A Model of the Natural Rate of Unemployment

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Since the publication of Edmund Phelps' volume, the "new" macroeconomics has treated the labor market as a dynamic process of rational search by unemployed workers for available vacancies. Wages are viewed as at least potentially flexible, though free contracting between workers and firms may lead to fixed wages in the short run. Imperfect information is a crucial element of the theory, for it implies both a need for contracting and a need for rational search rather than simple market clearing in each period.

A positive rate of frictional unemployment may exist in equilibrium, denoted as the "natural" rate. This unemployment is due to the frictions in the search process and imperfections in information rather than to any deficiency in aggregate demand. Milton Friedman defined the natural rate as

> the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is embedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on. [p.8]

This paper reexamines the micro foundations of the natural rate in a model of labor market equilibrium in which turnover flows and imperfect information are explicitly considered. Workers may quit their current jobs to enter the unemployment pool in order to search among available vacancies for a more preferred position. Firms economize on turnover by an appropriate wage policy. The model to be presented is essentially a stationary analogue to models formulated by Dale Mortensen and Phelps (1970b), with one major difference. In this model, the internal labor market for experienced trained workers is conceptually separated from the external labor market for new employees. Moreover, the firm is constrained by morale, moral hazard, and capital market imperfections to pay an identical wage rate to all its employees, regardless of seniority. As a result, both labor markets are unable to clear simultaneously, and in general, quantity adjustments are required in one of the markets. I focus on the case in which the quantity adjustments take place in the external new applicant market.

As a result of this friction in the labor market, equilibrium entails not only the usual voluntary frictional component of unemployment, but possibly also a component of involuntary unemployment. This involuntary unemployment is permanent; it may not be eliminated through aggregate monetary or fiscal policy. Instead it is structural in the sense that it derives from the inability of all markets to clear simultaneously, a friction that is imbedded in the structure of the economy. The equilibrium also contains components of disguised unemployment and search unemployment.

I. The Model[1]

The formal model has the following basic structure. The labor market contains no uncertainty in the aggregate, though every

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[1]This section follows the author (1973b).

worker and firm does face some private uncertainty. When a new employee joins a firm, he is uncertain of the particular set of nonpecuniary characteristics offered by the firm, but learns them through experience on the job. Once these characteristics become known, if the employee is dissatisfied and believes he can do better elsewhere, he quits and joins the unemployment pool to search for alternative employment. (In order to keep the model simple, on-the-job search is ignored.) Quits depend on the tightness of the labor market, rising when unemployment is low and falling when opportunities are scarcer. Unemployment and wage rates adjust until the costs of turnover to firms and the benefits of quitting to workers are equilibrated.

Turnover is costly to firms through its direct costs such as formal orientation programs, expenditures to foremen for "breaking in" new employees as well as indirect costs such as lowered productivity during the adjustment process. As a result, firms utilize wage policy to economize on turnover. This concern for turnover occurs regardless of conditions in the external labor market. Even if a lost worker can be immediately replaced with an identical new applicant, the new applicant is less valuable than an experienced worker, since the turnover costs must be borne again.

Since experienced workers are more valuable to the firm, we would expect to observe wage rates increasing with experience and training. However, even with self-selection there is a limit to the effectiveness of these wage differentials for eliminating turnover. If the time period in which a worker is "inexperienced" is relatively short, then it may be difficult to design a wage schedule that completely compensates for the cost differences. At the limit, if training is instantaneous upon the beginning of employment, then it is impossible for the firm to pay a wage differential to "experienced" workers, for a worker becomes experienced at the very moment he is employed. In this case the only device a firm could employ is an application fee. However, its effectiveness is also quite limited. There is a moral hazard problem in that workers may foresee the firm entering the "application business" of simply collecting fees. Furthermore, workers may not have access to the capital market to borrow a possibly very large application fee.

