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RAIDS AND OFFER-MATCHING

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Job changes often occur without spells of unemployment. Highly educated workers, for example, rarely suffer unemployment, even though job changes are common. A large proportion of their job switches occur only after the new job is secured. These workers, whose skills and ability levels are less homogeneous, differ from less skilled, perhaps more homogeneous workers who are more likely to experience unemployment in the process of changing jobs. Most research has focused on job changes that imply spells of unemployment. Indeed, the primary rationale behind the earliest papers on search theory was to explain unemployment.[1] But if there exists what some refer to as a "dual labor market,"[2] these theories may be most applicable to the secondary workers. This paper attempts to formulate a theory of turnover and wage dynamics that may better describe the primary labor force, defined as those who change jobs without unemployment.[3] In the process, a number of previously unexamined phenomena are explored.

The first task is to understand the relationship between worker quality and turnover. Do markets clear more quickly for the most able workers? Why is it that there is a tendency to try to hire the most able individual, even though his wage rate is higher? It appears that prices do not adjust fully for differences in quality. Buyers constantly seek that diamond in the rough. This also yields a variation on the Peter Principle: The best workers are stolen away so those who remain appear incompetent relative to their peers.

The process that is examined makes "stigma" an important feature of labor markets. Because of the information that is produced when workers receive or fail to receive outside offers, workers who are undesired by outsiders are treated differently from those who enjoy an active outside market. Thus, stigma, which can be thought of as the consequences of a worker's history of offers and/or employment, is modeled and treated explicitly.

Information about worker ability evolves over time. The model provides a parsimonious description of the process by which a worker's wage converges to his marginal product. The patterns of turnover and wage change can be related in a very simple way to the difficulty associated with learning a worker's ability. For example, when information is difficult to acquire, wages have little dispersion within an occupation, and stigma is unimportant. Further, there is only a very weak relation between ability and tenure. Other relationships are easily traced.

A number of implications are derived. Among the more interesting are:

(1) The best workers are more likely to be raided. Everyone goes after high quality, higher-priced ones rather than lower quality, lower-priced ones.

(2) Wages of workers who receive outside offers differ from wages of those who do not. A corollary is that the importance of stigma depends upon the probability that an outsider recognizes the ability of a given firm's workers. Stigma is not likely to be as pronounced for assembly line workers as it is for research academicians. As a result, wages converge less quickly to true output for assembly line workers than for academicians.

(3) The wage difference between the best paid and worst paid workers within an occupation is positively related to that occupation's equilibrium level of turnover. Turnover is a proxy for market information, which tends to drive each worker's wage toward his marginal product.

(4) The difference between the wages of those who turn over and those who do not is negatively related to the equilibrium level of turnover within an occupation. Low-turnover occupations are likely to have the most pronounced differences between the wages of movers and stayers.

(5) The oldest workers on a given job are the least productive. This paraphrases the Peter Principle[4] and results because the most able of the young workers are bid away.

(6) Workers who search for jobs during time not worked may actually have lower wages than those who "loaf" during the unworked time. Failed search carries worse connotations for the worker's productivity than not searching at all.

Before any implications are derived, it is necessary to construct a model and to outline a few basic relations. That is done in the next section.

I. A MODEL

To focus on competition among firms for workers, we begin with a simple model that captures the key features of the effects of informational differences and informed trading. This enables us to examine phenomena such as raids and offer matching in the labor market.

The Basic Set-Up:

Suppose that there are two firms, j and k, and that the worker is currently signed up to work for firm j. In April, j announces to the worker that it will pay him a salary of W, beginning September 1. After that announcement is made, firm k may decide to raid. Raiding means that k makes a counter-offer to the worker that exceeds W. After the counter-offer is made, j has the option to up its bid, followed by k's counter, and so forth until one of the two firms drops out of the bidding. All of this occurs before September 1.

The worker is worth M_j at firm j and M_k at firm k. Further,

$$M_j = M + S$$

$$M_k = M$$

so that M is the worker's general skill and S is specific to the current firm.[5] A negative value of S implies that the worker is better suited to firm k. Both M and S are random variables. For simplicity, it will be assumed throughout that they are distributed uniformly: M is uniform on the interval [0, 1] and S is uniform on the interval $[-\alpha/2, \alpha/2]$. Thus, M_j takes on values from $-\alpha/2$ to $1 + \alpha/2$ and M_k takes on values from 0 to 1. As α increases, the match-specific component becomes more important. At one extreme, with $\alpha = 0$, all skills are general. At the other extreme, assuming that $\alpha \leq 1$, there is as much variation in the specific component as in the general one.

Information about the worker's productivity takes the following form: With probability P_j firm j observes M_j exactly, i.e., j is "informed." With probability $(1 - P_j)$, firm j only knows the distribution of M_j. Similarly, with probability P_k, firm k observes M_k exactly. With probability $(1 - P_k)$, firm k knows only the distribution of M_k.

In general, one might expect that $P_j > P_k$. Still, this does not imply that $P_k = 0$. As an example, suppose that to become informed of a worker's productivity, it is necessary to read one of his papers in the AER. If a potential employer reads only one of twenty papers per issue, then the probability that any one paper is read is .05. Although the current employer is more likely to read one of his own workers' papers, so that $P_j > P_k$, it is still possible that an outsider may read one that the current employer overlooks (for example, when two of his workers have papers in the same issue).

This notwithstanding, unless otherwise noted, it will be assumed that $P_j = P_k = P$ for notation simplicity. The P can be thought of as an index of an occupation's "visibility." In some jobs, it is difficult (for insiders and outsiders) to learn the worker's marginal product. For others, the task is

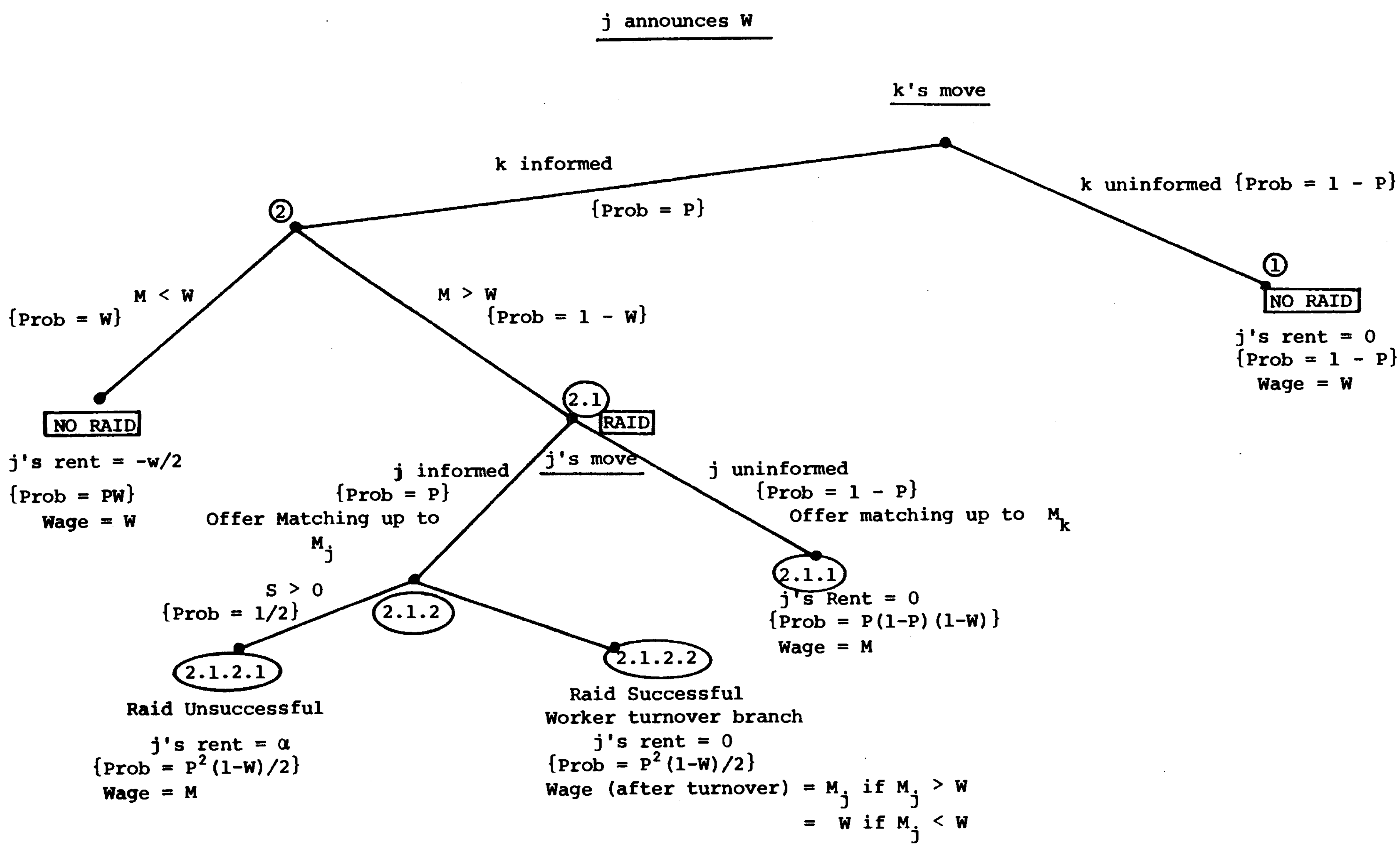
j announces W
k's move
k informed
{Prob = P}
k uninformed {Prob = 1 - P}
1
NO RAID
j's rent = 0
{Prob = 1 - P}
Wage = W
2
M < W
{Prob = W}
M > W
{Prob = 1 - W}
NO RAID
j's rent = -w/2
{Prob = PW}
Wage = W
2.1
RAID
j's move
j informed
{Prob = P}
Offer Matching up to
M_j
j uninformed
{Prob = 1 - P}
Offer matching up to M_k
2.1.1
j's Rent = 0
{Prob = P(1-P)(1-W)}
Wage = M
S > 0
{Prob = 1/2}
2.1.2
2.1.2.1
Raid Unsuccessful
j's rent = α
{Prob = P^2(1-W)/2}
Wage = M
2.1.2.2
Raid Successful
Worker turnover branch
j's rent = 0
{Prob = P^2(1-W)/2}
Wage (after turnover) = M_j if M_j > W
= W if M_j < W

