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1. INTRODUCTION

Job mobility received a great deal of attention early on in labor economics, both theoretical and empirical. A well developed tradition--dating at least as far back as Smith (1937, Book I, Ch. 10) and Marshall (1920, Chs. 6, 10), and extending forward to Lilien's (1980) much cited work--treats mobility as a consequence of intertemporal variation in exogenous variables operating at the industry level. Mobility generated by events specific to individual worker-firm pairings (indeed defining mobility as dissolution of such "matches") was also discussed early on, but modelled only much later.[1] This paper seeks to contribute to this latter literature.

Mobility involves reallocation over time. Unless it is to be viewed as exogenous separation of worker and firm, it is necessary for the theory to specify the time path of both the value of the current match and that of the best available alternative. The most common way to do so--although by no means the only possibility (c.f. Rosen (1972))--models these values as stochastic processes, and induces a random mobility process. The empirical content of this type of model is expressed in terms of restrictions on the probability of match dissolution, which is referred to as a "quit".

Stochastic models come in three general varieties, which can be distinguished by one aspect of the manner in which the probability structure is constructed.[2] An initial match is assumed, and alternative opportunities arrive over time, typically at random intervals.[3] Burdett (1978) and Flinn and Heckman (1982) suppose the value of the current match fixed and known once the match is struck, but permit the value of alternatives--another wage offer in Burdett, non market activities in Flinn and Heckman--to vary. In contrast, Jovanovic (1979a,b) specifies a random evolution for the value of the current match, and a constant (ex ante) value for the alternative--pairing with a randomly chosen firm. Most recently, Jovanovic (1984), Mortensen (1984) and Topel (1986) explore environments in which both the value of the current match and the alternative--the most attractive offer received to date--are stochastic. Jovanovic (1984) and Mortensen assume these two values stochastically independent. Topel allows correlation due to random exogenous accumulation of general skills with experience.

This class of models is broadly applicable since in several respects the environments studied are reasonably general; especially in Mortensen and Topel. But at the same time, and largely for the same reason, the list of specific testable implications derived to date is not long. The main propositions are as follows. All the models generate the result that the probability of a quit, conditioning on one of total experience or duration of current match ("tenure"), is declining in experience or tenure. Intuitively, more experienced workers, and those with long tenures, are more likely to be part of a good match.

Jovanovic (1984) and Mortensen add the proposition that given wage and tenure, workers having longer tenure are more likely to quit, opposite to the result when wages are not held fixed. The argument is easiest in discrete time. The value of the current match is the wage for the current period, together with the discounted value of an optimal mobility policy starting next period, at which time the wage applicable to that period will be known. A riskier distribution of future wages on the current match raises the value of the match, since the greater likelihood of higher future wages is beneficial, and the increased probability of lower wages can be offset by quitting; overall, the expected wage given sustaining the match is higher when the distribution of wages is more risky. On average, workers who have shorter tenure face greater uncertainty about the current match, and thus, wage constant, value it more and so are less likely to quit.

Topel provides three additional hypotheses. First, for the obvious reasons, holding tenure and experience constant, the higher the worker's current wage, the lower the probability that he will quit. Next, given the current wage and experience, greater tenure implies increased likelihood of a quit. Since fixing experience effectively holds constant the distribution of the value of alternatives to the current match, the reasoning is similar to that given in the previous paragraph. Finally, current wage and tenure constant, greater experience implies a larger quit probability, at least in the leading case. The argument is that greater experience implies (stochastically) larger general skills, which in the most plausible case improves the value of alternative jobs more than it raises the value of the current match when the wage is held fixed.

The goal of this paper is to expand and unify the set of testable restrictions implied by stochastic mobility theory. The need for a larger set of hypotheses is self evident. That unification would be useful is implied by the observation that the few hypotheses which exist do not offer a very coherent picture; for example, even the sign of the effect of tenure on the quit probability seems sensitive to the precise notion of the conceptual experiment being conducted.