It is surely unreasonable to explain unemployment solely on the basis of lack of knowledge of firms' characteristics. Product demand uncertainty and its role in layoffs seem to have more empirical significance. The appeal of this model rests not on its empirical validity, but on the logical structure of the analysis, and its focus on the interaction of the unemployment pool with the markets for experienced and inexperienced workers, through the costs of turnover to individual firms. While the exact formal basis for the quit decision is artificial, it does allow for a concentration on these complicated interactions without the additional complexity of an explicit model of demand uncertainty, complete with the necessity of modelling layoffs, implicit employment contracts, inventories, and other variables that would be required by a rigorous general equilibrium model.[2]

The same comment is required for the assumption that firms are unable to regulate the flow of excess applicants through a set of application fees or seniority wages. If moral hazard problems are ignored or eliminated through explicit contracts, the necessary set of markets will be complete and no involuntary unemployment will obtain in the model. On the other hand, as a practical matter, it is impossible for firms to contract away all the randomness and heterogeneity it faces in the labor market. Workers differ with respect to productivity, probability of absenteeism and quitting, and other variables that are crucial to determining a worker's value, yet are difficult to observe and write contracts on. Each of these variables could lead to incompleteness in the set of market-clearing prices required for full-employment equilibrium.

Any incompleteness in the number of prices and any uncertainty that affects the

[2]See Costas Azariadis and Martin Baily.

quit rate will enter the unemployment flows and equilibrium configuration in a manner similar to the example explored here. Thus it is useful to treat the assumptions as loose characterizations of important labor market phenomena, and build more realistic models once the logic is fully understood in a simple context.

A. *The Firm's Problem*

Assumption 1: *Firms produce output with employed labor E according to a nonincreasing returns production function*

$$Q = f(E), f' > 0, f'' \leqq 0$$

Assumption 2: *The capital market is ignored. However, there is a fixed cost $F \geq 0$ for setting up a firm.*

Assumption 3: *New workers (N) must be trained at the outset of employment.* Training costs (T) take place at increasing marginal costs in output terms according to

$$T = T(N) T' > 0, T'' > 0$$

Assumption 4: *Every firm is characterized by a given set of nonpecuniary job attributes.* Workers differ in preferences for these attributes. The attributes are not known to the workers upon becoming employed, but instead, they are learned by working at a firm. Once a worker learns a firm's attributes, he trades off his current wage plus nonpecuniary benefits against the expected benefit of quitting to look for another job and makes a quit decision.[3] If we let z denote a measure of labor market tightness, say the average wage rate adjusted for the probability of getting a job (and including the average nonpecuniary utility), then a firm's quit rate (q) depends on its wage w relative to z:

$$q = q(w/z), q' < 0\ q'' > 0$$

Thus, dissatisfied workers are more likely to quit the tighter are conditions in the labor market. In a stationary state, new hires equal quits.

$$N = q(w/z)E$$

Assumption 5: *The firm may hire new workers N only as long as it has enough willing applicants at its going wage rate.* The applicant function also depends on the firm's relative wage rate w/z, or

$$N \leq A(w/z), A' > 0$$

Assumption 6: *Firms are unable to charge an application fee.* This is a crucial assumption; the lack of competitive application fees is responsible for the incompleteness of markets and for the equilibrium unemployment.

Assumption 7: *The firm faces a perfectly competitive output market at a price equal to one (the numeraire) and chooses a wage of w.* Its optimization problem may be written as follows.

$$\max_{w,E,N} R = f(E) - wE - T(N) - F$$

$$\text{subject to: } N = q(w/z)E : \lambda$$
$$N \leq A(w/z) \quad : \mu$$

Letting λ and μ denote the multipliers we have the Lagrangian

$$L = f(E) - wE - T(N) - F + \lambda[N - q(w/z)E] + \mu[A(w/z) - N]$$

The first-order conditions expressing the firm's wage, employment, and new-hire tradeoffs at an interior solution $(E, w, N) > 0$ are written as follows:

$$(1) \quad E > 0, \quad f'(E) - w - \lambda q(w/z) = 0$$

$$(2) \quad w > 0, \quad -E[1 + \frac{\lambda}{z} q'(w/z)] + \frac{\mu}{z} A'(w/z) = 0$$

$$(3) \quad N > 0, \quad -T'(N) + \lambda = 0$$

In addition, we have the first-order conditions on the constraints,

$$(4) \quad \lambda[N - q(w/z)E] = 0$$

$$(5) \quad \mu[A(w/z) - N] = 0$$

[3]Alternatively, we could generate this quit-rate function if workers have a preference for job variety. For simplicity, on-the-job search is not permitted.

