where all workers are fired every period ( $\alpha = 1$ ), unemployed workers accept all wage offers ( $w^r = 200$ ) and the unemployment rate is 0. The average weekly wage that workers receive falls from \$737.62 when the unemployment rate is 4.1 percent, to \$500 when the unemployment rate is 0; meanwhile, the expected lifetime earnings,  $Ev^{offer}$ , of an unemployed worker fall from \$740,086 to \$500,000. This example makes clear that policies which reduce unemployment do not necessarily benefit workers.

The potential for such surprising effects is one reason that it is important to rigorously model economic behavior. While intuition is certainly useful as a guide, relying on intuition alone often provides an incomplete picture, and is sometimes just plain wrong.

FIGURE 6

### Effect of Changes in the Mean of Wage Distribution



### Changes in the Wage Offer Distribution

Next I address the impact of changes in the wage offer distribution. More specifically, I examine the effect of a permanent upward shift in the entire wage offer distribution, perhaps resulting from a permanent increase in productivity, and the effect of an increase in the “riskiness” of the wage offer distribution.

#### An Upward Shift in the Distribution

Suppose that the distribution of wages were to increase by the fraction  $\lambda$ , or  $\lambda$  times 100 percent, as the result of a permanent, across-the-board increase in productivity. This implies that the uniform distribution of wage offers shifts from  $[200, 800]$  to  $[200(1 + \lambda), 800(1 + \lambda)]$ .

Consider two cases. First, suppose that unemployment compensation,  $w^u$ , increases by the same percentage as all the wage offers. Equation (9), which determines the reservation wage, could then be rewritten

$$(16) \quad w^{r'} = (1 + \lambda)w^u + \left[ \frac{\beta(1 - \alpha)}{1 - \beta(1 - \alpha)} \right] \times \frac{((1 + \lambda)\bar{w} - w^{r'})^2}{2((1 + \lambda)\bar{w} - (1 + \lambda)\underline{w})},$$

where  $w^{r'}$  is the reservation wage given the new wage offer distribution. With a little bit of algebra, it is straightforward to show that

$$w^{r'} = (1 + \lambda)w^r.$$

That is, the reservation wage increases by the same percentage as the wage offers.

Next consider what happens to the job-acceptance rate,  $\psi'$ , which is determined by

$$(17) \quad \psi' = \frac{(1 + \lambda)\bar{w} - (1 + \lambda)w^{r'}}{(1 + \lambda)\bar{w} - (1 + \lambda)\underline{w}} = \frac{\bar{w} - w^{r'}}{\bar{w} - \underline{w}} = \psi.$$

The job-acceptance rate is unaffected by the shift in the wage offer distribution. This implies that the average duration of unemployment and the unemployment rate are also unchanged!

While this result is certainly a striking one, it is perhaps not so surprising. It essentially says that if the costs and benefits of searching for a job all go up by the same proportion, then the reservation wage will increase by the same proportion and unemployment will be unaffected. Consider an example where we simply measure the wage offer distribution and unemployment compensation in cents instead of in dollars. Clearly we would expect the reservation wage to increase from \$737.62 to 73,762 cents, with unemployment duration and rates unaffected.

Now consider a second case. Suppose that unemployment compensation does not increase with the wage distribution. Figure 6 shows that in this case the reservation wage increases less than proportionally with the wage offer distribution ( $w^{r'}/(1 + \lambda) < w^r$ ). This implies that the job-acceptance rate increases, unemployment duration falls, and the unemployment rate declines. The relative cost of searching increases since unemployment compensation, which serves as a subsidy to searching, does not increase with the wage distribution.

As an example, consider a 5 percent increase in the wage distribution, so that  $\lambda$  equals 0.05. For this case the reservation wage increases by 4.9 percent to \$773.96, and the unemployment rate falls slightly, from 4.13 percent to 4.09 percent. For this particular example, the 5 percent increase in the wage offer distribution has little impact on unemployment.

FIGURE 7A

## Effect of Changes in the Variance of Wage Distribution

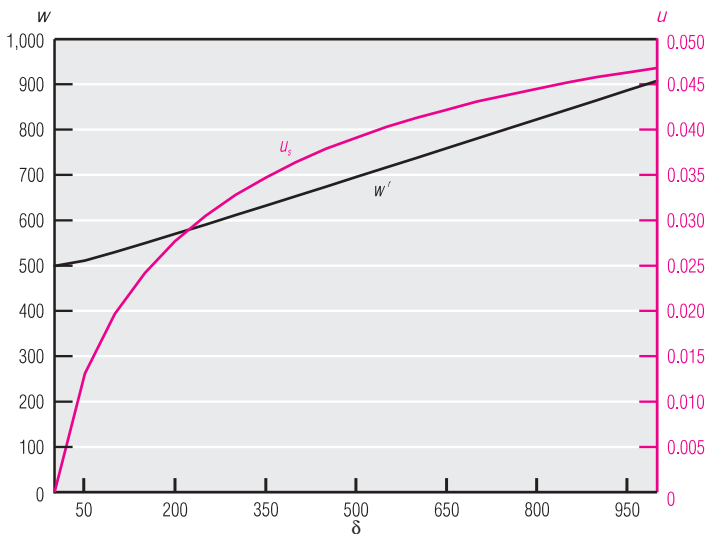
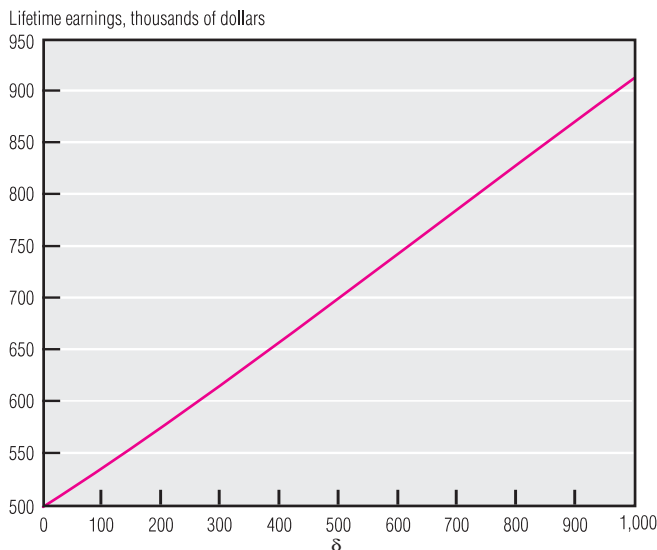


FIGURE 7B

## Effect of Changes in Wage Riskiness on Expected Lifetime Earnings



## Changes in the Riskiness of the Distribution

Next I examine the effect of a change in the “riskiness” of the wage offer distribution. To do this, I must first clarify what I mean by riskiness. I define riskiness as the difference between

the highest and lowest possible wage offers,  $(\bar{w} - \underline{w})$ . An increase (decrease) in riskiness will be defined as an increase (decrease) in this spread which does not affect the mean. Define the lower and upper bounds on wage offers to be  $500 - \delta/2$  and  $500 + \delta/2$ , where  $0 \leq \delta \leq \$1000$ . Thus  $\delta$  is the measure of riskiness since  $(\delta = \bar{w} - \underline{w})$ , and was set equal to 600 in the baseline numerical example. Notice that the mean of the distribution is 500 regardless of the value of  $\delta$ . When  $\delta$  is set to zero, there is no riskiness in wage offers in the sense that all wage offers are exactly \$500.

What happens to the reservation wage and the unemployment rate as the riskiness of the distribution changes? Figure 7a shows that the reservation wage increases with wage offer riskiness. This is not too surprising, given that the spread of the distribution is increasing. Furthermore, the job-acceptance rate decreases as riskiness increases, which implies that the unemployment rate rises. This seems to bear out the intuition that riskiness is bad for workers.

Before reaching that conclusion, however, consider the case in which there is no riskiness ( $\delta = 0$ ). Since there is no uncertainty in wage offers, there is no reason to search. Each job pays \$500, and workers who are unemployed at the beginning of the week always accept the offer. The steady state unemployment rate in this case is 0. But is an unemployed worker better off?

Let’s compare the expected discounted lifetime earnings,  $E_V^{offer}$ , for an unemployed worker first in the model with no riskiness, and then in the baseline numerical example with riskiness ( $\delta = 600$ ). In the case with no riskiness,  $E_V^{offer}$  is slightly less than \$500,000, the present value of \$500 per week forever (with no unemployment spells). But in the case with riskiness,  $E_V^{offer}$  is \$740,086.

At first blush it may seem surprising that an unemployed worker in the model with wage riskiness and higher unemployment has substantially higher expected lifetime earnings than an unemployed worker in the model with no riskiness and no unemployment. But it should not be. Given that the average duration of a job is almost four years, an unemployed worker would be much better off spending more time searching for a relatively high-paying job than she would be in a world where all jobs paid the average wage. Recall that the reservation wage in our numerical example was \$737.62, which is almost 50 percent higher than the average wage offer of \$500. Figure 7b shows that expected lifetime earnings steadily increase as the spread in the wage distribution increases. Here,

FIGURE 8A

## Effect of Higher Unemployment Compensation

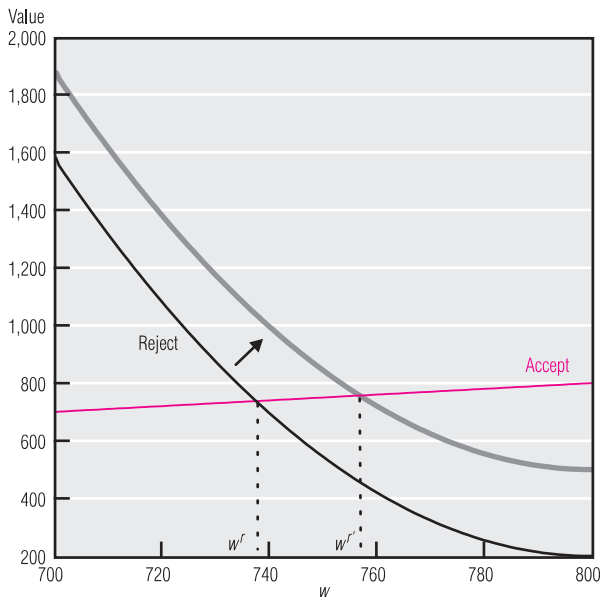
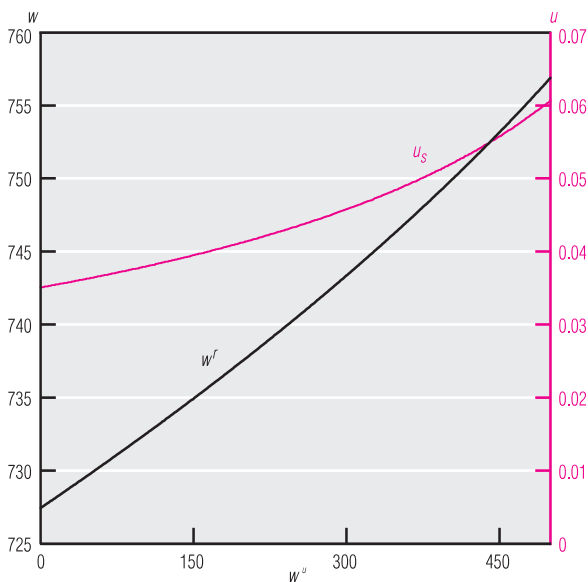


FIGURE 8B

## Effect of Changes in Unemployment Compensation



riskiness is good. Again, note that versions of the model with low unemployment are not necessarily the environments which benefit the workers most.