Figure 1

easier. At one extreme is an assembly line worker, whose individual output is difficult to separate from that of his co-workers. It is also unlikely to be observed by a potential raider. At the other extreme is an academic economist, who publishes his ideas and makes his product easily observed to insiders and outsiders.

The situation is depicted in figure 1. It starts after j has announced a wage offer of W, to which k must react. Wage W, derived below, is the optimal offer consistent with zero profits. Firm k is either informed, with probability P, or uninformed. If k is uninformed, then node 1 is relevant, where k's best strategy is to pass. A raid at any wage greater than W has negative expected value, and any raiding offer less than W is doomed to failure.[6]

A raiding offer by k at a wage greater than W encounters either an informed or uninformed j. If j is informed, then j fails to match the offer only when it exceeds M_j. But the expectation of M_k, given that $M_j < Z$ (for any Z) is

$$(1) \quad E(M|M + S < Z) = \frac{1}{\alpha/2 + \min(Z, \alpha/2)} \int_{-\alpha/2}^{\min(Z,\alpha/2)} \int_{0}^{Z-S} \frac{M}{Z - S} \, dM dS \; .$$

It can be shown that this is always smaller than W, the initial wage offer made by j.[7] Therefore, no raid by k that can be successful is profitable. This is a manifestation of "winner's curse." On average, a bid that successfully attracts a worker is too high if the bidder is uninformed. A worker who can be stolen away from an informed employer is a worker that k would rather do without at the price required to steal him.[8] So if j is informed and k is not it pays for k to pass.

If j is uninformed, then k's offer must be interpreted by j. If j believes that k only raids when k is informed, then j must calculate the expected value of M_j, given that $M \geq W_k$ since k would not offer W_k unless it were less than M:

$$E(M_j \mid M > W_k) = E(M \mid M > W_k) + E(S)$$
$$= (W_k + 1)/2 + 0 > W_k$$

since $W_k < 1$ and since M and S are independent. Thus, it always pays for j to match k's offer so k's raid cannot succeed if j is uninformed. Thus, although k does not know whether j is informed or not, it does not pay to raid under either situation.

If j assumes that k raids when k is uninformed as well as informed that $M > W$, then j's counter-offer will still be high enough to make it unprofitable for k to raid when uninformed. That is, the equilibrium will not be rational because j assumes that k raids when uninformed, but it does not pay for k to do so when j maintains that assumption.

The reason is that k knows that it can win a bidding war against j only when j is informed that $M + S < W_k$. (If j is uninformed, j follows k so k cannot outbid j.) Under those circumstances, when k wins, it receives

$$E(M \mid M + S < W_k) - W_k .$$

Equation (1) (and footnote 7) imply that this expression is negative. Thus, it does not pay for k to raid when uninformed so this violates j's initial assumption.

This somewhat lengthy discussion boils down to the conclusion that k's optimal strategy is to pass when uninformed. Thus, no raids occur at node 1. This means that j keeps the worker at wage W and has an expected rent of (1/2 - W).

Things are more interesting when k is informed. Under those circumstances, raids can take place, but are not automatic. Node 2 is reached when k is informed. There are two possibilities: k knows that $M > W$ (node 2.1) or k knows that $M \leq W$ (node 2.2). When $M \leq W$, it does not pay for k to raid because a successful raid would result in losses of $W - M$. As it turns out, j's expected rent at this node is negative as well:[9]

$$\text{J's Rent at 2.2} = E(M + S \mid M < W) - W \tag{2}$$
$$= E(M \mid M < W) + E(S) - W$$
$$= W/2 - W = -W/2 \ .$$

At node 2.1, when k is informed that $M > W$, it pays to raid. There is some positive probability that k will attract the worker at a price less than M. To see this, recognize that a raiding k encounters either an informed or uninformed j. If j is uninformed (node 2.1.1), j must infer M_j from the fact that k raided. As already noted, j's inference is that $E(M_j \mid M > W) = (W + 1)/2 > W$ so j matches every offer by k.[10] Under these circumstances, j retains the worker, but the expected rent to j from doing so is exactly zero since k drops out of the bidding only when the wage offer has reached M.

The reason that k engages in this bidding war is that k does not know that j is uninformed and when j is informed, k earns profit from the battle. That occurs at node 2.1.2. There, j is informed. The only factor that distinguishes j from k at this point is the specific factor, S. If $S > 0$ then j will always end up out-bidding k and will retain the worker. Since k and j only see M_k and M_j respectively, and not M and S separately, they do not know the outcome of the bidding until it has actually occurred.[11] This is shown at node 2.1.2.1. There j retains the worker, but ends up paying M for him because k drops out of the bidding only when the wage has gone to M. The expected rent that j receives at node 2.1.2.1 is

(3) $$J\text{'s rent at } 2.1.2.1 = E(M_j - M \mid M > W,\ S > 0)$$
$$= E(S \mid M > W),\ S > 0)$$
$$= \alpha/4 \ .$$

If $S < 0$, then j will lose the bidding war. This occurs on node 2.1.2.2. Firm j earns no rent (the worker leaves before work takes place), but firm k earns profit. Firm j drops out of the bidding only when the wage has reached $M + S$, or if $M + S < W$, then j never counters. Firm k receives M in output from the worker, at wage = $\text{Max}[W, M + S]$. Since $M > W$ and $M > M + S$, k earns rents.

It is node 2.1.2.2 that generates k's desire to raid. Although k does nothing other than raise the worker's wages on nodes 2.1.1 and 2.1.2.1, k is successful in stealing the worker at 2.1.2.2 and earns profit from doing so. There, k pays either W or $M_j = M + S$ when $S < 0$ for the worker, but receives M. If $W < M_j$, then j drops out when the wage reaches M_j. Thus, k receives $-S$ on each worker. If $W > M_j$, then j does not even respond to k's first offer and k receives $M - W$. This also shows why it is important to have some firm-specific output. Firm k wins the worker when S is negative. If S were always zero, then k would never raid. Although α may be very small, all that is required is that it remain positive to make it profitable for k to raid.