In order to focus on the possibility of involuntary unemployment, it is *assumed* the firm has excess applicants. From (5), we have

$$(6) \qquad A(w/z) > N \rightarrow \mu = 0$$

The remaining first-order conditions exhibit the tradeoffs facing the firm. Substituting λ from (3) into (2), we have

$$(7) \qquad E + \frac{T'(N)}{z} q'(w/z)E = 0$$

This is the wage-turnover cost tradeoff. If the firm raises its wage by a unit, direct wage costs per employee rise by E units; turnover falls by $(1/z)q'E$ units and these workers must be replaced, each at cost T'. Rewriting (7) and (3), we have

$$(8) \qquad T'(N) = -\frac{z}{q'(w/z)} = \lambda$$

Substituting (3) into (1), we have

$$(9) \qquad f'(E) = w + q(w/z)T'(N)$$

The marginal revenue product of an additional worker equals the marginal cost of an additional worker—the wage plus the portion of the worker's turnover costs amortized for a single period.[4]

Substituting (8) into (9), we have

$$(10) \qquad f'(E) = w\left[1 - \frac{q(w/z)}{(w/z)q'(w/z)}\right]$$

Denoting the quit-rate elasticity by $\epsilon > 0$, we have a variant of the conventional monopsony formula,

$$(11) \qquad f'(E) = w[1 + 1/\epsilon]$$

Noting that hires equal quits, we rewrite the constraint,

$$(12) \qquad N = q(w/z)E$$

Equations (9), (10), and (12) may be solved for (E, w, N) as functions of the single exogenous parameters z. It is easy to show that[5]

$$(13) \qquad E = E(z), \qquad E' < 0$$

$$(14) \qquad w/z = W(z), \qquad W' < 0$$

$$(15) \qquad N = N(z), \qquad N' \gtrless 0$$

If $f''(E) = 0$ (constant returns to scale), then $N'(z) < 0$. In order to demonstrate the involuntary unemployment result with as little complexity as possible, we make this assumption. As the labor market tightens (z rises), the firm finds its quit rate rising. It economizes on turnover costs by lowering employment (and new hires). However, it allows its relative wage w/z to fall, implying a higher quit rate at the new optimum. Thus, the firm adjusts its wage rate to the state of the labor market, but, as we shall show in Section II, this wage flexibility is not sufficient to completely eliminate unemployment in equilibrium.

B. *Incomplete Markets, Application Fees, and Market Clearing*

The insufficiency of wage flexibility in clearing the market is a consequence of the manner in which the applicant function enters the firm's optimization. The firm faces two interrelated labor markets, an *internal* labor market for experienced (trained) employees and an *external* market for new applicants. Since the firm has only a single wage rate with which to economize on labor simultaneously in both markets, this single wage is generally unable to clear both markets simultaneously.

Because of turnover costs, the internal labor market dominates the firm's decision making in a loose (low z) market; that is, the applicant function enters merely as a nonbinding constraint (equation (6)). The possibility of a binding constraint is discussed in Section IV.

On the other hand, as David Soskice points out, the firm could economize on applicants separately by charging an application fee in order to equate applicants to new hires. Letting the fee be denoted by $\hat{a}$, we have

$$(16) \qquad A(w - r\hat{a}/z) = N(z)$$

where $r\hat{a}$ is the (implicit) interest on the fee.

[4]If the quit rate is q per period, then a worker's expected tenure is $1/q$ periods. The $T'(N)$ is spread over the entire period equally. The discount rate has been set equal to zero for simplicity.

[5]See the author (1973b) for the details of these derrivations.

Clearly, there exists a fee $\hat{a}$ that would eliminate the excess applicants. Furthermore, if all firms charged excess applicant fees, these fees would lower the expected returns from quitting (z) and imply a labor market equilibrium with zero structural unemployment.