## Changes in Unemployment Compensation

Finally, consider what happens when unemployment compensation is increased. Figure 8a shows that an increase in unemployment compensation causes the reject curve to shift outward, implying an increase in the reservation wage. This is not surprising: Since unemployment compensation acts as a subsidy to searching, the worker is willing to wait longer for a high-paying job and thus increases her reservation wage.

The higher reservation wage implies a lower job-acceptance rate, an increase in the average duration of unemployment, and an increase in the unemployment rate. Figure 8b shows that the reservation wage and the unemployment rate increase steadily with increases in unemployment compensation. In the extreme case where  $w^u$  is set to 800, it is clear that unemployment will be 100 percent since no job pays better than collecting unemployment compensation.

Consider an increase in  $w^u$  from \$200 to \$300 per week. In this case the reservation wage increases from \$737.62 to \$743.35, average unemployment duration increases from 8.6 weeks to 9.6 weeks, and the unemployment rate increases from 4.1 percent to 4.6 percent.

There is a great deal of empirical evidence which supports the finding that increases in unemployment compensation result in higher unemployment. This does not imply that unemployment insurance necessarily makes workers worse off in the real world. The findings do suggest, though, that a tension exists between maintaining low unemployment rates and providing insurance for the unemployed.

## III. Concluding Remarks

Search models of unemployment provide a valuable tool for understanding the factors which determine the unemployment rate and the impact of labor market policies and regulations on unemployment. Furthermore, search theory provides an alternative perspective to the view that unemployment represents idle resources. In this theory unemployed workers

are not idle, but instead are engaging in the socially beneficial activity of finding a productive job match. The simple version presented in this paper illustrates how search models can be used to examine the influence of elements of the economic environment on the unemployment rate.

The search model discussed here is often referred to as a one-sided search model because it focuses solely on the job decisions of unemployed workers and abstracts from the search decisions of firms. More complex two-sided search models examine the optimizing decisions of workers and firms simultaneously. In addition, these models have incorporated a variety of other considerations which are abstracted from in the simple model, and they have proven to be capable of explaining many features of unemployment data within and across countries. This process of building better theories is perhaps the most important step in designing good economic policies, and search theory is playing a critical role in that process.

## Appendix

### Solving the Model

In this appendix I lay out the basic mathematical structure of the model and describe a strategy for solving it. The wage offers in each period are drawn from the same wage distribution  $F(w)$ , where  $F$  denotes the cumulative distribution function. That is,  $F(\hat{w}) = \text{prob}(w \leq \hat{w})$ . The definition of  $Ev^{offer}$ , the expected value of the  $v^{offer}$  value function, is

$$(A1) \quad Ev^{offer} = \int_{\underline{w}}^{\bar{w}} v^{offer}(w') dF(w').$$

The Bellman functional equation for  $v^{offer}$  is written

$$(A2) \quad v^{offer}(w) = \max \left\{ w^u + \beta \int_{\underline{w}}^{\bar{w}} v^{offer}(w') dF(w'), \frac{w + \beta \alpha \int_{\underline{w}}^{\bar{w}} v^{offer}(w') dF(w')}{1 - \beta(1 - \alpha)} \right\},$$

where the first term is the value of waiting and the second term is the value of accepting the wage offer. The equation determining the reservation wage  $w^r$  is

$$(A3) \quad \frac{w^r + \beta \alpha Ev^{offer}(w^r)}{1 - \beta(1 - \alpha)} = w^u + \beta Ev^{offer}(w^r),$$

which can be rewritten

$$(A4) \quad w^r = c[1 - \beta(1 - \alpha)] + [\beta(1 - \beta)(1 - \alpha) Ev^{offer}(w^r)].$$

Assuming a uniform distribution for  $F$  makes it possible to obtain a closed form solution for the integral expression that defines  $Ev^{offer}$ . This integral can be rewritten

$$(A5) \quad Ev^{offer} = \int_{\underline{w}}^{\bar{w}} v^{offer}(w') dF(w') = \frac{1}{\bar{w} - \underline{w}} \int_{\underline{w}}^{\bar{w}} v^{offer}(w') dw'$$

using the fact that the density function for a uniform distribution on  $[\underline{w}, \bar{w}]$  is  $1/(\bar{w} - \underline{w})$ . This latter integral is simply the area under the  $v^{offer}$  curve, whose shape is illustrated in figure 1. This integral can be written

$$(A6) \quad \int_{\underline{w}}^{\bar{w}} v^{offer}(w') dw' = v^{wait}(\bar{w} - \underline{w}) + \frac{1}{2}(\bar{w} - w^r)s(\bar{w} - w^r)$$

where  $s = 1/(1 - \beta(1 - \alpha))$  is the slope of  $v^{accept}$ . The first term is the area of the rectangle with width  $(\bar{w} - \underline{w})$  and height  $v^{wait}$ , and the second term is the area of the triangle with width  $(\bar{w} - w^r)$  and height  $s(\bar{w} - w^r)$ . Note, however, that this expression is still a function of  $Ev^{offer}$  since  $v^{wait}$  equals  $(w^u + \beta Ev^{offer})$ .

Substituting equation (A6) and the definition of  $v^{wait}$  into equation (A5), one obtains

$$(A7) \quad Ev^{offer}(w^r) = \left( \frac{1}{\bar{w} - \underline{w}} \right) \times \left[ (w^u + \beta Ev^{offer}(w^r))(\bar{w} - \underline{w}) + \frac{1}{2}(\bar{w} - w^r)s(\bar{w} - w^r) \right] = w^u + \beta Ev^{offer}(w^r) + \frac{s(\bar{w} - w^r)^2}{2(\bar{w} - \underline{w})}.$$

This expression can be rewritten to obtain  $Ev^{offer}$  as a function of  $w^r$

$$(A8) \quad Ev^{offer}(w^r) = \left( \frac{1}{1 - \beta} \right) \left[ w^u + \frac{s(\bar{w} - w^r)^2}{2(\bar{w} - \underline{w})} \right].$$



Finally, this expression for  $E_{V^{offer}}$  can be combined with (A4) to obtain an equation in  $w^r$  alone:

$$(A9) \quad w^r = w^u + \left( \frac{\beta(1-\alpha)}{1-\beta(1-\alpha)} \right) \left( \frac{s(\bar{w} - w^r)^2}{2(\bar{w} - \underline{w})} \right).$$

This is a quadratic equation in  $w^r$ . It can be shown that the smaller of the two roots for this expression is the equilibrium reservation wage if the solution is interior ( $\underline{w} < w < \bar{w}$ ). Given  $w^r$ , equation (A8) can be used to obtain  $E_{V^{offer}}$ , which in turn can be used to obtain  $v^{wait}$ ,  $v^{accept}$ , and  $v^{offer}$  using equations (2), (4), and (5) in the text.

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# What Labor Market Theory Tells Us about the “New Economy”

by Paul Gomme

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## Introduction

The average unemployment rate for 1997 was 4.9 percent, well below most estimates of the nonaccelerating inflation rate of unemployment (NAIRU).<sup>1</sup> One would therefore have expected to see an increase in inflation in 1997; yet, as measured by the CPI, inflation *fell* from 3.3 percent to 1.7 percent (December to December). This phenomenon of low unemployment accompanied by falling inflation has prompted some observers to claim that the economy is now operating under a new set of rules. The explanation is often couched in terms of a favorable technology shock which has *permanently* lowered the NAIRU.

This article asks whether economic theory supports the claim that a technology shock can change the *natural rate of unemployment*. This term is preferred to NAIRU in the context of the theory used below, which is silent on the determination of nominal magnitudes like the price level and inflation.<sup>2</sup> Rather, the theory speaks to the determination of *real* as opposed to *nominal* wages (that is, in terms of goods rather than dollars). Consequently, changes in the natural rate of unemployment need not have any repercussions for inflation.

Proponents of the view that a technology shock can change the natural rate of unemployment often rely, at least informally, on neoclassical labor demand and supply. A positive improvement in technology shifts labor supply to the right, since firms find all workers more productive. In equilibrium, total hours worked and output rise without contributing to inflation, since improved technology raises the real wage rate. However, as shown below, the neoclassical model cannot explain unemployment per se. Any individual who does not work has *chosen* not to work and so cannot be described as unemployed.

Next, a search model of unemployment is developed. This environment is characterized by imperfect information: Workers do not know the locations of well-paying jobs, and firms do not know the identities of highly productive workers. Consequently, workers must seek out firms in order to receive wage offers,

■ 1 The *Economic Report of the President* for 1998 estimated a NAIRU of 5.4 percent, revised down from 5.5 percent in the 1997 report.