Node 2.1.2.2 is special also because it is the only situation in which turnover occurs. This happens with probability $P^2(1 - W)/2$. Since, as will be shown below, W is decreasing in P, turnover increases as P rises. More "visible" occupations have more turnover. A number of related empirical implications are discussed later.[12]

Equilibrium and Offer Matching:

The interactions described above yield equilibrium: j assumes that k raids if and only if k is informed that $M > W$. Under that assumption, it pays for k to do just that. An alternative equilibrium, in which j assumes that k raids when informed that $M > W$ or when k is uninformed, is not consistent. Under these circumstances, k prefers not to raid when uninformed. Other possibilities (k raids only when uninformed or when informed that $M < W$) do not yield consistent equilibria either.[13]

One interesting feature of battles between j and k is that k hopes that j is informed. The reason is that if j is ignorant, j's best response is to follow k, so that k can never succeed in attracting the worker. If j is informed, then j allows the worker to leave when $S < 0$. It is under these circumstances that k makes money. What is also true, of course, is that the worker ends up being employed efficiently.

Also note that it is rational for j to match offers. The pattern of offer matching varies, however, with j's information. If j is uninformed, then j takes all cues from the market. It always pays to respond to k. If j is informed, j only responds to k's offer up to $M + S$. If S is negative, this means that the worker receives a wage less than M, even though a raid has occurred. So the worker prefers that k be informed that $M > W$, but that j be uninformed. Under these circumstances, he receives M. If both are informed, he receives M when $S > 0$, but only the maximum of $M + S$ and W when $S < 0$. This is necessarily less than M.[14]

Derivation of the Initial Wage Offer:

Firm j operates in a competitive labor market and cannot attract workers unless it offers the highest wage consistent with zero profits (and behaves efficiently). This means that W must be set so that j's expected rent on hiring a worker at W is zero. Of course, this takes into account that the level of W affects the number of raids that occur and that if a raid occurs, the worker is paid a wage other than W.

Firm j earns rent at nodes 1, 2.1.2.1, and negative rent at node 2.2. Thus, the expected rent is the probability of arriving at those nodes, times the expected rent at the relevant node. The zero rent condition is given by

$$(4) \qquad \text{Expected Rent} = 0 = (1 - P)[\tfrac{1}{2} - W] + \frac{P^2(1-W)}{2}[\alpha/4] + PW[-W/2] \; .$$

Solving (4) for W yields two roots, one of which is always negative and attracts no workers. The other is given by

$$(5) \qquad W = \frac{1}{8P}\left\{\alpha P^2 - 8P + 8 + \sqrt{(\alpha P^2 - 8P + 8)^2 - 16P(4P - 4 - \alpha P^2)}\right\}$$

This rather messy expression can be made intuitive in two ways: First, note that

$$(6) \qquad \lim_{\alpha \to 0} W = (\sqrt{1-P} + P - 1)/P \; .$$

Although α cannot be exactly zero (or k never raids), it is instructive to examine behavior at the limit.

As α becomes zero, the rent associated with node 2.1.2.1 goes to zero as well. This means that the rent that the firm earns on node 1 must offset the "winner's curse" effect on node 2.2. Consider what happens if $P = 0$. Under these circumstances, k never raids, so that j is left with the entire distribution of workers. The expected value of $M + S$ for the entire population is 1/2 so $W = 1/2$. The limit of the r.h.s. of (6) as P goes to 0 is 1/2. If $P = 1$, then a raid occurs any time the worker's wage is below his marginal product. Since $S = 0$, this means that the firm ends up paying M for all workers with $M > W$ (or losing them) which yields zero rent. But it also ends up paying W for all workers with $M < W$. This is a losing proposition for any $W > 0$ so the solution when $P = 1$ is $W = 0$. Substitution of $P = 1$ into (6) yields $W = 1$.

For $0 < P < 1$, W is bounded by zero and 1/2. The intuition is straightforward. Firm j knows that for any W, it will lose $P^2(1 - W)/2$ to firm k. This is illustrated in figure 2 by the shaded area so that j is left with the unshaded area. It must be the case that the W is chosen so that the expectation of M, over the distribution reflected by the unshaded area (normalized), is equal to W. A lower W means that more workers are picked off. It is clear that W must lie below 1/2 in order for the expectation after having removed the shaded area to equal W. Only if nothing were removed from the upper portion (i.e., if $P = 0$), would the expectation of M among the stayers be 1/2.

Stated in other terms, there are only two reasons that a worker is not stolen away when α approaches 0. Either his value to both j and k is below W so that k opts not to raid, or that $M > W$ but k is uninformed. As P increases, the probability that the worker is unraided merely because k is uninformed declines, so that workers who remain tend to be lower quality. As such, W must fall to compensate.

When α is greater than zero, (5) is difficult to interpret, but numerical solutions are instructive. Table 1 calculates W for values of α and P as given by (5).

The first two columns of table 1 report the value of W that yields zero profits, given the corresponding P and α. Three points, which are tedious to show analytically, are obvious from the table:

First, independent of α, the equilibrium level of W is .5 when $P = 0$. Since no raids occur, j is left with the entire distribution of workers, which has an expected value of output equal to .5.

Table 1

(1) P	(2) W	(3) Probability of leaving	(4) Expected Wage Leavers	(5) Expected Wage Stayers	(6) Gap	(7) Expected Wage
α = .001						
0.000	0.500	0.000	0.749	0.500	0.250	0.500
0.100	0.487	0.003	0.743	0.499	0.244	0.500
0.200	0.472	0.011	0.736	0.497	0.238	0.500
0.300	0.456	0.025	0.728	0.494	0.233	0.500
0.400	0.436	0.045	0.718	0.490	0.228	0.500
0.500	0.414	0.073	0.707	0.484	0.223	0.500
0.600	0.387	0.110	0.693	0.476	0.217	0.500
0.700	0.354	0.158	0.677	0.467	0.210	0.500
0.800	0.309	0.221	0.654	0.456	0.198	0.500
0.900	0.240	0.308	0.620	0.447	0.173	0.500
1.000	0.012	0.494	0.506	0.494	0.012	0.500
α = .25						
0.000	0.500	0.000	0.691	0.500	0.191	0.500
0.100	0.487	0.003	0.685	0.500	0.185	0.500
0.200	0.473	0.011	0.678	0.498	0.179	0.500
0.300	0.457	0.024	0.670	0.496	0.174	0.500
0.400	0.440	0.045	0.661	0.493	0.168	0.500
0.500	0.421	0.072	0.651	0.488	0.163	0.500
0.600	0.398	0.108	0.640	0.483	0.156	0.500
0.700	0.371	0.154	0.626	0.478	0.149	0.500
0.800	0.338	0.212	0.609	0.471	0.138	0.501
0.900	0.293	0.286	0.587	0.466	0.120	0.501
1.000	0.221	0.390	0.550	0.469	0.081	0.501
α = .5						
0.000	0.500	0.000	0.640	0.500	0.140	0.500
0.100	0.487	0.003	0.634	0.500	0.134	0.500
0.200	0.474	0.011	0.627	0.500	0.128	0.500
0.300	0.459	0.024	0.619	0.497	0.122	0.500
0.400	0.444	0.045	0.611	0.495	0.115	0.501
0.500	0.427	0.072	0.602	0.493	0.109	0.501
0.600	0.408	0.107	0.592	0.491	0.102	0.501
0.700	0.387	0.150	0.581	0.488	0.094	0.502
0.800	0.363	0.204	0.569	0.486	0.083	0.503
0.900	0.334	0.270	0.554	0.484	0.069	0.503
1.000	0.296	0.352	0.534	0.487	0.047	0.504
α = .75						
0.000	0.500	0.000	0.597	0.500	0.097	0.500
0.100	0.487	0.003	0.590	0.500	0.091	0.500
0.200	0.474	0.011	0.583	0.500	0.084	0.500
0.300	0.461	0.024	0.576	0.500	0.077	0.501
0.400	0.447	0.044	0.568	0.498	0.070	0.501
0.500	0.433	0.071	0.560	0.498	0.062	0.502
0.600	0.418	0.105	0.552	0.497	0.054	0.503
0.700	0.402	0.146	0.543	0.498	0.046	0.504
0.800	0.386	0.197	0.534	0.500	0.036	0.506
0.900	0.368	0.256	0.525	0.501	0.023	0.507
1.000	0.349	0.325	0.514	0.506	0.008	0.509
α = 1						
0.000	0.500	0.000	0.562	0.500	0.062	0.500
0.100	0.487	0.003	0.555	0.500	0.055	0.500
0.200	0.475	0.011	0.547	0.500	0.047	0.501
0.300	0.463	0.024	0.540	0.500	0.039	0.501
0.400	0.451	0.044	0.532	0.501	0.031	0.503
0.500	0.439	0.070	0.525	0.502	0.023	0.504
0.600	0.427	0.103	0.518	0.504	0.014	0.506
0.700	0.417	0.143	0.512	0.507	0.005	0.508
0.800	0.407	0.190	0.506	0.511	-.005	0.510
0.900	0.398	0.244	0.501	0.516	-.016	0.513
1.000	0.390	0.305	0.496	0.524	-.028	0.516