Unfortunately, the use of such application fees is generally limited. Union regulations, antidiscrimination laws, and morale problems generally require firms to maintain equal pay for equal work. In addition, there is a serious moral hazard problem. If the equilibrium fee is very large, workers might (correctly) fear that a firm has entered the "application" industry; that is, it would be in the firm's interest to falsely advertise vacancies to collect application fees.

Another possibility to ensure market clearing is a rising wage structure. This policy is not considered in the optimization written previously because training takes place instantaneously.[6] If training takes time, however, then the application fee may be interpreted as the wage differential between trained and untrained workers. As before, however, this policy has only limited scope. The entire training costs must be captured during the apprenticeship program. This is impossible if training costs are so large to require a negative apprenticeship wage.[7] Furthermore, since training here is firm specific, workers may be averse to bearing such costs in the absence of explicit contractual obligations on the part of the firm.

II. Market Equilibrium

In the absence of application fees or other contractual arrangements, we may solve for the free entry equilibrium in the labor market. Formally, an equilibrium is a number of firms n and wage rates, employments, new hires, and applicants $[w_i, E_i, N_i, A_i]$ for the n firms, such that the n internal labor markets for experienced workers (quits) and n external labor markets for new applicants are cleared. Since there are only n prices attempting to clear $2n$ markets, it is not surprising that quantity rationing must serve as the clearing device in some markets, leading to the possibility of unemployment at the equilibrium.

Equations (13)–(15) summarize the demands of a single firm in this economy as a function of the aggregate variable z. For simplicity, assume that every firm has identical technology and that workers' preferences over nonpecuniary characteristics of firms are symmetric across the attributes offered.[8] Hence, no equalizing wage differentials are necessary; every firm has an identical quit-rate function and all choose identical $[w, E, N, A]$. Under these assumptions, we may easily solve for the equilibrium z^* for n, the number of firms in the market.

Let z, the summary measure of labor market tightness, equal the expected wage in the market.[9] Letting π denote the probability that an unemployed (searching) worker obtains an offer, since every firm pays an identical wage, we have

$$z = \pi w \tag{17}$$

If the equilibrium $\pi < 1$, then involuntary unemployment is positive, whereas full employment entails $\pi = 1$. The supply of workers to the market (each supplying one unit of labor) depends on the probability of employment as well as the wage. Let supply S be given by

$$S = S(z), S' > 0 \tag{18}$$

Since $nE(z)$ workers are employed and $S(z)$ workers each supply a unit of labor, the stock of involuntarily unemployed $U(z)$ is given by

$$U(z) = S(z) - nE(z) \tag{19}$$

[6]Since all trained workers are perfect substitutes, they ought to be paid identical wages at the optimum. See Joseph Stiglitz.

[7]Joanne Salop and the author and A. Weiss explore models of self-selection and apprenticeship.

[8]That is, firms are equidistantly spaced in attribute space relative to preferences. For the details, see the author (1978).

[9]To be fully rigorous, z ought to denote the expected wealth stream accruing to the worker if he quits. This approximation is used for expositional convenience and does not alter the logic of the result. See the author (1973a) for the rigorous formulation.

Note that $U(z)$ does not include those workers who are frictionally unemployed. This can be illustrated by examining the functioning of the market. The state of the market before the period begins can be described as follows: Of the $S(z)$ workers in the market, $nE(z)$ are employed and $U(z)$ are unemployed. At the beginning of a period, some workers quit (a total of $Q(z) = nq(W(z))E(z)$) and enter the unemployment pool. (On-the-job search has been ignored for simplicity; it could be added without changing the basic results of the model, if it is more efficient to search while unemployed.) Thus the total number of workers searching for a job are those that were previously unemployed ($U(z)$) plus those that have just quit ($Q(z)$) or a total of $U(z) + Q(z)$. Of these workers, $nN(z)$ are hired; this is the measure of frictional unemployment in the market. If hiring is done randomly among all the applicants, the probability π that any particular searcher is hired is given by

$$(20) \qquad \pi \equiv \pi^u(z) = \frac{nN(z)}{U(z) + Q(z)}$$

Since the market is in equilibrium, hires equal quits, or

$$(21) \qquad Q(z) = nN(z)$$

Thus, $U(z)$ measures involuntary unemployment and $Q(z)$ measures frictional unemployment.