■ 2 That is, money is *neutral*: A once-and-for-all change in the level of the money supply will have a proportional effect on the price level but will leave all real magnitudes unchanged. In fact, here money will be *super-neutral*: Changes in the time path of the money stock will have no real effect.

just as firms evaluate potential employees. Workers choose a *reservation wage* above which they accept employment (since the costs of continued search outweigh the expected benefits), and below which they reject job offers (since the opposite is true). In the basic search unemployment model, a permanent, positive technology shock will shift the *distribution* of wages to the right. That is, each worker is more productive at all potential jobs and so will receive higher wage offers from any employer he contacts. Suppose that the costs of search rise in proportion to productivity. This will be true if, for example, the only search costs are forgone wage income and the delay in receiving a new wage offer. In that case, an individual's reservation wage will also rise in proportion to productivity and the improved technology will have *no effect* on the unemployment rate.

If individuals are initially unaware of the shift in the wage distribution, they will not change their reservation wages. As a result, the unemployment rate may fall in the short run, since individuals find a greater proportion of wage offers meeting their reservation wage. Over time, as individuals learn of the shift in the wage distribution, they will revise their reservation wage upward, and the unemployment rate will be unchanged. The analysis thus far casts doubt on a fall in the natural rate of unemployment that is driven by technology shocks.

Alternatively, if, following a technological improvement, search costs rise more than benefits, then the unemployment rate may fall. Two plausible reasons for this scenario are: 1) a cap on unemployment insurance benefits, and 2) unchanged benefits of leisure or home production opportunities enjoyed during a spell of unemployment. Both reasons operate by reducing the effective subsidy rate to search, thus raising search costs relative to benefits.

The basic search model can be extended to incorporate search effort. Consider, first, the problem faced by someone who is unemployed. In choosing his search intensity, he must make a conjecture about the level of recruiting by firms which affects his likelihood of successfully meeting up with a firm. A good time to be looking for a job is when plenty of firms are trying to hire. Next, notice that firms must likewise form a conjecture regarding the level of search by the unemployed: Posting lots of job vacancies does not do much good if there are few unemployed people looking for work. Owing to these conjectures—or expectations—regarding the behavior of agents on the

other side of the job market, there may be multiple equilibria with self-fulfilling expectations. High and low unemployment equilibria can exist in an economy with identical fundamentals: The difference is in the expectations of firms and the unemployed. If the economy starts in a high unemployment equilibrium, a positive technology shock may move the economy to the low unemployment equilibrium. Firms raise their recruiting efforts since the value of filling jobs has increased, and the unemployed increase their search effort as a consequence. Firms then recruit more, and so on. The externality to search—for example, that the unemployed benefit from increased recruiting by firms—leads to the reinforcing effects of search effort on both sides of the market. The net result is an increase in the number of matches between firms and the unemployed, hence a lower unemployment rate.

Under the multiple equilibrium story, the technology shock need not be permanent in order for the unemployment rate effect to be permanent. By permanently changing expectations regarding search effort, even a temporary technology shock may permanently lower unemployment. Notice, as well, that old-fashioned Keynesian “pump priming” would have the same effect. For example, government could hire people into temporary jobs, increasing the returns to search by the unemployed. Observing that more individuals are looking for work, firms will find that the returns to recruiting are higher and so increase their hiring. Thus, another chain of events is put into motion which can move the economy from a high to a low unemployment equilibrium.

A final variant of the search model looks at a *matching function*. This model postulates that the number of successful matches depends on the number of unemployed persons and on the number of vacancies posted by firms. Rather than affecting the productivity of jobs/workers, suppose that the technological improvement operates on the matching function: For the *same* number of vacancies and unemployed, *more* matches are consummated. While this technological improvement will lower the unemployment rate permanently, the mechanics are far different from those typically invoked by the advocates of the “new economics.” Of course, improvements in the matching function may be positively correlated with aggregate productivity gains. For example, computer technologies are generally credited with much of the aggregate productivity gains in recent years, and also make it easier for firms and the unemployed to contact each other.

FIGURE 1

### Neoclassical Labor Market Equilibrium

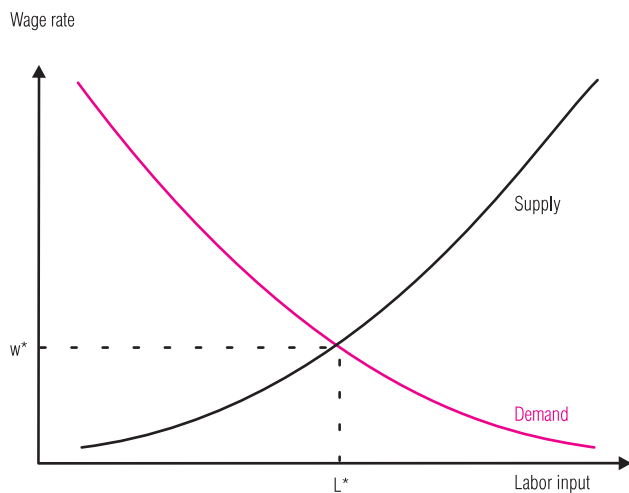
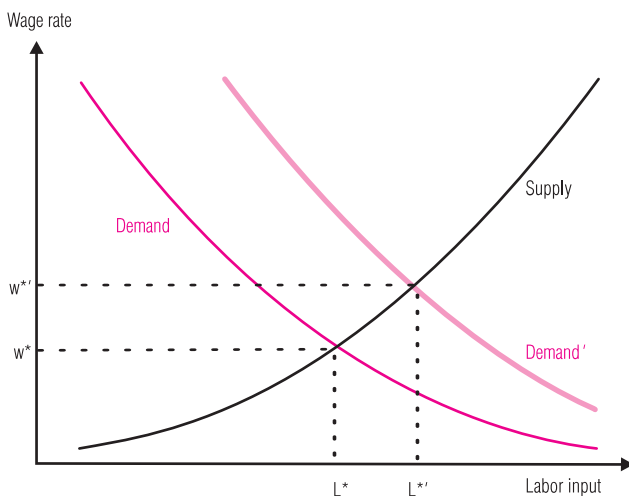


FIGURE 2

### A Shift in Labor Demand



## I. The Neoclassical View of the Labor Market

In the neoclassical model, the labor market is like any other. That is, the labor market is treated as a continuous auction, with equilibrium given by the intersection of labor demand with labor supply (see figure 1). At the equilibrium wage rate,  $w^*$ , the quantity of labor required by firms is just equal to the

number of hours individuals are willing to work at that wage.

Consider the effects of a permanent improvement in technology. Since firms find each and every worker more productive, they are willing to offer a higher wage to each one, and labor demand shifts to the right (see figure 2). In the new equilibrium, both the labor input and the wage rate are higher. Since the technological improvement is permanent, the increase in the labor input is also permanent.

If firms and workers are fully informed about all prices in the economy, then it is irrelevant whether the wage rate discussed above is expressed in nominal terms (in dollars) or in real terms (in terms of goods). In the classical model, money is said to be *neutral*: The level of the money supply determines the general price level, but has no influence on real quantities like the level of employment. Consequently, the change in employment owing to an improved technology need not be inflationary.

Notice that nothing has yet been said of unemployment. According to the neoclassical model, there is no unemployment, since anyone not working at the prevailing wage rate has *chosen* not to work; presumably, they have better things to do with their time. As a consequence, the neoclassical model cannot explain the current situation of low unemployment and low inflation.

## II. A Basic Search Model

Perhaps the most important reason why individuals are unemployed is that they do not know which firms will offer high wages. Likewise, firms post vacancies because they are ignorant of the identities of highly productive workers.<sup>3</sup>

Each individual in the economy is endowed with a unit of time. For now, assume that people receive no utility from leisure. Thus, when employed, an individual will supply the entire unit of time; when unemployed, he will use the entire unit of time looking for a job.<sup>4</sup> Suppose that each period (for example, a week), an unemployed individual contacts exactly one firm. Once contact has been made, both the firm and the individual learn the individual's productivity at that firm. That is, each match

■ 3 For a more comprehensive treatment of the model, see Sargent (1987), Jovanovic (1979), and Lucas and Prescott (1974).

■ 4 Equivalently, suppose that the utility cost of working is equal to that of searching. Then these utility costs wash out of the analysis.

FIGURE 3

## Wage-Offer Distribution

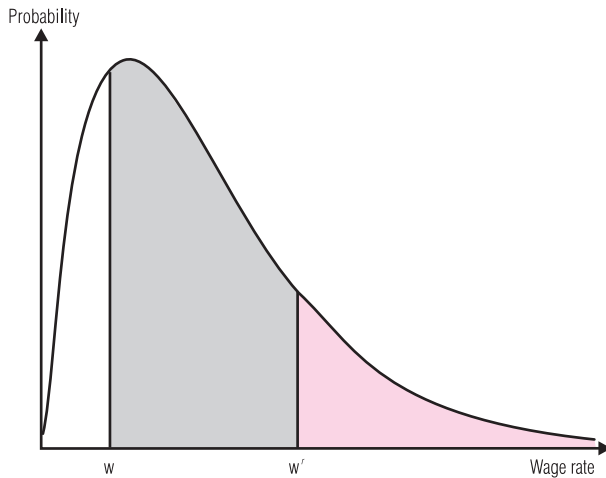
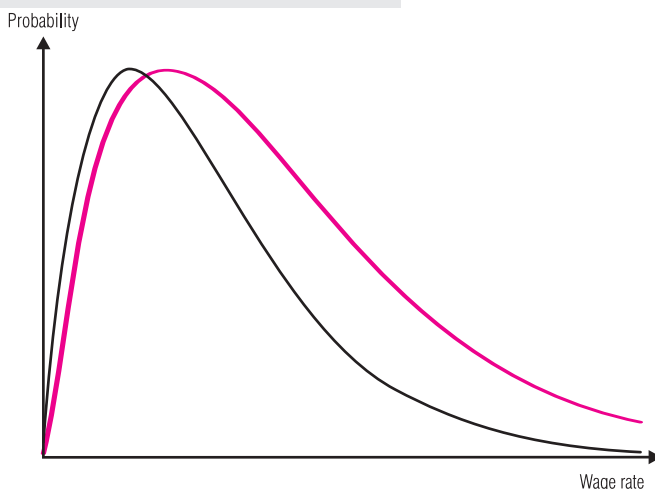


FIGURE 4

A Shift in the Wage-  
Offer Distribution

has an idiosyncratic component that depends on both the firm and the individual. The outcome of a bargaining process between the firm and unemployed person will be a wage offer.<sup>5</sup> Once a firm and worker have agreed to a wage, they are assumed to enter a long-term relationship in which the worker continues supplying labor to the firm at the agreed wage.<sup>6</sup>

Now, consider the decision process of an unemployed individual. This person is assumed

to know the distribution of wages which he will receive; when he contacts some firm, he knows the probability of receiving a wage offer of, say,  $w$ . One such distribution is given in figure 3. This individual must decide whether to accept a wage offer,  $w$ . Suppose that this offer is quite low, as it would be if his productivity at a particular firm was also very low. Since deciding to work for a firm means entering into a long-term relationship with it, agreeing to such a wage would imply accepting a low wage for several years. An individual who rejects such an offer is hoping to receive a higher wage offer from some other firm in the future. Figure 3 shows that the probability of receiving such an offer, given by the area under the wage distribution curve to the right of  $w$ , is quite high. Of course, there is some possibility of receiving an even lower wage offer, but receiving a higher wage offer is more likely.