Second, for all values of α, $\partial W/\partial P < 0$. As the probability of being raided rises, the equilibrium level of W falls. There are a number of effects. As P rises, the force of winner's curse (node 2b) increases. This implies that a lower W is required to keep profits the same since rent here equals -W/2. Also as P rises, the probability that no raid will occur falls (node 1 is less likely). This also implies that a lower W is required to keep profits the same since rent on this branch is $1/2$ - W. Offsetting this is that the probability of landing on branch 2.1.2.1 is higher, the higher is P. Firms are more likely to know about their own workers in more visible occupations. Since rent equals $\alpha/4$ on this branch, a higher P implies that the firm must pay higher W to keep profit the same. The first two effects swamp this one, but the last effect becomes more important the higher is the job-specific component. This is seen in the table. The value of W falls more rapidly with P for small values of α than for large values of α. That is, $\partial^2 W/\partial P\,\partial\alpha > 0$.

Third, as α rises, W rises for a given P, $(P > 0)$, i.e., $\partial W/\partial\alpha \geq 0$. This is another manifestation of the last point. As firm-specific capital becomes more important, the rent that j earns when on branch 2.1.2.1 increases. Since the factor market is competitive, it must redistribute this rent to the workers and this can only happen by making a higher initial wage offer.

II. Implications and Extensions of the Model

Turnover:

Recall that turnover occurs only on branch 2.1.2.2. The outsider must be informed that $M > W$ and the current firm must be informed of the worker's output as well. Furthermore, the worker must be worth more to the outsider than to the insider $(S < 0)$ or turnover will never occur.

This observation gives rise to a number of implications. First, the probability of turnover is

(7) $$\text{Prob. of Turnover} = P^2(1 - W)/2$$

which, as already mentioned, is increasing in P since $\frac{\partial}{\partial P} = P(1 - W) - \frac{P^2}{2}\frac{\partial P}{\partial W}$ and $\partial W/\partial P < 0$. Individuals in more visible occupations are more likely to change jobs.

More important, perhaps, is that it is individuals from the top of the distribution who get raided. They are both more likely to change jobs and are also more likely to have their wages raised above the initial quote. Because of imperfect information about worker quality, the initial wage offer tends to overvalue low quality workers and undervalue high quality ones. Outsiders attempt to pick off only the high quality ones. All firms know this when they hire workers of uncertain quality, and that is the reason why W is generally lower than 1/2. But it is still true that the first employer ends up with workers whose average product is below that of the ex ante distribution. Raided workers and those who turn over without spells of unemployment are diamonds in the rough.[15]

It is appropriate for employers to respond to outside offers because those offers convey information about the worker. Additionally, even when the current employer has complete information about a worker, a response up to M_j is appropriate because quasi-rents are increased by adopting this strategy.[16]

Since neither P nor α are likely to be observable, it is useful to state implications in terms of other observable variables. In this context, the observable variables are W, the initial offer and wage that unraided workers receive; the wage that workers who turn over receive; the wage of stayers (raided and unraided); and the probability of turnover within an occupation. First, the theory provides predictions on the relation of W to the probability of turnover.

Recall that the equilibrium wage W depends only on α, the importance of firm specificity, and on P, the visibility of a job. As α rises, W rises for a given P. Also, $\partial/\partial W$ in (7) is negative. This implies that if an increase in α is the reason for a higher W, j's starting wage and the probability of turnover will be negatively correlated. Further, as P falls, W rises. An increase in W and decrease in P both imply less turnover through (7). Thus, if P is the cause of the change in W, W and turnover will be negatively correlated.

The conclusion then is that independent of the source of variations in W, the probability of turnover and the initial wage that j offers (and that unraided workers receive) are negatively related across occupations. This provides an empirically testable and novel prediction about the relation of turnover to the level of wages within an occupation.

Other Wages and Turnover:

It may seem somewhat counterintuitive that wages are lower in more visible occupations. Increases in P imply that there are more circumstances where j finds itself competing with k. Competition among buyers usually improves the situation of the worker. That is true here as well because there is a distinction between the average wage that the worker receives and the wage that the employers are willing to pay to workers who do not receive outside offers. Although W falls with P, it is not true that the average wage falls. Visibility helps sort workers to their most productive use.

The worker receives W when no raid occurs. This happens at nodes 1 and 2.2. At nodes 2.1.1 and 2.1.2.1, the worker receives M and stays with j.

At node 2.1.2.2, the worker leaves and receives W^+ if $W > M + S$ (j does not respond to k's first offer) and $M + S$ ($S < 0$) if $W < M + S$ (j continues to match until k outbids him). Thus, the wage that one observes in an occupation is made up of the wage of leavers and stayers. Since stayers come from two groups (those who are raided and stay and those who are never raided), their average wage is given by

$$E(\text{wage}|\text{stay}) = \frac{W(1-P+PW) + E(M|\text{raided \& stay})[P(1-P/2)(1-W)]}{(1-P+PW) + P(1-P/2)(1-W)}$$

or

$$(8) \qquad E(\text{wage}|\text{stay}) = \frac{W(1-P+PW) + (1/2+W/2)P(1-P/2)(1-W)}{(1-P+PW) + P(1-P/2)(1-W)} .$$

The expected wage for leavers is a convex combination of those who leave at wage W^+ and those who leave after a battle between j and k, at wage $M + S$. This is somewhat messy to derive and is relegated to the appendix. It is given by

$$(9) \qquad E(\text{wage}|\text{leave}) = \theta W + (1 - \theta)(1/2 + W/2 - \alpha/8)$$

where θ is defined as the probability that a leaver left at wage W rather than after a bidding war, and from the appendix,

$$\theta = \frac{\alpha}{4(1 - W)} .$$

The expected wages for leavers and stayers are given in columns 3 and 4 of table 1. Leavers' wages decline monotonically in P, but stayers' wages do not. Stayers' wages are either W or M. The fall of W with increased P is offset by the higher probability of receiving M rather than W as P rises. Leavers' wages fall in P because a higher P implies a lower W. Lower W means that a lower average quality worker is susceptible to raid as

P increases (i.e., $M > W$ is a necessary condition for raiding).

The difference between the wages of leavers and that of stayers is reported in the sixth column of table 1. It is generally positive, implying that leavers do better than the average stayer. Recall that leavers receive the minimum of $M + S$ and W, given that $S < 0$. Stayers get either W or M. As α gets large so that S becomes important, stayers can actually do better than leavers. This is because stayers who remain after a raid find their wages bid up to M, whereas leavers get $M + S$ when $S < 0$. If S is important, j does not bid very hard against k so the worker changes jobs at a relatively low wage.

The difference between the leavers' and stayers' wages decreases in P. As P increases, workers are more likely to get M or $M + S$ rather than W. It is this point that lies behind the standard intuition. Higher visibility increases the probability of a battle. Battles imply that workers get something nearer to marginal product. This implies that the difference between the average wage of movers and stayers declines with turnover in the occupation. Since turnover is directly related to P (see eq. (7)), high turnover occupations are those associated with small gaps. But it also implies that the average wage change associated with a job switch is increasing in P. The wage change is measured not by the difference between the average wage of leavers and stayers, but by the difference between the average wage of leavers and W. That value is increasing in P.

The study of the difference between wages of movers and stayers is of great empirical interest (see, for example, early papers by Heckman and Willis (1977), Bartel (1980), Bartel and Borjas (1981), and Borjas and Rosen (1980)). This model provides a theory behind these empirical relationships.