The vehicle through which these improvements will be obtained is a very elementary stochastic mobility model in which both the value of the current match and that of the alternative vary over time. The model thus has the flavor of the Jovanovic-Mortensen-Topel analyses. Precisely, it is a specialization and extension of the general information accumulation environment developed in MacDonald (1982). In that economy, even the simple stylized facts of job mobility do not follow without a set of technological restrictions, since the notion of a "good match" is not well defined in general. There is thus no "good match" for older workers, or those with longer tenure, to find. The present model therefore specializes the technology to permit good matches. The extension involves the incorporation of a richer process through which worker-specific information is accumulated. The details of the model are given in Section 2.[4]

The model's implications are explored in Section 3. Hypotheses are derived concerning the dependence of the probability of a quit on four conditioning variables--current wage, experience, tenure, and an index of past mobility behavior. Since the model is a simple one, a complete characterization of its equilibrium is obtained, and a variety of predictions derived.

Briefly, the results are as follows. In the model's equilibrium, wages are associated one-to-one with an entity that completely determines the probability of a quit. Thus wage constant, the probability of a quit is unaffected by other conditioning variables; experience etc. Note that this result stands in contrast to those summarized above; reasons will be discussed once the model is set out.

The other results refer to the effect of experience, tenure and past mobility when the wage is not held constant. In this case these variables are imperfect proxies for the entity which would be controlled for in a precise manner by inclusion of the wage. The tenure effects are very robust.

Irrespective of whether experience and/or past mobility, or neither, is held constant, workers with longer tenure are less likely to quit. Experience effects are more dependent on the exact experiment being conducted. Loosely, greater experience implies a weaker or stronger attachment to the current match, hence a higher or lower probability of a quit, depending on whether tenure is held fixed or not. Greater past mobility operates much like less experience.

Section 4 considers empirical implementation of the model. Appropriate econometric methodology is discussed, followed by some material on the likely impact on testing the model of allowing for two important omissions from the theory--accumulation of general skills and a non-steady state economy. Finally, some illustrative data from the literature is presented.

Once the structure of the model is set out, proofs of all the propositions are straightforward but extremely tedious calculations and are therefore omitted.

2. A MODEL OF EQUILIBRIUM JOB MOBILITY

The situation to be modelled is as follows. Both workers and firms are heterogeneous; workers in terms of their productive traits, and firms in terms of outputs and type of demands placed on workers. At the time of entry into the labor force, there is uncertainty regarding the productivity of any worker-firm match. As work proceeds, the observed outcomes of existing matches resolve this uncertainty, but imperfectly. In equilibrium, it may pay for certain matches to be terminated as time passes, and new ones struck--job mobility.

To model this process, the technologies available for production of goods in each period are first specified, followed by a description of the prospects for inferring match quality from observation of output. The initial structure of information, and the maximization problems faced by workers and firms are set out next. Finally, the model's equilibrium is displayed.

2.1 Technologies

Job mobility of workers is the focus of the analysis. The specification of technologies is therefore as simple as possible.

There are two types of firms, labelled α and β, with types indexed by f; $f=\alpha,\beta$. Different types produce distinct goods, but all firms produce their output using time supplied by workers as the sole input. Production is additively separable; essentially an individual level activity.

Production requires exactly one unit of time from any worker, and each worker's output is subject to unobserved idiosyncratic random effects. These stochastic influences are intended to represent the familiar situation that individuals are more productive in some periods than they are in others for no readily identifiable reason.

Let Q^f represent the output of a worker employed in a type f firm. Depending on the random effects, Q^f may take on one of three values. Units are chosen so that the smallest possible value Q^f might take on is unity for both firm types. Also, it is notationally convenient to require that the other possible outputs are numerically the same across firm types. Let q_1 and q_2 represent these levels; $q_1 < q_2$. Thus, each worker employed by a type f firm will produce output of $Q^f = 1$, q_1, or q_2, with $1 < q_1 < q_2$.