A particularly high wage offer will almost certainly be accepted, since the chances of receiving an even higher one are remote. This means that an individual who rejects a very high offer in the hope of an even higher one will have a long wait.

The outcome to the individual's decision problem can be summarized by a reservation wage,  $w^r$ : The individual will reject all wage offers below  $w^r$  and accept all other offers. The reservation wage balances the costs of continued search against the benefits. In this model, the cost of prolonging a search is the wages lost while the individual waits for a new offer. The benefit of a longer search is the expectation of being matched with a firm offering a higher wage. At  $w^r$ , the (expected) benefits of continued search just equal the costs.

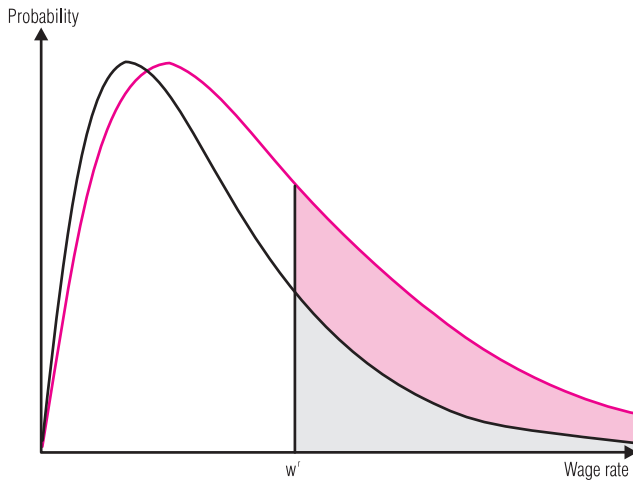
Figure 3 shows the probability of receiving a wage at least equal to the reservation wage. This is also the probability of an individual leaving the pool of unemployed. Individuals *choose* to be unemployed (in the sense that they are rejecting wage offers) because it is rational to do so. A spell of unemployment can be thought of as an investment in finding a well-paying job. Since individuals are allocating themselves to relatively more productive jobs in the economy, search unemployment is both privately and socially desirable.

■ 5 Assume that the firm always offers a wage rate at which it would actually be willing to hire the worker. That is, the firm does not lose money by hiring the worker at the wage offered.

■ 6 On-the-job search is ruled out solely in the interests of parsimony.

FIGURE 5

### An Unanticipated Shift in the Wage-Offer Distribution



### A Permanent Technology Shock

Suppose that the productivity of *all* jobs increases. To start, suppose that both firms and workers are aware of this improvement in productivity, and that firms are now willing to pay 10-percent-higher wages. In this case, the distribution of wages faced by an unemployed individual will shift to the right, as depicted in figure 4.

How should an unemployed individual's behavior change? It turns out that since *all* wage offers have risen 10 percent, his reservation wage should also rise 10 percent. Increasing the reservation wage in this manner will imply that the search costs (at this new reservation wage) will increase 10 percent, as will the benefits, since *all* wage offers have increased 10 percent. The original reservation wage equated the costs and benefits of search, so a 10 percent increase in the reservation wage will continue to equate the costs and benefits of search. Given this increase in the reservation wage, the likelihood that an unemployed individual will receive an acceptable offer is unchanged: All wage offers have risen 10 percent, as has the reservation wage. Consequently, there will be no effect on the unemployment rate. These points are developed in more detail in the appendix.

### An Unanticipated Aggregate Productivity Increase

Now, suppose that while all firms know that the productivity of all jobs has increased 10 percent, individual workers are initially unaware of this improvement in technology. Then the unemployed will have no reason to alter their reservation wage, and as a group they will receive more acceptable job offers. Equivalently, the likelihood that an unemployed individual will receive an acceptable wage offer increases (compare the shaded areas in figure 5). Under this scenario, the unemployment rate will fall, since the job-finding rate has increased.

One would anticipate that, over time, workers will learn about this shift in productivity. As a result, reservation wages will gradually creep up until they have risen 10 percent. Once all workers have found out about the 10-percent improvement in wage offers, the analysis proceeds as above when workers were fully informed of the increase in wage offers. That is, the unemployment rate will fall only in the short term;<sup>7</sup> in the long term, it will be unchanged.

### Possibilities for Long-Run Effects?

Thus far, the analysis has relied on the fact that search costs increase in proportion to the benefits. Consider two factors which may contribute to a larger increase in the search costs. First, most states impose a maximum on unemployment insurance (UI) benefits. In this context, it is useful to think of UI benefits as a subsidy to search. For individuals whose UI benefits are capped, the 10-percent increase in the wage offer distribution implies that the subsidy to unemployment has fallen relative to wages, effectively increasing search costs. Such individuals should increase their reservation wage by less than 10 percent in order to reduce the

■ 7 The view that the current low unemployment rate is a temporary phenomenon has been expressed by Federal Reserve Governor Lawrence H. Meyer, among others. In a recent speech, Meyer (1997) said: "The consensus estimates of NAIRU as this expansion began—about 6 percent—did not prepare us for the recent surprisingly favorable performance.... my response is to update my estimate of NAIRU and add other explanations consistent with this framework, but not to abandon this concept. One possible explanation is that one or more transitory factors, for the moment, are yielding a more favorable than usual outcome. A coincidence of favorable supply shocks is clearly, in my judgment, an important part [of] the answer to the puzzle."

costs of search (since a lower reservation wage implies a shorter duration of unemployment). Thus, the aggregate unemployment rate should fall. However, to the extent that legislation maintains a link between the cap on UI benefits and average wages, this channel for reducing the unemployment rate will likely be of limited duration.<sup>8</sup>

Second, the unemployed may have more opportunities to pursue leisure and home production activities than those who are engaged in full-time work. These alternative uses of time also act as a subsidy to unemployment. Suppose, for example, that the value of leisure is unchanged following a shift in the wage distribution, then as with maximum UI benefits, the unemployed should increase their reservation wage by *less than* 10 percent (that is, the reservation wage should decrease relative to the average wage), and the unemployment rate should fall.

### III. Search Intensity

The unemployed can vary their search intensity by sending out more resumés, filling out more job applications, calling more employers, or pursuing prospective jobs more aggressively. Likewise, employers can alter their search intensity by posting more job vacancies, using larger advertisements, assigning more employees to recruiting, and sending recruiters to more places where potential employees are concentrated, such as university campuses. Of course, these activities are costly to firms.

An individual who increases his search intensity will reduce the (expected) length of time between job offers, or equivalently will increase the number of job offers per unit of time. The payoff to increased search intensity by the unemployed will, in turn, depend on the search intensity of firms: It does little good to look hard for a job if firms simply are not hiring. Consequently, if the unemployed believe that firms are recruiting intensively, then the unemployed will do the same, since they are more likely to encounter a firm offering an acceptable wage.

Likewise, if firms believe that the unemployed are searching intensively, then they will want to do likewise: A good time to be seeking employees is when lots of people are looking for jobs. These beliefs of firms and the unemployed are self-fulfilling in the sense that intensive search by the jobless is justified by vigorous firm recruiting, and vice versa. With high search intensity on both sides of the job market, unem-

ployment will be low, since many unemployed individuals are finding suitable jobs.

Of course, a high unemployment equilibrium is also possible. In this case, the unemployed do not look very hard for jobs, since they believe that firms are not engaged in much recruiting; firms do not recruit heavily because they believe that the unemployed are not searching very hard. Again, these beliefs are self-fulfilling.

Starting from a high unemployment equilibrium, consider the effect of a positive technology shock that shifts the wage-offer distribution. Suppose that the unemployed initially increase their reservation wage in proportion to the shift in the wage-offer distribution, and do not change their search effort. Prior to the technological improvement, firms chose the number of vacancies to be posted in such a way that the marginal cost of posting another vacancy just equaled the (expected) marginal benefit due to sharing in the surplus created by a successful match with an unemployed person. For simplicity, assume that the cost of posting a job vacancy is unchanged. Then firms will wish to recruit more heavily, since the expected marginal benefits of posting a vacancy now exceed the marginal cost. In response, the unemployed will find it optimal to increase their search intensity. Firms, in turn, will want to intensify their recruiting efforts further, and so on. The net result is an increase in search effort by both firms and the unemployed (with the final increase being larger than the impact effect), leading to more matches and so to a lower unemployment rate. That is, a positive technology shock may move the economy from a high to a low unemployment equilibrium. Furthermore, the fall in the unemployment rate will be permanent, regardless of whether the productivity shock is permanent or temporary.

Naturally, the shock effecting the move from a high to a low unemployment equilibrium need not be technological. For example, the government could temporarily hire people to perform socially useless activities (for example, digging holes on even-numbered days, and filling them in on odd-numbered days). By

■ 8 In light of this analysis, one might well ask *why* the state subsidizes unemployment (through the UI system), since the outcome will necessarily be a higher unemployment rate. Two obvious answers come to mind. First, some workers are simply unlucky in that they lose their jobs through no fault of their own. UI benefits allow such individuals to better smooth their consumption over time. That is, UI is an insurance against some forms of consumption risk. Second, not all unemployment is necessarily bad. As pointed out above, unemployment can be thought of as an investment in well-paying jobs. It probably would not be desirable to require an unemployed person to accept the first job that is offered.

increasing the economy's recruiting, the government provides the unemployed with an incentive to increase their search effort. In turn, firms will increase *their* recruiting efforts, since more unemployed people are looking for work. Again, a sequence of events is put in motion which will move the economy to a low unemployment equilibrium. Once this new equilibrium is reached, the government can terminate its hiring activities.