Intra-firm Wage Dispersion and Stigma:

As P increases, the difference between the wage of unraided and wages of raided workers who remain with the firm rises. Recall that workers who are raided necessarily have $M > W$. Also recall that those workers who remain after a raid are paid M (nodes 2.1.2.1 and 2.1.1). Now,

$$E(M \mid M > W \text{ and } S > 0) = E(M \mid M > W)$$

because M and S are independent. This implies that the expected wage at both nodes are the same and equal to $(1 + W)/2$. Thus, the gap between the expected wage paid to those who remain, but are raided and those who are not raided is

(10) $$\text{Internal wage gap} = (1 + W)/2 - W = 1/2 - W/2 \; .$$

Differentiating (10) with respect to P yields

$$\partial/\partial P = -1/2 \; (\partial W/\partial P) > 0 \; .$$

Thus, the difference between the way that raided and unraided workers are treated depends positively on the visibility of the occupation.

This proposition has obvious intuitive appeal. If P is small then little can be inferred from the fact that a worker was not raided. However, if P is large, j can be certain that the reason that no raid occurred is that $M < W$. Recall that there are two reasons why a raid does not occur: The worker may have $M > W$, but the outside firm has not discovered this; the worker is an undiscovered star. Alternatively, the worker has $M < W$ so that he is already overpaid and is not susceptible to raid. As P rises so that his output becomes more visible, the likelihood of being an undiscovered star declines, so that wages of those left unraided must decline. Therefore, workers in visible jobs who do not receive outside offers are worse off than those without outside offers in less visible jobs.

This is what is meant by "stigma." Failing to receive an offer carries a message, even if it is inappropriate for any given worker. There are workers who are simply unlucky; they have $M > W$, but fail to receive outside offers by chance. Still, they are lumped with others who do not receive offers and a negative inference is drawn about their productivity levels.

Stigma should be worse for academic economists than for assembly line workers. Since academic economists publish their work, output is quite visible to outsiders as well as insiders; P is high. Thus, not receiving an offer carries significant information. However, the fact that an assembly line worker at GM is not raided by Ford does not reveal a great deal about that worker's productivity. It would be difficult for Ford to observe that $M > W$, even if it were.

This provides a direct implication for the relation of intra-firm wage dispersion to turnover in an occupation. Since turnover varies directly with P, higher turnover occupations are also those where the treatment accorded raided workers differs most dramatically from that given to unraided workers. If turnover among research professors is higher than turnover among non-researchers, intra-firm wage dispersions should be greater in the research institutions. This is an easily tested proposition.

What is also true, is that the wage of a worker in a more visible occupation is a better measure of his product than the wage of a worker in a less visible one. Since raids assist in moving wages away from W and toward M, higher turnover occupations also have compensation that is more closely geared to productivity.[17]

Further, wage dispersion among raided workers who remain with the firm increases as P and the level of turnover rise. Since $\partial W/\partial P < 0$, more turnover implies more workers are susceptible to being raided. The variance of M among raided workers necessarily rises. After an unsuccessful raid, workers receive M (as opposed to W or M + S). Therefore, the variance in wages among raided workers who remain rises with occupational turnover rates.

A similar argument holds for raided workers who leave. An increase in P implies that W falls. Those who leave either receive W or M + S (S < 0). The last paragraph implies that increases in P increase the variance in M + S since S is independent of M. Additionally, since W declines in P, and since the wage of raided workers always equals or exceeds W, a reduction in W adds variance. Finally, since the proportion of job switchers who receives the constant W is given by θ, and since θ increases in W, an increase in P which reduces W implies fewer job switchers with W. Thus, the variance in wages among leavers increases with the level of occupational turnover. All of these predictions are empirically testable as well.

Raiders' Profits:

The model, as it stands, carries the implication that the raiding firm, k, has positive expected profits, whereas the initial firm, j, does not. This is a direct result of awarding k an exogenous P that is greater than zero. Since k can raid selectively, and since it sometimes has information that the worker is underpaid, it owns a specialized factor. When k is informed and when S < 0, profits are made. The profit that k receives is the rent to that specialized factor that places k in the right place at the right time. Competition does not imply that rents to specialized factors must be dissipated.

On the other hand, since the new-hire market is competitive, j must compete with other firms, including k, that are ex ante identical. Even though at the time that the worker is hired, M is not known, the possibility

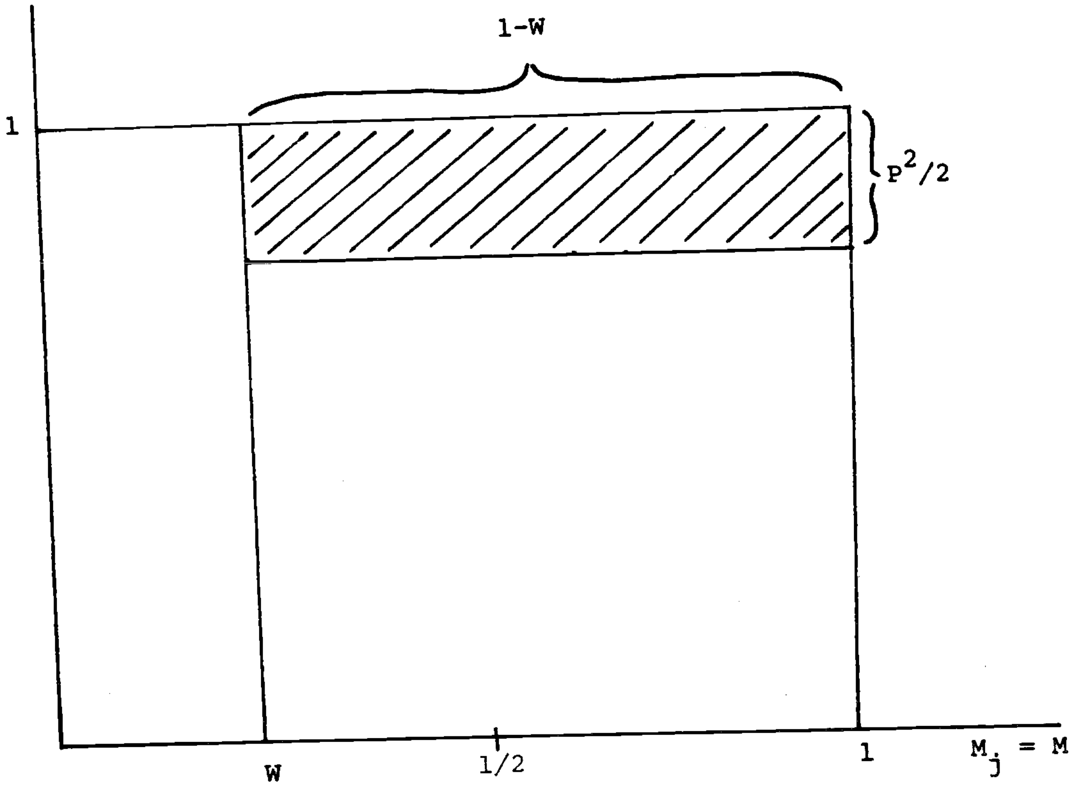

Figure 2

that it will be learned forces all j-type firms to push up W until expected profit is zero.

Raiders' profits would also be zero if we allowed that there were a cost to acquiring P. Suppose that there were a number of potential k firms who were competing for the right to know a worker's output with probability P. The price of that information would be driven up to the point where k's expected profits were zero as well. The rent would revert to another factor of production. For example, if the information were acquired by reading the AER, then the Review's price would rise until k's expected profits were zero. This trivial change prevents all firms from wanting to enter the raiding business, rather than the new-hire business.

Productivity and Job-Tenure:

The Peter Principle says that workers keep getting promoted until they can no longer handle the job. Stated alternatively, the newest workers in a job have a higher probability of being promoted out of that job than the older ones. The fact that a worker has been in a job for a long time means that he has not been raided successfully in the past. That failure reflects one of three things: 1. The worker was raided, but $S > 0$ so that the worker remained at the job. 2. $M > W$ but no outsider discovered it. 3. $M < W$ so a raid was not profitable.