2.2 Worker Traits and the Stochastic Structure of Output

There is a continuum of workers, normalized to size one, which comprises two types of workers, A and B. These worker types differ according to endowed productive talents. Production is subject to stochastic influences, but the talents possessed by workers of type A are such that they are a better match for firms of type α than are type B workers in the sense that a type A worker is more likely to produce higher levels of output in a type α firm. Similarly, type B workers are a better match for type β firms.

Formally, it is assumed that the unobserved random elements in production at the level of the individual worker can be represented by a pair of stochastically independent (across workers as well) binomial random variables, each having "success" probability given by the parameter θ. This specification appears to be the simplest which is rich enough to generate the job mobility results presented below.

Consider a type α firm, and the effect of random effects therein. The output of a type A worker is assumed to be augmented by a pair of successes, diminished by a pair of failures, and otherwise unaffected (i.e. a single success and failure are offsetting). Thus, conditioning on worker type A, the stochastic structure of production in a type α firm is

$$\Pr(Q^{\alpha} = q_2|A) = \theta^2,$$

$$\Pr(Q^{\alpha} = q_1|A) = 2\theta(1-\theta), \qquad (1)$$

and hence

$$\Pr(Q^{\alpha} = 1|A) = (1-\theta)^2.$$

In contrast, for workers of type B in a type α firm,

$$\Pr(Q^{\alpha} = q_2|B) = (1-\theta)^2,$$

$$\Pr(Q^{\alpha} = q_1|B) = 2\theta(1-\theta), \tag{2}$$

and hence

$$\Pr(Q^{\alpha} = 1|B) = \theta^2.$$

That an A-α match would dominate a B-α match is equivalent to $\theta > ½$, which is therefore imposed.

Type B firms are treated symmetrically, but with type B workers being a better match; $\Pr(Q^{\beta} = q_2|B) = \theta^2 = \Pr(Q^{\beta} = 1|A)$, etc.