#### IV. A Matching Technology

To simplify the analysis somewhat, suppose that in a given period, an unemployed individual either will or will not receive a wage offer. If he receives a wage offer, it is some constant,  $w$ . Likewise, a firm with a vacancy either has a job applicant or not. All applicants are assumed to be equally productive, so the firm hires any applicant, paying the wage rate,  $w$ .

The matching technology works as follows: The number of matches in the economy (that is, the number of jobless people who successfully find work) depends on the number of unemployed and on the number of job vacancies posted. Of course, the number of matches cannot exceed the number of unemployed individuals, nor can it exceed the number of posted job vacancies. Assume that each unemployed person is equally likely to receive a wage offer. Likewise, suppose that all firms posting vacancies are equally likely to have a job applicant in any given period. The number of matches in a given period is increasing in the number of unemployed people looking for jobs and in the number of vacancies posted by firms. Finally, the matching technology is typically assumed to exhibit constant returns to scale: Doubling the number of unemployed and the number of vacancies doubles the number of matches consummated.

Instead of an aggregate technology shock which affects the productivity of workers on the job, suppose that the shock affects the rate at which matches occur. That is, for a given number of unemployed and vacancies, there are simply more matches. By way of example, the Internet has made it easier for employers to post vacancies and for the unemployed to search for jobs (particularly in faraway places). Since the number of matches has increased, the unemployment rate must fall.

Of course, improvements in the matching function and in overall economic productivity may move in tandem. The computer example

is a particularly apt one, since productivity gains in recent years have been largely attributed to the adoption and spread of computer technologies.

#### V. Conclusions

This article uses economic theory to assess recent claims that the economy has a new "speed limit"—that the economy can operate at a lower unemployment rate without exerting upward pressure on the inflation rate due to an improvement in technology. The models analyzed above embody the classical dichotomy between the real and nominal sides of the economy. As a consequence, there need not be any relationship between inflation and unemployment in these models. The key question is whether a technological improvement will permanently lower the unemployment rate.

In the neoclassical view, the labor market operates as a continuous auction market. An implication of this model is that *there is no unemployment*; individuals without jobs have chosen not to work at the equilibrium wage rate. This observation prompts a look at search unemployment models.

In the basic search unemployment model, the outcome of the decision problem faced by the unemployed is a reservation wage: Offers below this wage are rejected, while all others are accepted. In this model, a permanent improvement in productivity of all jobs which increases wage offers will, at best, lower the unemployment rate only temporarily. Once workers are fully aware of the shift in the wage-offer distribution, they will increase their reservation wage so that the fraction of acceptable wage offers is the same as it was before the productivity change.

The no-change-in-unemployment result in the basic search model relies on the assumption that search costs increase by the same proportion as search benefits. Should the costs of search increase by more than the benefits—perhaps due to caps on unemployment insurance benefits or the unchanged value of leisure and home production opportunities which may be enjoyed in greater abundance when an individual is unemployed—then the unemployment rate may fall.

In an extended search model, both firms and the unemployed are permitted to vary their effort. This model can be characterized by multiple rational expectations equilibria. That is, there can be high and low unemployment



equilibria whose only difference lies in expectations. Specifically, a low unemployment equilibrium will result if the unemployed search hard because they believe that firms are recruiting heavily, and firms recruit energetically because they believe the unemployed are searching intensively. Conversely, a high unemployment equilibrium will result if neither side of the market searches vigorously because each believes that the other is not searching very hard. Now, even a temporary technology shock may move the economy from a high to a low unemployment equilibrium by initiating a chain of events that intensifies search efforts by both firms and the unemployed.

The final model is characterized by a matching technology which depends on the number of unemployed and the number of vacancies. Here, a permanent improvement in the matching technology will lead to a lower unemployment rate.

Most advocates of the “new economy” paradigm seem to view recent events as an improvement in worker productivity, not in the matching technology. No doubt, many would be uncomfortable with the multiple equilibria explanation of events—if only because traditional Keynesian tools could also move the economy between equilibria. This leaves the basic search model, which predicts a permanent fall in unemployment only if the costs of search rise by more than the benefits (a scenario that could result from a cap on unemployment insurance benefits) or if the technology shock does not change the value of alternative uses of time while an individual is unemployed.

## Appendix

### The Basic Search Model: The Worker's Problem

The typical worker seeks to maximize expected lifetime utility, given by

$$\sum_{t=0}^{\infty} \beta^t c_t,$$

where

$$c_t = \begin{cases} w_t & \text{if employed and} \\ 0 & \text{otherwise.} \end{cases}$$

Notice that workers are assumed to be risk-neutral (utility is *linear* in consumption).

Wage offers are distributed according to  $g(w)$ , which is defined over  $[\underline{w}, \bar{w}]$ . The associated cumulative density function is  $G(w) \equiv \int_{\underline{w}}^w g(w) dw$ . Let

$$w_{t+1} = \begin{cases} 0 & \text{with probability } p \\ w_t & \text{with probability } 1 - p, \end{cases}$$

where  $p$  is the exogenous separation rate.

The worker's problem can be cast using the tools of dynamic programming. The value of working at a particular wage,  $w$ , is given by

$$V^w(w) = w + \beta[pV^u + (1 - p)V^w(w)].$$

Similarly, the value of being unemployed is given by

$$V^u = G(w^r)V^u + \int_{w^r}^{\bar{w}} V^w(w)g(w)dw,$$

where, as above,  $w^r$  is the reservation wage rate.  $G(w^r)$  is the probability of rejecting a wage offer, given the reservation wage. Notice that the reservation wage will have the property that

$$V^w(w^r) = V^u.$$

The shift in the wage distribution owing to an improvement in technology should be thought of as a “stretching out” of the wage-offer distribution. That is,

$$G(w) = \bar{G}(w/\lambda) \text{ for all } w \text{ and for all } \lambda,$$

where  $\bar{G}$  is the new wage-offer distribution.

The claim that a technology shock resulting in a shift in the wage distribution by a factor  $\lambda$  will increase the reservation wage by the same factor  $\lambda$  is now relatively straightforward to see. In particular, provided the reservation wage does increase by the factor  $\lambda$ , all the quantities describing the value functions  $V^w(w)$  and  $V^u$  will also rise by the same factor  $\lambda$ .

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# Unemployment and Economic Welfare

by David Andolfatto and Paul Gomme

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## Introduction

Statistics that measure labor market activity, such as employment and unemployment, are often interpreted in the press and by politicians as measures of economic performance and social well-being. Discussions that focus on cross-country comparisons of unemployment, for example, seem to be based without exception on the premise that unemployment represents a social and economic ill, so that less of it is generally to be preferred. The purpose of this note is to demonstrate that some care should be exercised when constructing a map between labor market behavior and economic welfare and that, generally speaking, such interpretations are not justified in the absence of information concerning the economic circumstances that determine individual labor market choices.

## I. Some Labor Market Facts

Each month, the Current Population Survey (CPS) assigns the noninstitutional civilian population of the United States to one of three mutually exclusive groups: Employment, Unemploy-

ment, or Nonparticipation. The survey begins by determining whether a person is *employed*, which is defined roughly as having allocated *any* time at all toward paid work in the previous week. Those that are not employed in this sense are defined as *nonemployed*. The survey then asks all nonemployed individuals a series of questions designed to detect some minimum level of *active job search*. Those nonemployed individuals that report themselves as having engaged in some minimum level of active job search over the previous week are classified as *unemployed*.<sup>1</sup> The remaining group of nonemployed individuals are classified residually as *nonparticipants*.

Of course, these three classifications are extremely crude. We know, for example, that there is a tremendous amount of variation in hours worked per month across employed individuals. While it is unclear how much time is typically devoted to job search activities, we can safely assume it varies from a few hours per month browsing over help-wanted ads

■ 1 Individuals who report themselves on temporary layoff are also classified as unemployed whether or not they report any search activity. It should be pointed out, however, that these individuals form only a small fraction of the total number of unemployed.

to many hours per month seeking out job opportunities that are well-matched to an individual's attributes.

Concerning the curious category of unemployment, it seems apparent that the CPS (and, indeed, most people) implicitly attaches a great deal of weight to the time used for job search by the nonemployed. Despite the popularity of the unemployment measure among commentators and policymakers, many economists question the usefulness of the concept of unemployment, preferring instead to focus on employment (or nonemployment) and on the allocation of time across other activities, for example, on-the-job search, learning, and household production. It is also interesting to note that many extensive time-use studies, such as those surveyed in Juster and Stafford (1991), do not even include a category for job search, let alone job search conducted by nonemployed individuals. Ultimately, the justification for isolating job search as a crucial activity distinct from the many other competing uses of time among the nonemployed has to be based on the theoretical and empirical relevance of the concept.

Abstracting from seasonal variation, the CPS reveals that net monthly changes in employment and unemployment tend to be relatively small. However, the stability displayed by these stocks masks the very high degree of turnover that exists in the labor market: Each month, literally millions of individuals make transitions between different labor market states. Historically, about 2 percent of the adult workforce in the United States flows into and out of employment every month.<sup>2</sup> Based on current population estimates, this represents approximately 4 million workers either losing or leaving their jobs, and roughly the same number acquiring jobs, resulting in a total turnover of about 8 million workers per month.<sup>3</sup>

A second striking feature of the CPS flows data concerns the degree of mobility displayed by the group of individuals labeled "nonparticipants." Contrary to what one might expect, fully half of the flows into and out of employment are accounted for by individuals making transitions to and from nonparticipation. While nonparticipants are, by definition, not "actively" seeking employment opportunities, this apparently does not preclude the possibility of being available for employment (for example, if called on by a former employer). This feature of labor market behavior calls into question the usefulness of attempting to make a distinction between unemployment and nonparticipation. However, the absolute size of the flows between

employment and unemployment are as large as those that occur between employment and nonparticipation. This, together with the fact that the unemployment stock is much smaller than the stock of nonparticipants, implies that the average probability that an unemployed person makes a transition to employment is much higher than the corresponding probability for a nonparticipant. This feature of the data is consistent with the notion that unemployment is a labor market state that facilitates the job-finding process, an interpretation that conflicts with the common textbook perception that "unemployment represents wasted resources."<sup>4</sup>

The remainder of this paper is concerned with developing a simple theoretical framework that might be used to interpret the labor market behavior described above; this interpretive device is then used to determine under what conditions changes in employment and unemployment can be associated with changes in economic welfare. The analysis proceeds in two steps. First, a basic model of employment–nonemployment is developed and analyzed. This model is then extended to incorporate the phenomenon of unemployment.