Substituting (21) and (19) into (20), we have $\pi^u(z)$ as pictured in Figure 1.

$$(22) \qquad \pi^u(z) = \frac{nN(z)}{S(z) - nE(z) + nN(z)}$$

Differentiating, we have[10] $d\pi^u/dz < 0$. Substituting $W(z)$ from (14) into the definition of z in (17), we have a second expression for π.

$$(23) \qquad \pi = \pi^w(z) \equiv \frac{1}{W(z)}$$

Differentiating, we have

$$\frac{\partial \pi^w}{\partial z} > 0, \qquad \text{since } W' < 0$$

[10]Assuming $N'(z) < 0$. Recall that constant returns production is sufficient for $N' < 0$.

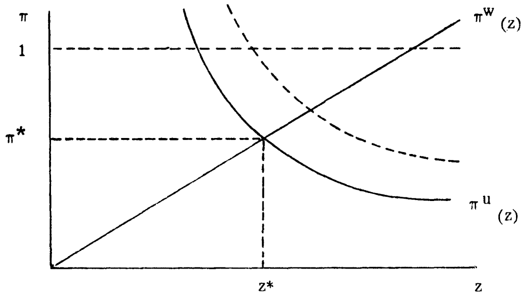

FIGURE 1. EQUILIBRIUM

We set $\pi^u(z) = \pi^w(z)$ to solve for the equilibrium value z^*, as a function of the parameter n.

$$(24) \qquad \frac{1}{W(z^*)} = \frac{nN(z^*)}{S(z^*) - nE(z^*) + nN(z^*)}$$

which defines

$$(25) \qquad z^* = z(n)$$

If $N'(z) < 0$, a unique underemployment equilibrium obtains as pictured below. $\pi^* \epsilon (0, 1)$ is also necessary.

$$(26) \qquad 0 < \pi^* < 1 \leftrightarrow U(z^*) > 0 \leftrightarrow S(z^*) > nE(z^*)$$

This depends quite crucially on the number of firms, n, as well as the supply of labor function.

As the number of firms increases, the $\pi^u(z)$ function shifts up[11] and π^* and z^* rise. Thus, we must ask the question of whether entry by new firms will continue to tighten the labor market until $\pi^* = 1$. In general, this need not be true. Suppose free entry continues until profits per firm equal zero; then rewriting profits $R(z)$ as a function of z, we have

$$(27) \qquad R(z) = f(E(z)) - zW(z)E(z) - T(N(z)) - F$$

The number of firms depends crucially on the level of fixed costs F. By setting F we can essentially set the number of firms n at any level desired. Formally, we have

$$(28) \qquad R(z) = 0$$

From (25) we have $z^* = z(n)$, $z' > 0$. Equa-

[11]Since $n = qE < E$.

tions (25) and (28) may be solved for the unique equilibrium values (z, n). Uniqueness may be demonstrated using the envelope theorem.[12]

$$\frac{dR}{dn} = \left[-wE + \frac{\partial R}{\partial w}\frac{\partial w}{\partial z} + \frac{\partial R}{\partial N}\frac{\partial N}{\partial z} + \frac{\partial R}{\partial E}\frac{\partial E}{\partial z}\right]\frac{dz}{dn}$$

Since $\partial R/\partial w = \partial R/\partial N = \partial R/\partial E = 0$ at the optimum for each firm, we have

$$\frac{dR}{dn} = -wE\left(\frac{dz}{dn}\right) < 0$$

At a zero profit level, a new entrant will incur negative profits. Thus, *an equilibrium in the labor market may exist in which the equilibrium probability of employment (z) is less than one*. Referring back to (26), this implies that unemployment $U(z)$ is positive.