Pure job matching predicts the opposite of the Peter Principle since it implies that over time, workers get sorted to their most productive job. Thus, individuals with higher levels of tenure in the job are likely to be a better match than those with low tenure. As such, the older workers in the job should have higher productivity. This is the effect of point #1 in the last paragraph. Obviously, the importance of the matching effect depends on α. For reasonable values of α, the stigma effect (point #3 above) dominates so that the Peter Principle holds. The proof follows:

The probability that the worker remains is

$$1 - \text{Prob(being at node 2.1.2.2)},$$

or $1 - P^2(1-W)/2$. Thus the expected output of workers who remain is:

$$E(M+S \mid \text{remain at } j) =$$

$$\left\{\frac{1}{[1-P^2(1-W)/2]}\right\}\Big\{\underbrace{\tfrac{1}{2}(1-P)}_{\text{node 1}} + \underbrace{\tfrac{W}{2}(PW)}_{\text{node 2.2}} + \underbrace{P(1-P)(1-W)(\tfrac{1}{2}+\tfrac{W}{2})}_{\text{node 2.1.1}} + \underbrace{\tfrac{P^2(1-W)}{2}(\tfrac{1}{2}+\tfrac{W}{2}+\tfrac{\alpha}{4})}_{\text{node 2.1.2.1}}\Big\}$$

or

$$(12) \qquad E(M + S \mid \text{remain at } j) = \frac{4 - WP^2\alpha + 2W^2P^2 + P^2\alpha - 2P^2}{4(2 + WP^2 - P^2)} .$$

In order to have output of older workers exceed that of new workers it is necessary that $E(M + S \mid \text{remain at } j) > 1/2$ since $E(M + S) = 1/2$. This requires that

$$4 - WP^2\alpha + 2W^2P^2 + P^2\alpha - 2P^2 > 2(2 + WP^2 - P^2)$$

or that

$$\alpha > 2W .$$

For low values of α, this condition is violated for all P (see table 1, $\alpha \leq .5$), so that older workers have lower expected productivity than 1/2. The Peter Principle holds. As α gets larger, the sorting effect becomes more important. As α goes to 1, it is guaranteed that $\alpha \geq 2W$ since $W \leq 1/2$.

This demonstrates that the relation of job tenure to worker productivity depends on the importance of job-specific skills. As these diminish, the Peter Principle is more likely to be observed. The existing empirical evidence, to the extent that it can be believed, supports the dominance of the Peter Principle over job-matching effects.[18]

To extend the concept to within-firm promotion, it is necessary to think of j and k as departments within a firm. This changes things somewhat because one expects cooperation between departments to a greater extent than between firms. But as long as some rivalry exists, say due to the failure to solve all agency problems perfectly, the analysis still holds.[19]

Search and Unemployment:

The implications of this model differ from those of search theory in an important respect. The stigma effect discussed above relates to the negative information that firms obtain from the failure to be raided. A simple reinterpretation of the model provides implications for the relation of unemployment to wages.

Stigma may refer to workers who suffer spells of unemployment and find that subsequent demand for their services is adversely affected. Indeed, there is a significant literature that attempts to analyze these spells and to determine whether they are the result of inherent worker heterogeneity or of the signalling effect of unemployment.[20]

This paper focuses on job changes without unemployment. However, if the current firm, j, is reinterpreted as the state of unemployment and W is defined as the reservation wage, then the model applies to unemployed workers as well. As the worker is "unraided" out of unemployment, the worker's expectations about his opportunities change. He updates W based on the bad news. Individuals who leave the state of unemployment quickly have the highest expected wages since the expected wage of leavers generally exceeds 1/2. Those who are unemployed for longer periods have lower expected wages because they are, on average, lower ability workers and their reservation wages are lower on average.

There are two interesting interpretations of P in this context. Since P measures the probability that an outside firm finds the worker, P is higher for non-working individuals who are actively seeking work than for those who are not. The higher is P, the lower is the expected output at firm k of the unraided worker.[21] This means that when P is high, the force of stigma is large and when P is low it is small. If P is higher for individuals who are actively seeking work, then those who do not find jobs should have lower wages when they eventually do find work than those who are not looking for work. The intuition is clear: If a worker is looking hard for a job and fails to find one, then much can be inferred about his productivity from the failure. However, if the individual is not looking for a job, not much can be inferred from the fact that he did not find one.

This implies that for a given time out of work, those who are searching actively should have <u>lower</u> wages when they find a job than those not searching. This is the opposite of the search theory implication. If search is costly, then in equilibrium workers who search must expect to receive a higher wage when they find a job than those who do not search. In Lazear (1974), it was found that time not worked spent searching for a job was more detrimental to subsequent wage growth than time not worked where search did not occur. This argues for the importance of stigma; worker heterogeneity, reflected by the time spent finding a job, dominates search effects. Failed search is worse than loafing.

A similar point relates to the business cycle. The probability of being discovered, P, is higher during expansions than during contractions. In a recession, when firms are not as actively searching for workers, P is low. This implies that individuals who are unemployed during a recession should suffer less detrimental effects to their subsequent wage than those who are unemployed during expansions. Intuitively, there is not much stigma associated with being unemployed during a recession because few firms are looking for workers. But if the worker cannot find a job during an expansion, then he is more likely to be a bad apple. The effect of unemployment on subsequent wages can be estimated and it is straightforward to test whether this varies with business cycle conditions.

III. Summary and Conclusion

Since a significant fraction of job changes occur without intervening spells of unemployment, it is important that the theory of job turnover and wage dynamics incorporate this feature. It implies that only certain types of workers, namely those who are currently underpaid, are raided by outsiders. Thus, raids and turnover are selective. All firms recognize this fact and wages adjust accordingly. Worker heterogeneity is at the heart of the analysis; job changers are different from those who remain with their firm. On average, leavers have higher levels of general productivity than stayers, although stayers who have been raided (unsuccessfully) in the past have the highest average productivity specific to the current firm.

The theory gives rise to a number of specific implications regarding the relation of wage levels and changes to job changes. Turnover, which proxies market information in equilibrium, moves a worker's wage toward marginal product. The analysis has attempted to provide a general theory of occupational wage dispersion. Additionally, the theory implies:

1. Raids are selective. The best workers are more likely to receive outside offers. This means that the initial wage does not fully adjust for quality.

2. It is rational for firms to treat workers with outside offers differently from those without them since the offer carries information about the relation of productivity to current wage.

3. The oldest workers on the job are the least productive. This Peter Principle result is the opposite of that suggested by a theory of job matching.

4. Searching may be worse than loafing since failed search carries a negative signal that is not associated with loafing.

The last two implications, which are at variance with two theories that are standard in the turnover literature, find some empirical support.

Footnotes

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[1]See Phelps (1970), for a collection of these early papers.

[2]See Doeringer and Piore (1981), Thurow (1972),

[3]The most notable model of wage determination is Becker (1975). Others include Lazear (1979), Lazear and Rosen (1981), and Harris and Holmstrom (1980). The model that most effectively deals with job turnover in the absence of unemployment is Jovanovic (1979). Although the theory of specific human capital attempts to integrate wage dynamics with labor turnover, too much indeterminacy remains to have a very informative set of predictions. This is rectified somewhat by the work of Kuratani (1973), Hashimoto (1979), Hashimoto and Yu (1980) and Hall and Lazear (1982).

[4]See Peter (1969).

[5]The S component is in the spirit of Jovanovic (1979).

[6]This depends in part on j's beliefs about what k does. In this section it is assumed that j assumes that k only raids when k is informed. Below, it will be shown that that is an equilibrium assumption and that others can be ruled out.

[7]For $Z > \alpha_2$, $E(M|M + S < Z) - Z = Z(-2 + \alpha)/2 < 0$ since $\alpha < 1$. For $Z < \alpha_2$,

$$E(M|M + S < Z) - Z = 1/16[4Z(\alpha-4) + 4Z^2 + \alpha^2] .$$

As will be shown below, j's starting offer

$$W = \frac{\alpha P^2 - 8P + 8 + \sqrt{(\alpha P^2 - 8P + 8)^2 - 16P(4P - 4 - \alpha P^2)}}{8P} .$$

For $Z = W$, $E(M|M + S < Z) - Z < 0$ for all (α, P). Further, in the relevant range

$$\frac{\partial[E(M|M + S < Z) - \bar{Z})}{\partial Z} < 0$$

so no $Z > W$ can result in positive profits to the raider.

[8]See, for example, Wilson (1977), Milgrom and Weber (1982), and Riley and Samuelson (1981) for a more complete discussion.

[9]Of course, an informed j could sever all workers with $M < W$. If workers and firms are risk neutral, it does not matter because W will adjust to take into account that j is left with some poor workers. The slightest risk aversion on the worker's part implies that it is better to offer all workers who are not raided W and to avoid terminations.

[10]Recall that M and S are independent and S has mean zero so $E(M_j) - \text{wage} = E(M) + 0 - \text{wage} = M - M = 0$.