## II. A Simple Model of Worker Turnover

Consider an economy consisting of a fixed number of individuals. Each person has preferences given at each point in time by  $U = \ln(c) + z$ , where  $c$  represents the consumption of market goods and services and  $z$  represents the consumption of services produced in the nonmarket sector.<sup>5</sup> Notice that according to this specification of preferences, individuals find it very painful to subsist at very low levels of market consumption; i.e.,  $U \rightarrow -\infty$  as  $c \rightarrow 0$ .

Each person is endowed with an indivisible unit of discretionary time, which may be utilized either in the production of market goods or services (employment) or in some other activity (nonemployment). People generally differ in how their time is valued across alternative uses. Below, we interpret this heterogeneity as emanating from differences in individual

■ 2 See Blanchard (1997, p. 295).

■ 3 These figures actually underestimate the degree of turnover, as they abstract from job-to-job transitions.

■ 4 Mankiw (1994, p. 137).

■ 5 The structure of the economy will be such that myopic decision-making is optimal.

FIGURE 1

## The Work Decision

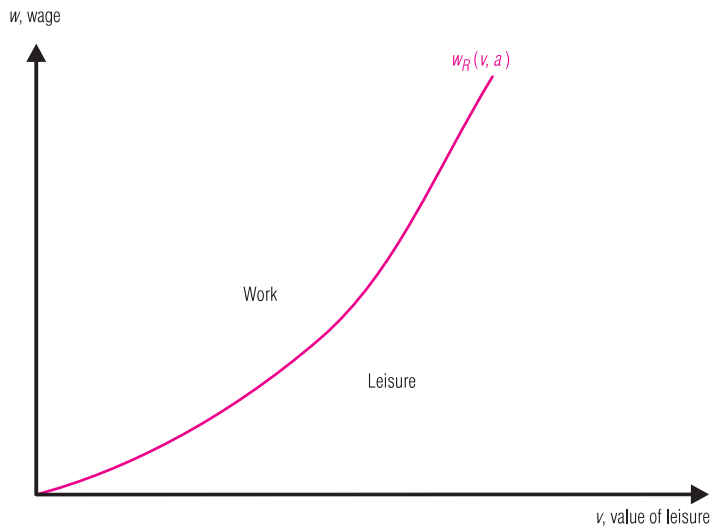
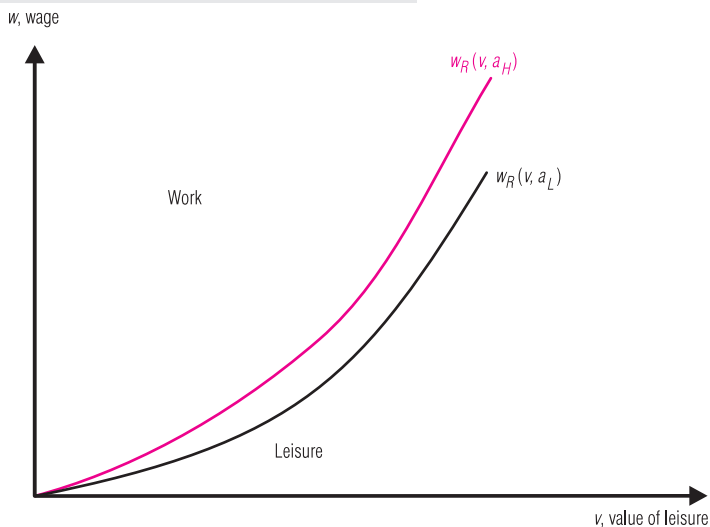


FIGURE 2

## The Effect of Nonlabor Income



economic circumstances as summarized by the triplet  $(w, a, v)$ . Here,  $w$  represents the market value of an individual's particular skill (real wage) or, equivalently, the amount of output that can be produced with one unit of labor (productivity). The parameter  $a$  represents an individual's nonlabor income, for example, interest income on property, income from a spouse, unemployment insurance, or welfare, charity, and so on. The parameter  $v$  represents the value of time allocated to nonmarket activities, for example, home production or leisure.

Generally, we shall think of each of these parameters as differing across individuals at any given point in time as well as changing periodically over time for any one person.<sup>6</sup>

We are interested in modeling an environment where individual labor market transitions are associated with changes in economic well-being, as is likely the case in reality. For this to be true, financial markets must to some extent be incomplete, since otherwise individuals could insure themselves perfectly against any idiosyncratic labor market risk. For simplicity, we assume an extreme form of incompleteness and abstract from financial markets entirely.

In the absence of financial markets, each person faces a simple set of period budget constraints:  $c \leq wn + a$  and  $z \leq v(1 - n)$ , where  $n \in \{0, 1\}$  represents the time allocation decision. An individual facing economic circumstances  $(w, a, v)$  must choose how to best allocate time between employment and nonemployment. The utility payoff associated with employment ( $n = 1$ ) is given by  $\ln(w + a)$ , while the utility payoff associated with nonemployment ( $n = 0$ ) is given by  $\ln(a) + v$ . Clearly, the individual should choose the action that yields the highest utility payoff.

For a given configuration of  $(a, v)$ , one can define a *reservation wage*  $w_R$  such that any person with an employment opportunity  $w \geq w_R$  will choose to work, while any person with an employment opportunity  $w < w_R$  will choose some nonmarket activity. The reservation wage is defined to be that wage for which an individual is just indifferent between working or not; i.e.,  $w_R$  satisfies:

$$(1) \quad \ln(w_R + a) = \ln(a) + v,$$

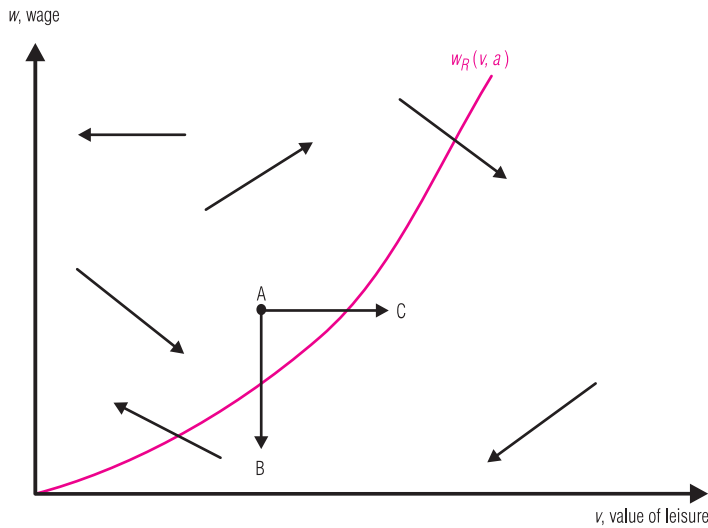
which can be solved explicitly as  $w_R = (e^v - 1)a$ . Figure 1 plots the reservation wage as a function of  $v$ , holding fixed the level of nonlabor income  $a$ .

The reservation wage has a very useful economic interpretation. In particular, it can be thought of as representing a person's level of "choosiness" over available job opportunities: A higher reservation wage means that a person is more discriminating. Theory sensibly suggests that a person's level of job-choosiness should depend positively on the level of nonlabor income and on the quality of opportunities in the nonmarket sector. People are more discriminating when they can afford to be. Figure 2

■ 6 In order to maintain the optimality of myopic decision-making, assume that  $(w, a, v)$  are identically and independently distributed random variables.

FIGURE 3

## Possible Changes in the Value of Leisure and the Wage Rate



plots the reservation wage function for two different levels of nonlabor income  $a_H > a_L$ .

With the reservation wage so defined, the optimal time allocation decision is given by (see figure 1):

$$(2) \quad n(w, a, v) = \begin{cases} 1 & \text{if } w \geq (e^v - 1)a; \\ 0 & \text{if } w < (e^v - 1)a, \end{cases}$$

with maximum utility given by:

$$(3) \quad W(w, a, v) = \max\{\ln(w + a), \ln(a) + v\}.$$

Theory suggests that an individual is more likely to be employed when  $w$  (the return to working) is high, and less likely to be employed when either  $a$  or  $v$  are high (as these latter variables increase the reservation wage). The welfare function  $W$  (also referred to as the indirect utility function) tells us that individual well-being is an increasing function of nonlabor income and a nondecreasing function of both the real wage and the value of time in the nonmarket sector. All of this makes perfect sense. It also implies that *there is no necessary correlation between employment status and economic well-being*.

This assertion holds true at the aggregate level as well. For a theory of aggregate employment, one must describe how the economic attributes  $(w, a, v)$  are distributed over individuals. Let  $g(w, a, v)$  denote the fraction of the population with attributes  $(w, a, v)$ . Then aggregate employment is given by:

$$(4) \quad N = \sum_{w,a,v} n(w, a, v)g(w, a, v).$$

Improvements in aggregate economic conditions can be modeled as changes in the distribution function  $g$  such that more individuals are concentrated over higher values of  $w$ ,  $a$ , or  $v$ . In the first case (higher values of  $w$ ), aggregate employment can be expected to rise, while in the second and third cases, employment can be expected to fall. In each case, any reasonable measure of social welfare can be expected to increase.

Note that, even in the absence of aggregate uncertainty (i.e., a stationary distribution function  $g$ ), the equilibrium of this economy will in general feature flows of workers into and out of employment (recall that individuals begin each period by independently drawing a new realization of  $(w, a, v)$  from the distribution  $g$ ). Examples of such transitions are plotted in figure 3. Keep in mind that, because financial markets are absent, these transitions are typically associated with significant changes in personal living standards. Two points deserve to be made here. First, note that one cannot infer any change in personal well-being simply on the basis of an observed change in labor market status. Consider, for example, a person who begins the period at point  $A$  in figure 3. Suppose that at the end of the period, we observe that the individual exits employment. Whether this person is better or worse off clearly depends on the change in economic circumstances that triggered the transition. For example, a deterioration in the value of market time (point  $B$ ) or an improvement in the value of nonmarket activities (point  $C$ ) may both trigger such a transition. Second, note that these transitions are not the direct cause of any change in living standards; rather they represent the “rational” behavior of individuals in response to exogenous changes in economic circumstances. The following example will illustrate this latter point.