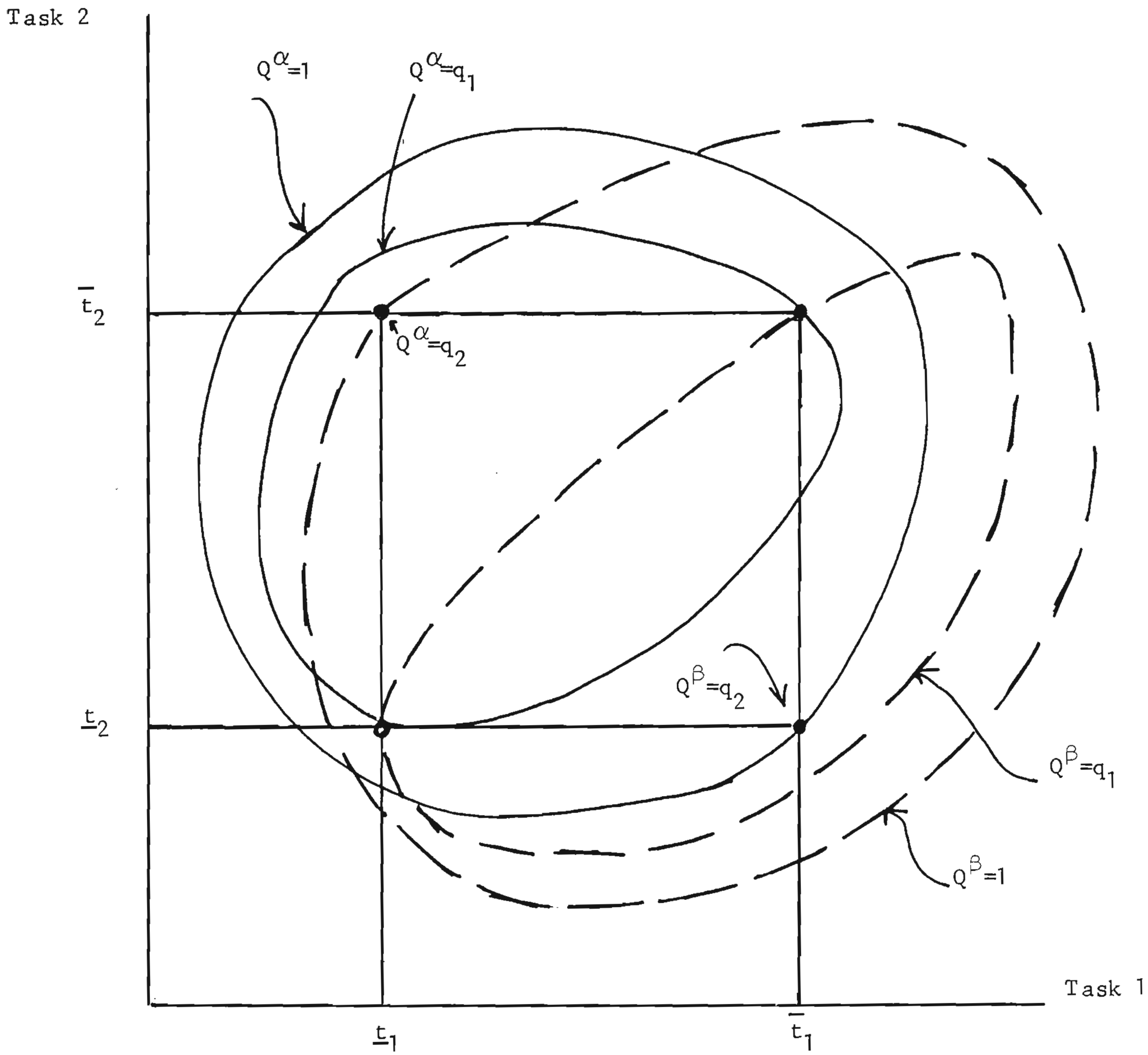
Under this specification, observed output is a useful but imperfect indicator of match quality. For example, a string of $Q^{\beta} = 1$ observations would indicate the match is likely of the A-β variety.

Though the technologies and stochastic structure are not elaborate they admit a variety of interpretations.

For example, Figure 1 represents the type of situation studied by Rosen (1978). Jobs require the completion of tasks 1 and 2. The perfect mix of tasks for the α technology is $(\underline{t}_1, \bar{t}_2)$, yielding output $Q^{\alpha} = q_2$. Less useful is either $(\underline{t}_1, \underline{t}_2)$ or $(\bar{t}_1, \bar{t}_2)$, both of which yield $Q^{\alpha}_1 = q_1$. Worst of all is $(\bar{t}_1, \underline{t}_2)$, generating $Q^{\alpha} = 1$. The ranking under the β technology is just the reverse. The talents of workers of type A (B) are such that when they are attempting to perform the required tasks on the job, they perform task 1 at rate $\underline{t}_1$ $(\bar{t}_1)$ with a probability θ, equal to the probability with which they perform task 2 at rate $\bar{t}_2$ $(\underline{t}_2)$, and so on.

Figure 1

Isoquants for the α (solid) and β (dashed) technologies



2.3 Information

There are two kinds of information in the model--general population information, and worker-specific. To highlight the role of the information accumulation process, it is assumed that the general population information--the fraction of workers with talents of each type--is equal to one half. In this case it is solely worker-specific information that determines whether it is more or less likely that the worker is of one type or the other.

Worker-specific information comprises the history of output from matches in which the worker has participated. If the current period is the worker's first in the labor force, there is no worker-specific information. The explicit structure of information will not be required until Section 3. Thus all information pertaining to a given worker will simply be labelled H, for "history".

