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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).[1] 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.[2] 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 *superneutral:* 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

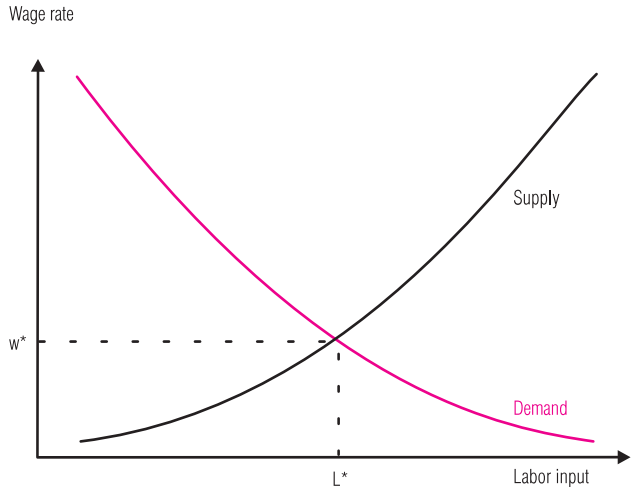
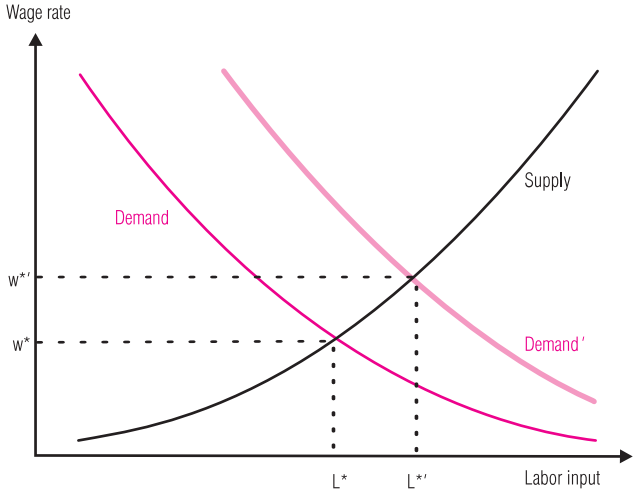


FIGURE 2

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.[3]

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.[4] 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

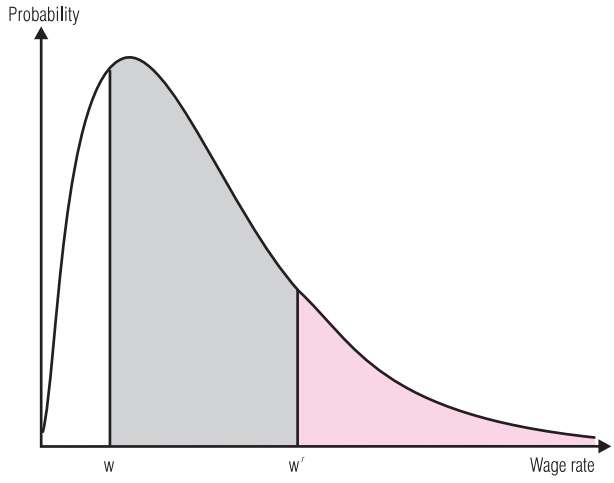
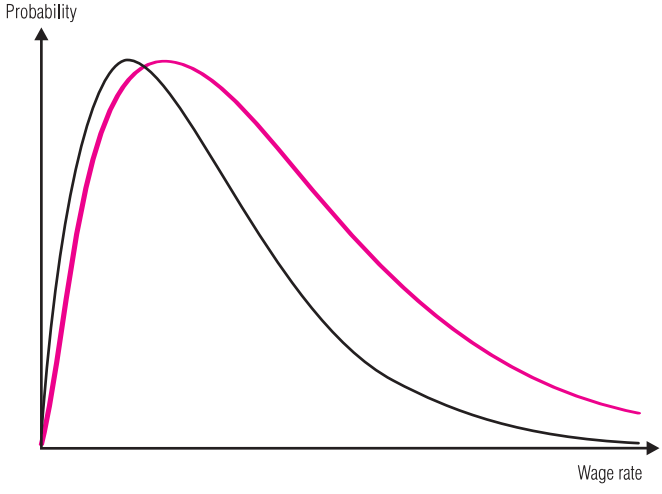


FIGURE 4

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.[5] 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.[6]

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.

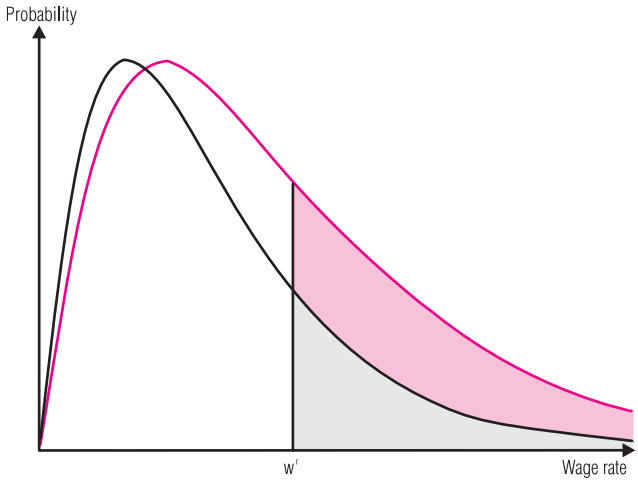
Figure 3 shows the probability of receiving a wage at least equal to the reservation wage. This is also the probability of an individual leaving the pool of unemployed. Individuals *choose* to be unemployed (in the sense that they are rejecting wage offers) because it is rational to do so. A spell of 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;[7] 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.[8]

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, unemployment 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 $G(w) \equiv \int_{\underline{w}}^{\bar{w}} g(w)dw$. 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,

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

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

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

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