Imagine that individuals in the economy described above differ only with respect to their employment opportunities  $w$  and that  $w > 0$ , so that everyone always has the option of working at a job that produces positive output (note:  $w$  may be arbitrarily close to zero so that the opportunity may not be particularly attractive). Let  $F(w)$  denote the fraction of workers with a job with a wage no better than  $w$  and assume that workers independently draw a new wage every period from the distribution  $F$ . Individuals value nonmarket activities identically according to  $v > 0$ , and we assume that each person has zero nonlabor income; i.e.,  $a = 0$ .

Recall that the reservation wage is given by  $w_R = (e^v - 1)a$ , so that in this example,  $w_R = 0$  since  $a = 0$  (people cannot afford to be very choosy here). Since  $w > 0$  by assumption, it follows that everyone chooses to work in this economy, and that, consequently, transitions into and out of employment are absent. Judging by these aggregate labor market statistics, the economy appears tranquil (low turnover) and robust (high employment).

However, these statistics hide the fluctuations in individual well-being that occur as people find the return to their labor changing over time. Some individuals may experience precipitous wage declines as the demand for their labor all but disappears (perhaps owing to the arrival of a new technology that is not well-matched to their skills). These unfortunate people refuse to exit from employment (as they arguably should in order to pursue relatively more valuable nonmarket activities such as retraining), since they must work in order to eat; as such, they become a part of the “working poor.”

This equilibrium is inefficient relative to one in which insurance markets (or some equivalent institution) operated to alleviate individual income risk. Recall that, at the beginning of each period, an individual draws a new wage according to the distribution  $F$ ; the expected utility payoff for the representative individual in this world is given by:

$$(5) \quad EU^A = \int_0 \ln(w) dF(w).$$

In addition, note that per capita output is given by  $y^A = \int_0 w dF(w)$  with an employment level  $N^A = 1$ .

Consider now the allocation that would be chosen by a social planner wishing to maximize the expected utility of the representative individual (the same allocation would result in a world with a perfectly functioning insurance market). The social planner must choose a reservation wage  $w_R$  that determines who works and who does not, along with a feasible set of consumption levels for the employed  $y^e$  and nonemployed  $y^n$ . Conditional on these choices, the representative individual has an expected utility payoff given by:

$$(6) \quad EU = [1 - F(w_R)]\ln(y^e) + F(w_R)[\ln(y^n) + v],$$

where  $F(w_R)$  represents the probability of non-employment. Assume that the planner chooses  $(w_R, y^e, y^n)$  in order to maximize  $EU$  subject to the feasibility constraint (total consumption cannot exceed total output):

$$(7) \quad [1 - F(w_R)]y^e + F(w_R)y^n \leq \int_{w_R} w dF(w).$$

The reader can verify that the solution to this problem entails a reservation wage that is strictly positive,  $w_R^* > 0$ , together with equal consumption across labor market states,  $y^e = y^n = y^* = \int_{w_R^*} w dF(w)$ . The expected utility delivered to the representative individual is  $EU^* = \ln(y^*) + F(w_R^*)v$ . It can be easily demonstrated that  $N^* = 1 - F(w_R^*) < N^A$  (employment is lower under the planner),  $y^* < y^A$  (output is lower under the planner), and that  $EU^* = \ln(y^*) + F(w_R^*)v > EU^A$  (people are better off under the planner). In addition, as time unfolds, note that individuals will generally experience transitions into and out of employment under the allocation chosen by the planner.

The availability of consumption insurance means that people who temporarily find their earnings capabilities severely diminished need not waste valuable time engaged in very low productivity tasks; time can instead be reallocated to more productive nonmarket applications. Employment and market incomes in such an environment are necessarily lower (relative to a situation where everyone is compelled to work), but this does not necessarily imply that economic well-being is lower.

### III. Unemployment

Recall that the CPS definition of an unemployed person is someone who is both nonemployed and actively searching for employment. Why are there people in the economy whose economic circumstances are such that they are compelled to spend precious time looking for buyers of labor willing to pay an acceptable price for their particular job skill? It must be the case that people have incomplete information concerning the location of their best job opportunity, and that the job search activity generates information whose expected return exceeds the value of this foregone time spent in alternative activities. Incomplete information of this sort is likely to be a natural feature of any dynamic economy in which changes in the structure of technology and tastes randomly create, destroy, and reallocate employment opportunities across different sectors.

There are several ways in which one might model the job search activity of nonemployed workers. Here, we shall take a particularly simple approach that is in keeping with the

analysis developed earlier.<sup>7</sup> Following the setup above, assume that all individuals have access to some employment opportunity in the market sector. While some readers may view such an assumption as a gross violation of reality, our view is quite the opposite. In particular, note that we do not place any restriction on the *quality* of potential employment opportunities, so that our setup does allow for the possibility that there is a scarcity of what might be considered to be “good” jobs.

As with the earlier analysis, assume that individuals are distributed in some exogenous manner over the space  $(w, a, v)$ . In that analysis, it was implicitly assumed that individuals had complete information about the location of their best job opportunity  $(w)$ , so that the job search (and hence unemployment) in that environment proved unnecessary. However, suppose now that while individuals are endowed with a job opportunity  $w$  at the beginning of the period, they are generally aware that better (and worse) prospects exist elsewhere. Assume that these prospects  $p$  are distributed according to a known distribution  $Q(x) = \Pr[p \leq x]$ , where  $Q' > 0$ . Job search is modeled as a random draw from this distribution.

In particular, assume that an individual may divert some given fraction of the period time endowment  $0 < (1 - \xi) < 1$  toward job search. (for simplicity, assume that such an action necessitates the abandonment of the beginning-of-period job opportunity). Following this exertion of job search effort, the individual realizes a new job opportunity  $p$  from the distribution  $Q$  and may at this stage choose to devote any remaining time  $\xi$  toward employment or home production activities.

Let us now determine the expected utility payoff associated with the job search decision. Once the new job opportunity is realized, the individual faces a standard employment–nonemployment decision and chooses a reservation wage  $p_R(a, v)$  that satisfies:

$$(8) \quad \ln(\xi p_R + a) = \ln(a) + \xi v.$$

If the new employment opportunity offers a wage  $p < p_R$ , the individual will find it optimal to spend any remaining time at home. With  $p_R$  so determined, the expected utility of undertaking the search activity is given by:

$$(9) \quad \lambda(a, v) = Q(p_R)[\ln(a) + \xi v] + \int_{p_R} \ln(\xi p + a) dQ(p).$$

Here,  $Q(p_R)$  is the probability that the new job prospect is of an unacceptably low quality, in which case the person earns a utility payoff  $[\ln(a) + \xi v]$ . The term  $dQ(p)$  can be interpreted as the probability of locating a job with wage  $p$ , which earns utility payoff  $\ln(\xi p + a)$ ; the second term in the right-hand side of the expression above simply adds up the utility payoff associated with each acceptable job weighted by the probability of finding a job of that particular quality.

In the earlier analysis, which abstracted from unemployment, a reservation wage  $w_R$  was determined that partitioned the population into employment and nonemployment; these two groups we shall now refer to as “type-A” and “type-B” individuals, respectively. Think of type-A individuals as those who (given current economic circumstances) prefer work to leisure (i.e.,  $w > w_R$ ), while type-B individuals are those who prefer leisure to work (i.e.,  $w < w_R$ ).

With the option of job search available, some type-A individuals may now choose to abandon their current employment opportunity in pursuit of a new (and hopefully better) one. The return to work is given by  $\ln(w + a)$ , while the return to search is given by  $\lambda(a, v)$ . Clearly, the optimal strategy is to form a reservation wage  $w'_R$  satisfying:

$$(10) \quad \ln(w'_R + a) = \lambda(a, v),$$

such that all type-A individuals with  $w > w'_R$  should choose to work full-time, while those with  $w < w'_R$  should abandon their current employment opportunity in search of another. It can be demonstrated that  $w'_R \geq w_R$  for type-A individuals; i.e., the option of a search activity makes these people even more choosy about their beginning-of-period employment opportunity.

Likewise, a group of type-B individuals may now choose to sacrifice some of their leisure time to look for work (i.e., for a wage that dominates their current employment opportunity). As the return to leisure is given by  $\ln(a) + v$ , the optimal strategy for type-B individuals is to set a reservation “leisure wage” of  $v_R$  satisfying:

$$(11) \quad \ln(a) + v_R = \lambda(a, v_R),$$

such that all type-B persons with  $v > v_R$  should choose full-time leisure, while those with  $v < v_R$  should devote some time to active job search.

■ 7 The model that follows is closely related to that developed by Burdett, Kiefer, Mortensen, and Neumann (1984); and Andolfatto and Gomme (1996).