Taken together, this treatment of general and worker-specific information implies that at the time of entry into the labor force, there is no information relevant to the matching process; surely an extreme specification. The point of this strong assumption is to allow the accumulation of worker-specific information to have a nontrivial impact right from the outset, and thus to permit the number of periods in the analysis to be relatively few. Adding prior information relevant to the matching process does not change the results substantially, but does cause the affect of information accumulated on the job to become operative later in the worker's labor force experience.

How is the existing information distributed? As is conventional in stochastic matching models, all information--in particular the history of output from all matches--is common knowledge. The analysis can be replicated exactly as is under the assumption that only the worker's wage, output from latest match, and total experience, are observable by other agents; see below.

2.4 Optimization by Firms

Acting as perfect competitors, each firm decides whether it wishes to demand the services of a worker with a given history given the wage rate required to attract such workers. The objective is to maximize expected profits. Given the features of the technology assumed for firms of type f, in particular the absence of capital and the additive separability, a firm of type f will plan to hire a worker with some history H if the value of expected output exceeds the wage.

Let w(H) be the wage required to attract workers with history H. It will be assumed that the outputs of both firm types are perfect substitutes in consumption. The relative prices of outputs are then predetermined. Here they will be set to unity. The firms' optimizing behaviour can then be given the following characterization. A firm of type f will then strictly prefer, be indifferent, or decline to hire a worker with history H depending on whether

$$E(Q^f|H) \gtreqless w(H),$$

where E( ) is the expectations operator and

$$E(Q^f|H) = E(Q^f|A)Pr(A|H) + E(Q^f|B)Pr(B|H). \tag{3}$$

Pr(A|H) is the conditional probability that the worker is a type A, given H, and Pr(B|H) = 1 - Pr(A|H). For future reference, the symmetries in production imply $E(Q^\alpha|A) = E(Q^\beta|B)$ and $E(Q^\alpha|B) = E(Q^\beta|A)$.

2.5 Optimization by Workers

Workers participate in the economy for five periods, which is the smallest number of periods that will permit the phenomena to be analysed to operate nontrivially. In each period, the worker must decide, given his past observed output, whether to work; that is, whether to supply his unit of working time to some firm. Since participation is not the focus of the analysis, it will be assumed that equilibrium wages are always sufficient to induce the worker to prefer work to non participation. Thus, assuming risk neutrality--consistent with the treatment of commodity prices--the behavior of a worker with history H will simply be to supply his effort to any firm which is willing to pay w(H).

2.6 Equilibrium

Given the behavior of firm and workers, the model's equilibrium can be constructed. For any history H, let

$$w(H) = \max_{f} \{E(Q^{f} | H)\}. \tag{4}$$

Is this system of wages part of an equilibrium? As indicated above, a firm of type f will be willing to hire a worker having history H provided $E(Q^f | H) \geq w(H)$. Thus any firm of type $f = F(H)$, where

$$F(H) \equiv \operatorname*{argmax}_{f} \{E(Q^{f} | H)\}$$

will be willing to hire workers with history H.

Next, w(H) was assumed always to be such that workers are willing to work at wage w(H). Thus, the system of wages (4) together with any allocation of workers to firms such that workers with history H work for firms of type f if and only if $f = F(H)$, constitutes an equilibrium of the model. More specifically, note that from (3) and the symmetries in production,

$$E(Q^{\alpha}|H) \gtreqless E(Q^{\beta}|H) \Leftrightarrow P(A|H) \gtreqless ½ \tag{5}$$

Thus, in equilibrium, workers for whom $P(A|H) > ½$ work for a type α firm, those for whom $P(A|H) < ½$ work for a type β, and the rest may work for either.