Suppose the supply of labor function shifts, due to governmental manpower programs or migration by new workers into the economy. This rise in the $S(z)$ function lowers π in the short run as more applicants compete for the available vacancies in the market. Quits fall as employed workers perceive the worsened opportunities from search which in turn allows firms to lower wage rates. Profits rise and induce entry by new firms. Surprisingly, the new equilibrium entails an identical z as originally. We may prove this as follows.

Letting the supply shift parameter be denoted by α and rewriting the equilibrium condition (24) and free entry condition (27), we have

$$(29)\quad \pi(z) \equiv \frac{1}{W(z)} = \frac{nN(z)}{S(z,\alpha) - nE(z) + nN(z)}$$

$$(30)\quad R(z) = f[E(z)] - zw(z)E(z) - T(N(z)) - F = 0$$

Equation (30) may be solved for a unique level $\hat{z}$ for all α and n; as α changes, the equilibrium number of firms n simply adjusts to maintain equality in (30). Thus policies that increase the supply of labor to the market have no effect on the *expected* real wage in equilibrium. The proportion of these new workers who become employed is identical to the proportion previously employed.

This unemployment $U(\hat{z})$ is a permanent state of the market. Macro-economic stabilization policies cannot eliminate it. Instead, it arises from the structure of the economy—the lack of market clearing in external labor markets in conjunction with firms' monopsony power in internal labor markets. It is involuntary in the sense that the unemployed workers would be willing to accept a job at the going wage rate; however, at the going wage, offers are not forthcoming to all the unemployed. I call this unemployment *involuntary structural unemployment*. This involuntary structural unemployment is in addition to *frictional unemployment* resulting from workers quitting one job to look for another. Frictional unemployment is measured simply by new hires (or quits) of $\hat{n}N(\hat{z})$.

III. Wage Differentials, Search Unemployment, and Disguised Unemployment

The equilibrium constructed has no wage differentials. However, if firms differ in turnover costs, they will make different optimal wage-turnover tradeoffs. This is expressed in equation (8), which may be rewritten as

$$T'(N) = -\frac{z}{q'(w/z)}$$

If there are turnover-cost induced wage differentials,[13] the optimal behavior by applicants will lead to the existence of equilibrium *search unemployment*. We may model this formally as follows.

Applicants choose a firm (a queue) in order to maximize expected return. If firm j pays a wage w_j, has vacancies N_j and applicants $A_j > N_i$, the expected wage to an applicant from waiting in firm j's queue is

[12] The condition that n must equal an integer is ignored. This is not an unreasonable approximation if n is fairly large.

[13] Permanent noncompensating wage differentials may also be due to differences in production functions, discount rates, etc. See the author (1973a).

given by z_j, where[14]

(31) $z_j = w_j N_j / A_j \quad j = 1, 2, \ldots, n$

Suppose there are $\bar{A}$ total applicants in the market. If each applicant observes $[w_j, N_j, A_j]$ and chooses a queue to max z_j, the number of applicants will adjust until an equilibrium queue distribution is achieved in which returns are identical in each, or

(32) $z_j = \bar{z}$ for all j

Solving (31) and (32) we have

(33) $A_j = N_j(w_j/\bar{z})$

(34) $\bar{A} = \sum A_j$

Clearly $\bar{z}$ will depend on $\bar{A}$ and $[w_j, N_j]$.

For example, suppose firms' wages were distributed uniformly in (w_a, w_b) and due to both production function and training function differentials, every firm had an identical number of vacancies N. Then solving explicitly, we have

(35) $A(w) = (w/\bar{z}) \cdot N$

This is a linear function of w. Since

(36) $\bar{A} = \int_{w_a}^{w_b} A(w)dw$

we have

(37) $\bar{z} = \left(\frac{w_b^2 - w_a^2}{2}\right) \frac{N}{\bar{A}}$

In Figure 2, the area between $A(w)$ and N consists of search unemployment[15] plus structural involuntary unemployment. On the diagram, this is shown as follows. The area between $S(w)$ and N measures search unemployment and the area between $A(w)$ and $S(w)$ measures structural involuntary unemployment. Frictional unemployment is measured as the area under N, the total flow of vacancies in the market.