FIGURE 4

## The Search Decision

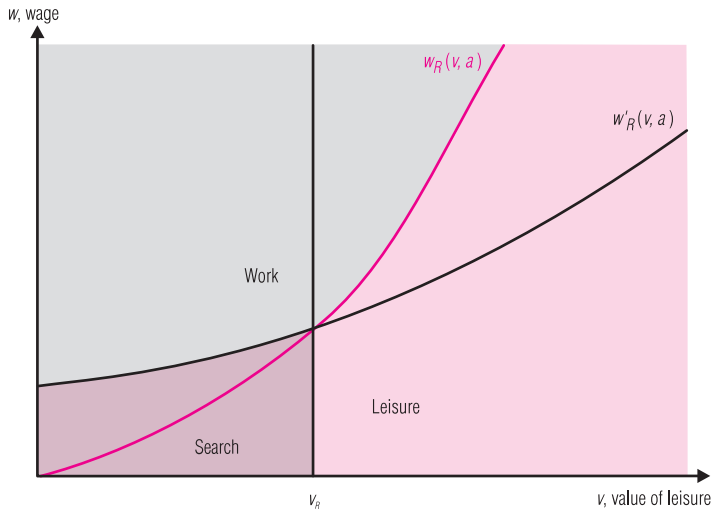


FIGURE 5

## The Unemployment Decision

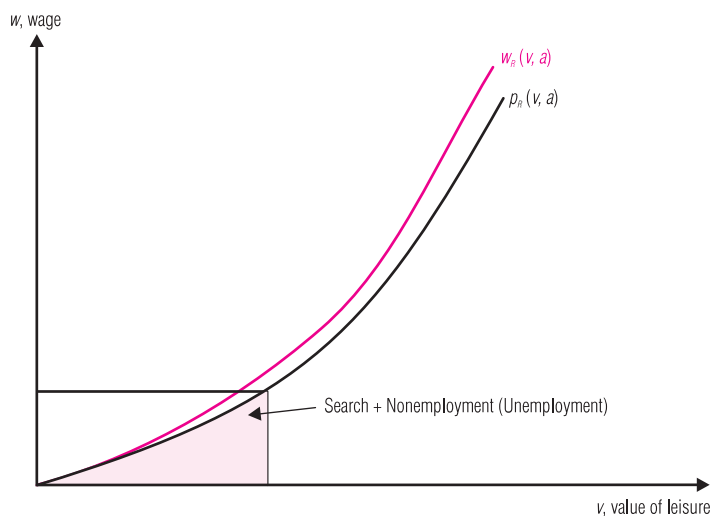


Figure 4 plots the reservation wage functions  $w_R$ ,  $w'_R$  and  $v_R$  for a given level of nonlabor income.

In order to calculate the equilibrium level of employment and unemployment, let us assume that the CPS is undertaken at the end of each period. To begin, it is clear that all type-A individuals with  $w > w'_R$  would be classified as employed, as these individuals work throughout the period. As well, all type-B individuals with  $v > v_R$  would be classified as nonparticipants, as these individuals engage in nonmar-

ket activities throughout the period. All remaining individuals allocate at least some time to search. However, not all of these individuals would be classified as unemployed by the CPS. In particular, all searchers who are successful at finding a suitable job within the reference period of the survey and work any amount of positive hours would be classified as employed. The unemployed are those who search for work but are unsuccessful at obtaining a suitable job within the reference period of the labor force survey. In terms of figure 5, the unemployed would be those who find themselves in the shaded region of the parameter space at the end of the period.

How are the economic attributes ( $w$ ,  $a$ ,  $v$ ) related to individual labor market choices? Recall the earlier analysis of employment and nonemployment. In that model, conditional on the level of nonlabor income  $a$ , the employed tended to be those people with high ( $w/v$ ) ratios; i.e., those individuals whose productivity in the labor market dominated their productivity in the home sector. In that model, the employment decision is a poor indicator of economic well-being, as it depends (conditional on  $a$ ) primarily on the ratio ( $w/v$ ), while economic welfare depends on the *levels* of  $w$  and  $v$ .

What general inferences can be made about unemployment and individual well-being? According to the model of unemployment developed above, there is a sense in which the unemployed tend to be relatively disadvantaged (conditioning on the level of nonlabor income). Being measured as unemployed for the period indicates that, at some time in the recent past, the available job opportunity  $w$  was of poor quality and that the value of time spent in alternative uses  $v$  was also of poor quality. (Individuals with good quality  $w$ 's tend to be employed, while individuals with good quality  $v$ 's tend to be nonparticipants.) As economic well-being depends (indirectly) on the levels of  $w$  and  $v$ , it follows that choosing to search (a prerequisite for being unemployed) is associated with a low level of welfare.

Having said this, note that there may be many individuals in the model who are employed and yet experience even lower levels of welfare than the unemployed (even holding equal the level of nonlabor income). Recall that after a job search yields an employment opportunity that pays  $p$ , an individual is free to work for wage  $p$  or spend the time at home earning the "leisure wage"  $v$ . If the latter choice is made, then the job search is deemed unsuccessful and the person is classified as unemployed. If the former choice is made, then the

person is classified as employed for the period. Note that this work–leisure choice depends, as before, primarily on the ratio ( $p/v$ ), and so whether the person chooses employment or unemployment at this stage reveals very little about the levels of  $p$  or  $v$  (and hence the level of welfare).

For example, consider two individuals with identical  $p$ 's and  $a$ 's, but with different  $v$ 's. It is conceivable that the person with the poor home opportunity will at this stage choose employment, while the person with the relatively good home opportunity will choose not to work (and therefore be measured as unemployed). In this example, the unemployed person is clearly better off than the employed person, while both persons are worse off compared to most other members of the population who did not feel the need to search.

What about the relationship between the level of nonhuman wealth  $a$  and unemployment? Consider two societies that are identical in every respect except that one society generates all of its income from labor, while the other is also endowed with a source of nonlabor income  $a > 0$ . What can be said about the equilibrium level of unemployment and level of welfare in these two economies?

From the earlier analysis of employment and nonemployment, we know that there is no nonemployment (and hence no unemployment) in the economy with zero nonhuman wealth. Individuals may still choose to search and generate new job opportunities  $p$ , but when  $a = 0$  it turns out that  $p_R = 0$ , so that individuals will choose to work at whatever new prospect makes itself available (as long as  $p > 0$ ). Thus, we observe paradoxically that the wealthier economy will exhibit a higher measured rate of unemployment. There is a sense here in which unemployment represents a “luxury” that only very rich countries can afford. Citizens of poor countries are compelled to work (either in the market or at home) or die; in either case, they are unlikely to be recorded as being “unemployed” by the CPS.<sup>8</sup>

More generally, the model suggests an ambiguous relationship between unemployment and wealth. The reason for this is as follows. First, from the condition determining  $v_R$ , one can demonstrate that  $v_R$  is a decreasing function of  $a$ . In other words, higher levels of wealth have the effect of making leisure more affordable; this effect leads to higher nonparticipation and hence less search activity (and hence lower unemployment). Second, from the condition that determines  $w'_R$ , it appears that  $w'_R$  may either increase or decrease with higher

levels of wealth. On the one hand, a higher level of nonlabor income may make an individual more willing to forego the hassles associated with job search. On the other hand, a higher level of nonlabor income means that an individual can better afford to engage in job search activities. Which effect dominates depends on the precise form of preferences, the level of nonlabor income, and the distribution of available job opportunities. If  $w'_R$  is decreasing in  $a$ , then people are less willing to search, so that unemployment falls, reinforcing the participation effect. In this case, unemployment unambiguously declines as nonlabor income rises. If  $w'_R$  is increasing in  $a$ , then people are more willing to search, leading to an increase in unemployment, offsetting the participation effect. The overall effect on unemployment then depends on the relative strength of these two effects.

Finally, a remark on the optimal level of unemployment. With incomplete consumption insurance markets, the equilibrium level of unemployment will likely be too low. The reason for this is similar to before: Individuals who find themselves temporarily in dire straits are compelled to work rather than search and/or engage in other nonmarket activities. This basic result calls into question the conventional wisdom which views unemployment as “idle” or “wasted” resources.

#### IV. Conclusions

Economic theory asserts that living standards (utility) ought to depend primarily on the level of broadly defined consumption (including leisure). The simple, yet in many ways plausible, model developed above demonstrated the tenuous link between labor market choices and economic well-being. Economic welfare was shown to be linked indirectly to the *level* of human capital in the market and at home, and to sources of nonlabor income. These parameters determine the individual's ability to generate high consumption levels.

Labor market choices concerning whether to be employed or nonemployed, however, in general reflect the *relative* returns to engaging in alternative activities, and hence are poor indicators of the level of welfare.

■ 8 One might also point out that there is likely very little reason for job search activity in poor, stagnant economies (aside from migration to cities). In such environments, the set of available employment opportunities is likely very limited so that information concerning their location is readily available; individuals face a standard employment–nonemployment decision.

However, the decision to undertake labor market search was shown to be correlated with poor opportunities in the market and at home. Since the extent of search activity and the level of unemployment are obviously linked, there is reason to believe that unemployed workers are generally worse off in welfare terms relative to that set of the population that appears content with current market/home opportunities. However, it would be a mistake to infer that the unemployed are the least well-off members of the workforce. In particular, individuals who are endowed with very poor human capital and no outside source of income may be compelled to work at jobs that others can afford to eschew; these poorly endowed individuals comprise the “working poor.”

Thus, while the unemployed tend to be disadvantaged relative to perhaps the majority of the population, it does not necessarily follow that they should constitute the primary target of social policy (should redistribution policy be deemed desirable). Furthermore, it does not necessarily follow that the elimination of unemployment would lead to an improvement in their economic well-being. Whether a reduction in unemployment is associated with an improvement in welfare would depend on the particular change in economic circumstances that altered the return to job search activities. Unemployment may fall because of any number of diverse reasons, for example: (1) an improvement in the quality of labor market opportunities; (2) a deterioration in the distribution of new job opportunities; (3) cutbacks in public unemployment insurance (reductions in  $a$ ); or (4) the arrival of an oppressive regime that im-

poses “work camps” and bans job search activity.<sup>9</sup> Clearly, not all of these examples would be unambiguously associated with improvements in overall social welfare.

The undue focus on unemployment as a measure of economic performance and welfare has contributed much mischief to discussions concerning the design and implementation of labor market (and monetary) policy. Throughout the 1980s, for example, the Canadian unemployment rate averaged about four percentage points higher than the United States, after decades of close correspondence.<sup>10</sup> This event was widely portrayed as reflecting some underlying malaise in the Canadian economy, a belief that seemed to persist despite the fact that real per capita income growth and employment rates in the two countries remained similar. Indeed, the Canadian economy even managed to maintain a stable after-tax distribution of income over this high-growth period, while in the United States the income distribution widened. Clearly, one must look deeper than simple measures of labor market activity before making definitive statements about economic performance and well-being.<sup>11</sup>

■ 9 See Eason (1957), who quotes from *Pravda* (January 31, 1954): “In 1953, as in preceding years, there has been no unemployment [in the Soviet Union].”

■ 10 See Andolfatto, Gomme, and Storer (1997); and Burtless (1997).

■ 11 Rogerson (1997) makes a similar point concerning European unemployment.

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