[11]The idea is that a firm can at best assess the worker's value to itself. It is rare that the firm can determine the part of that value that is general as opposed to firm-specific. Under these conditions, k and j bid against one another and only the fact that j is willing to continue to raise after k has stopped reveals that $S > 0$.

[12]This ignores the kind of bargaining problem between worker and firm that Mortensen (1978) discusses. Rubinstein (1982) solves that problem when the value of the good is known to both parties, but the essence of the problem here is that even if the worker knows M, there is uncertainty as to whether

the firm knows M. Recall that the firm is only informed P of the time so (1 - P) of the time only knows the distribution and W is the optimum under these circumstances. This means that 1 - P of the time, a worker who demands a wage greater than W will be let go. For most reasonable values of P (likely to be small), it is optimal for the worker merely to accept W. There are two caveats: First, if the worker costlessly and immediately can obtain another job that pays W, then all workers with $M > W$ try to bargain. Second, if the demand by the worker conveys the appropriate information to the firm about M, it may pay to bargain even if the firm is uninformed (see the discussion by Fudenberg and Tirole (1983) on the effects of adding a period to a game). Note also that the higher is M, the more the worker has to gain so the more likely is the worker to demand a wage greater than W.

[13]It might seem that an informed j would behave differently with respect to high-ability workers than with respect to low-ability ones. This is not correct. The informed j could make W a function of M. But nothing is gained for workers with $M > W$. No $W(M) \leq M$ acts as a deterrent to an informed k. No $W(M) > M$ is necessary if k is informed and no uninformed k raids. Nothing is gained by conditioning W on M, even when j has the information to do so.

Further, risk-neutral workers who do not know their abilities will not sign with any firm that retains the right to <u>reduce</u> wages after observing M. This would result in an expected wage for unraided workers that is less than W and since W to unraided workers guarantees zero profit, a fixed W to all unraided workers dominates. A fixed W is also less susceptible to moral hazard where the firm attempts to deceive the worker into believing that M is small.

[14]See Grossman (1976), Grossman and Stiglitz (1976, 1980), Carlton (1982), and Gould and Verrecchia (1983) for examples of drawing inferences from observable market variables.

[15]This result is in some respects the opposite of that obtained by Greenwald (1978). Greenwald, who first extended Akerlov (1970) to examine the possibility of winner's curse in the labor market, provides a model that is a better description of turnover with unemployment. It differs from the current model primarily in two respects.

First, workers leave their jobs when they obtain sufficiently low draws of S and enter the state of unemployment. It is true here as well that workers with low S's are the ones more likely to change jobs, but that does not happen with unemployment. As such, the bidding war between j and k provides some different implications about wage changes. Since the purpose of this paper is to examine job changes that occur without unemployment, the Greenwald set-up is not directly applicable.

Second, this model places emphasis on the precision of the estimate of worker's output as well as the mean. This takes the form of informed vs. uninformed firms. This, too, is important because it implies selective raiding strategies. Outsiders do not buy unless they are quite certain about what they are getting because they understand that they are subject to winner's curse.

[16]This ignores any changes in the probability of a raid that results from offer matching. Hall and Lazear (1984) examine when offer matching encourages inefficient job search.

[17]See the pioneering work by Reder (1955) for an early attempt to explain differences in wages across occupations.

[18]See Medoff and Abraham (1980).

[19]Abraham and Medoff (1983) find a negative simple correlation between time on the current job and the probability of promotion out of it. This is consistent with this model where most of the high ability workers are stolen away or promoted out early and those who remain are of lower ability.

[20]See, for example, Ellwood (1982); also Clark and Summers (1982) and Flinn and Heckman (1983).

[21]The expected output of unraided workers is

$$E(M|\text{ unraided}) = \frac{(1-P)(1/2) + PW(W/2)}{1 - P + PW} .$$

A sufficient (but not necessary) condition for its derivative with respect to P to be negative is that $\alpha \leq 1$.

References

Abraham, Katherine G., and Medoff, James. "Years of Service and Probability of Promotion," unpublished manuscript, Massachusetts Institute of Technology, July 1983.

Akerlov, George. "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," Quarterly Journal of Economics 84 (August 1970): 488-500.

Bartel, Ann P. "Earnings Growth on the Job and Between Jobs," Economic Inquiry 18 (January 1980): 123-37.

Bartel, Ann P., and Borjas, George J. "Wage Growth and Job Turnover: An Empirical Analysis," in S. Rosen, ed., Studies in Labor Markets. Chicago: University of Chicago Press for National Bureau of Economic Research, 1981.

Becker, Gary S. Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education, 2d ed., New York: Columbia University Press for National Bureau of Economic Research, 1975.

Borjas, George, and Rosen, Sherwin. "Income Prospects and Job Mobility of Young Men," in R. Ehrenberg, ed., Research in Labor Economics, vol. 3. Connecticut: JAI Press, 1980, pp. 159-83.

Carlton, Dennis W. "Planning and Market Structure," in John J. McCall, ed., The Economics of Information and Uncertainty. Chicago: University of Chicago Press, 1982.

Clark, Kim, and Summers, Larry. "The Dynamics of Youth Unemployment," in Richard Freeman and David Wise, eds., The Youth Labor Market Problem: Its Nature, Causes, and Consequences. Chicago: University of Chicago for National Bureau of Economic Research, 1982.

Doeringer, P., and Piore, M. Internal Labor Markets and Manpower Analysis. Lexington, MA: Heath, 1981.

Ellwood, David T. "Teenage Unemployment: Permanent Scars or Temporary Blemishes?" in Richard Freeman and David Wise, eds., The Youth Labor Market Problem: Its Nature, Causes, and Consequences. Chicago: University of Chicago for National Bureau of Economic Research, 1982.

Flinn, Christopher, and Heckman, James. "Are Unemployment and Out of the Labor Force Behaviorally Distinct Labor Force States?" Journal of Labor Economics 1 (January 1983): 28-49.

Fudenberg, Drew, and Tirole, Jean. "Sequential Bargaining with Incomplete Information," R. E. Stud. L(2), 161 (April 1983): 221-47.

Gould, John P., and Verrecchia, Robert E. "The Specialist as Economic Agent," unpublished manuscript, University of Chicago, 1983.

Greenwald, Bruce C. "Adverse Selection in the Labor Market," unpublished Ph.D. Dissertation, Massachusetts Institute of Technology, September 1978.

Grossman, Sanford. "On the Efficiency of Competitive Stock Markets Where Traders Have Diverse Information," Journal of Finance 31 (1976): 573-85.

Grossman, Sanford, and Stiglitz, Joseph. "Information and Competitive Price Systems," American Economic Review 66 (1976): 246-53.

__________. "On the Impossibility of Informationally Efficient Markets," American Economic Review 70 (1980): 393-408.

Harris, Milton, and Holmstrom, Bengt. "A Theory of Wage Dynamics," Review of Economic Studies 49 (July 1982): 315-33.

Hashimoto, Masanori. "Bonus Payments, On-the-Job Training, and Lifetime Employment in Japan," Journal of Political Economy 87 (October 1979): 1086-1104.

Hashimoto, Masanori, and Yu, Ben. "Specific Capital, Employment Contracts, and Wage Rigidity," Bell Journal of Economics (Autumn 1980): 536-49.

Heckman, James J., and Willis, Robert. "A Beta-Logistic Model for the Analysis of Sequential Labor Force Participation by Married Women," Journal of Political Economy (February 1977).

Jovanovic, Boyan. "Job Matching and the Theory of Turnover," Journal of Political Economy 87 (October 1979): 972-90.

Kuratani, Masatoshi. "The Theory of Training, Earnings, and Employment: An Application to Japan." Unpublished Ph.D. Dissertation, Columbia University, 1973.

Lazear, Edward P. "Why Is There Mandatory Retirement?" Journal of Political Economy 87 (December 1979): 1261-64.

Lazear, Edward P., and Rosen, Sherwin. "Rank-Order Tournaments as Optimum Labor Contracts," Journal of Political Economy 89 (1981): 841-64.

Lazear, Edward P. "The Timing of Technical Change: An Analysis of Cyclical Variations in Technology Production," unpublished Ph.D. Dissertation, Harvard University, 1974.

Medoff, James, and Abraham, Katharine. "Experience, Performance and Earnings," Quarterly Journal of Economics 95 (December 1980): 703-36.