It may be noted that equilibrium may entail zero involuntary unemployment. (For example, $S(w)$ could measure the *total* applicants per firm.) However, equilibrium does imply that only the minimum wage firm may have a binding queue. In equilibrium any firm choosing $w > w_a$ will have excess applicants.[16]

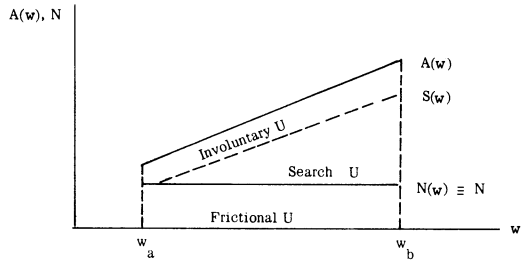

FIGURE 2. EQUILIBRIUM WITH WAGE DIFFERENTIALS

Finally, we may also measure the *disguised unemployment* that arises as a result of the existence of *structural unemployment*. If there were no structural unemployment, there would be a supply $S(w)$. However, because of the limited opportunities in the market, only $S(z)$ enter the labor force. Thus a stock of potential workers $D(z)$ never enter, where $D(z) = S(w) - S(z) \geq 0$. These workers comprise *disguised unemployment*.

IV. Full-Employment Equilibrium

The solution of the formal model demonstrates only the possibility of an equilibrium with structural unemployment, not its necessity. In the analysis it is *assumed* that the necessary condition $\pi < 1$ is fulfilled. Fortunately, some supply function $S(z)$ or fixed cost F can always be found that ensures that z equilibrates at $\pi < 1$. On the other hand, for small $S(z)$, an equilibrium with $\pi = 1$ obtains, a full-employment equilibrium.

Moreover, the analysis of Section I assumes that the applicant constraint is not binding. In my 1973b paper, the possibility of a binding applicant constraint is considered, the regions where it is binding are derived, and the expanded $W(z)$, $E(z)$, and $Q(z)$ functions are calculated. Employing that expanded analysis in the present equilibrium model, involuntary structural unemployment obtains for certain values of the technological and supply parameters of

[14]As before, the expected *wealth* in each queue should be calculated.

[15]See Robert Hall for an application of this analysis.

[16]This flows directly from (38) and (39). If for the $w > w_a$ firm, $z(w) = z_a$ and $w > w_a$, then $\pi(w) = N(w)/A(w) < 1$.

the model. Moreover, cases may exist in which there are multiple equilibria, some with full employment and some with unemployment. This is no surprise, for multiple equilibria and nonexistence often occur in models of price-setting agents and incomplete markets.[17]

When the possibility of wage differentials is included as in Section III, a similar expansion of the analysis is necessary; the involuntary unemployment area between $A(w)$ and $S(w)$ may disappear. However, as long as there are wage differentials, equilibrium must entail a positive level of search unemployment, as more applicants queue at high wage than low wage firms.

V. Conclusions

An incomplete set of market-clearing wages will prevent the labor market from attaining the classical zero involuntary unemployment equilibrium. Instead a permanent level of involuntary structural unemployment and disguised unemployment may result as quantities adjust to the nonmarket-clearing wages. This unemployment is in addition to the frictional and search unemployment of the "new" macroeconomics.

The job shortage interacts with firms' monopsony power in the labor market to ensure that the aggregate unemployment rate is not optimal. Even if the level of frictional unemployment were efficient, the three other types of unemployment are not. Search unemployment requires an equalization of *average* rather than marginal rates of substitution; disguised and structural unemployment entail quantity rather than price adjustments.

Finally, the analysis of the paper has focused on the existence of a structural unemployment equilibrium. It should be noted that an equilibrium may also exist with zero structural unemployment. Such multiple equilibria generally exist in economies with incomplete markets or market power. However, a detailed analysis of the exact conditions under which multiple equilibria obtain is left to a sequel.

[17]See John Roberts and Hugo Sonnenschein, and the author (1978) for examples.

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