Milgrom, Paul R., and Weber, Robert J. "A Theory of Auctions and Competitive Bidding," Econometrica 50 (September 1982): 1089-1122.

Mortensen, D. "Specific Capital and Labor Turnover," Bell Journal of Economics 9 (1978): 572-86.

Peter, Lawrence. The Peter Principle. New York: William Morrow and Co., 1968.

Phelps, E., et al. Microeconomic Foundations of Employment and Inflation Theory. New York: Norton, 1970.

Reder, Melvin W. "Theory of Occupational Wage Differentials," American Economic Review 45 (December 1955): 833-52.

Riley, John, and Samuelson, W. "Optimal Auctions," American Economic Review 71 (1981): 381-92.

Rubinstein, A. "Perfect Equilibrium in a Bargaining Model," Econometrica 50 (Year): 97-110.

Thurow, Lester. "Education and Economic Equality," The Public Interest 28 (Summer 1972): 68-81.

Wilson, Robert. "A Bidding Model of Perfect Competition," Research in Economic Studies 4 (1977): 511-18.

APPENDIX

THE EXPECTED WAGE OF LEAVERS

For the worker to leave j for k, it is necessary that $M > W$ and $S < 0$. The shaded area in figure A.1 is the relevant region. Line AB has the equation $M + S = W$. If $M + S < W$, then j does not even respond to k's first offer so the wage that the worker receives is W^+ when the realization of (M, S) is in triangle BCD. If $M + S > W$, then the bidding war ensures that the worker receives $M_j = M + S$ $(S < 0)$. This occurs in trapezoid BCEF.

Given that the worker turns over, the probability that he does so at W is

$$\theta = \frac{\text{Area BCD}}{\text{Area CDFE}}$$

$$= \frac{\alpha^2/8}{\alpha/2(1 - W)}$$

$$= \frac{\alpha}{4(1 - W)} .$$

The probability that he turns over at $M + S$ is $1 - \theta$. Therefore, the

$$\text{Expected Wage of Leavers} = \theta W + (1 - \theta)E(M + S \mid M > W - S, S < 0)$$

$$= \theta W + (1 - \theta)\frac{2}{\alpha}\int_{-\alpha/2}^{0}\int_{W-S}^{1} \frac{M + S}{1 - (W - S)}\, dMdS$$

$$= \theta W + (1 - \theta)[1/2 + W/2 - \alpha/8] .$$

Note, for example, that if $\alpha = 0$, $P = 0$, then $W = 1/2$ so $\theta = 0$ and Expected Wage = 3/4. Raiders raid only those with $M > 1/2$ and pick them up at wage M (since $S = 0$). Thus, they get the mean of the distribution on M, conditional on $M > 1/2$, which equals 3/4.

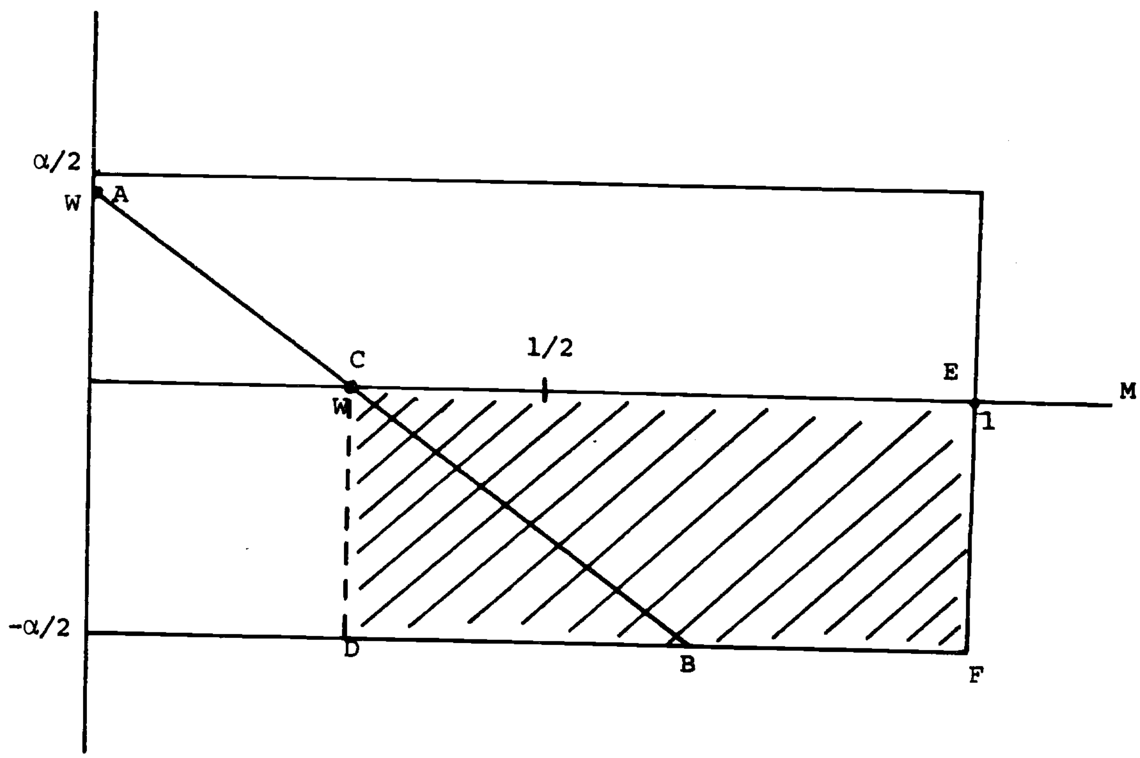

Figure A.1

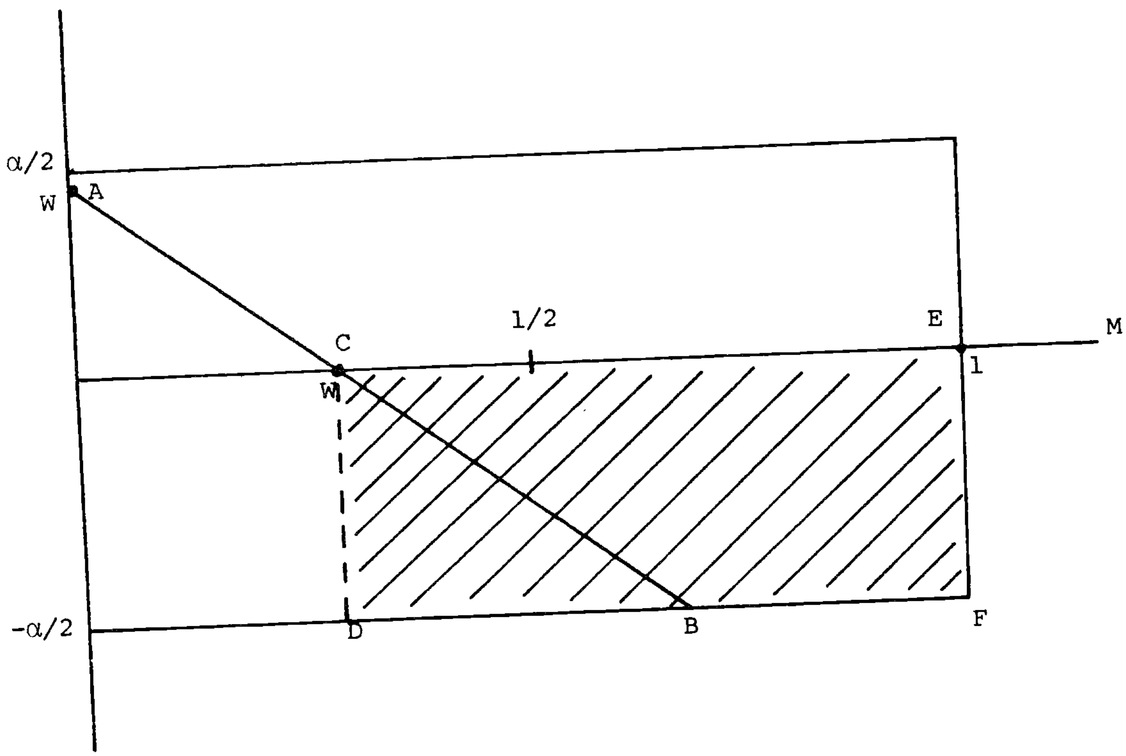

Figure A.1