Two points should be emphasized. One is that due to the symmetries assumed in the production process, when $Pr(A|H) = ½$ for some H, the equilibrium matching of workers to firm <u>types</u> (as opposed to firms <u>within</u> a type) is not determined. In what follows it will be assumed that in any period this assignment is made on the basis of a toss of a fair coin. This assumption is not innocuous for it implies some dissolution of matches, hence job mobility, even if history evolves so that $Pr(A|H) = ½$ continues to hold. With the inclusion of a good deal of algebra it is possible to show that this assumption is only needed because output is constrained to take on but three values. A richer stochastic structure can be examined, and this assumption dropped, with no substantive alteration in the results.[5]

Second, although the model assumes symmetric information, the same equilibrium may be supported if prospective employers know only the worker's wage and output in the previous period, and number of periods in the labor force (experience). The argument is not difficult. Under these informational assumptions, firms contemplating hiring a worker having no prior work history, or a one period history, know everything they would know under symmetric information, in which case (given the additively separable technologies) wages rates for those workers must be given by (4). Firms considering workers with two periods of experience know less than they would under symmetric information-- the initial period's output is not known--but can infer this information from wages paid and output produced last period. Thus the wage for workers with histories two periods long must be given by (4) as well, and so on.[6] Thus, while symmetric information is assumed, the equilibrium allocations and wages can be supported as a competitive equilibrium when firms know much less about the details of individual worker's job experience than they do under symmetric information.

To summarize what has been obtained so far, workers are one of two types, depending on their productive traits, and work in every period. Firms, also of two varieties, produce output using a stochastic technology which uses worker's time as the sole input. The stochastic structure of production interacts with the endowed traits of workers, and type A (B) workers are more productive--in a stochastic sense--in type α (β) firms than are type B (A) workers. Observation of output is the means by which matches are improved. In the model's equilibrium, workers supply their labor to the firm type where they are expected to produce output having greatest value. As new observations on output emerge, the equilibrium matching of workers to firm types may change, in which case a reallocation is called for. For any given worker-firm match, dissolution (a "quit") is a random event, the properties of which are studied in the next Section.

3. RESULTS ON EQUILIBRIUM JOB MOBILITY

The stochastic process generating output from worker-firm matches implies job mobility -- intertemporal reallocation of workers across firm types -- as part of the model's equilibrium. In this Section the expressions required to analyse the probability with which reallocation occurs are derived, and a body of hypotheses obtained. The reader who is not interested in the mechanics of the derivations may wish to skip Sec. 3.2.1 and 3.2.2.

It may be useful to begin with an example. Consider a worker in his first period in the market. All variables refer to their beginning of period values, in which case this worker has zero experience, tenure, and no prior mobility. What is the probability with which he will be employed by a different firm type in the next period; i.e. that the analyst would observe a quit?

Given the informational setup, as far as the agents in the economy are concerned the worker is equally likely to be a type A or type B. He is therefore valued equally by all firm types and assigned to one on the basis of a coin toss, and earns a wage equal to $E(Q^{\alpha})$. Suppose the worker is allocated to a type α firm. If $Q^{\alpha} = q_2$ is observed subsequently -- history becoming $H=\{q_2\}$ -- that this outcome is more likely if the worker is a type A implies $Pr(A|H) > ½$. The worker will be employed by a type α firm in the next period. If $Q^{\alpha} = q_1$, equally likely for all worker types, $Pr(A|q_1) = ½$ continues to hold and the worker will remain in a type α firm unless the coin toss indicates otherwise. Finally, if $Q^{\alpha} = 1$, $Pr(A|1) < ½$ and a quit will certainly be observed. Overall then, the probability with which a worker who has just entered the labor force will quit is the probability that the output realization described will occur, which, from what follows, turns out to be ½.

There are many different quit probabilities that can be derived, each conditioning on a different set of variables and corresponding to a distinct conceptual experiment. The conditioning variables examined here are the current values of the wage rate (w), labor force experience (x), tenure (t), and the number of jobs the worker has had prior to the current match (μ). The probability of a quit conditional on these variables will be written $\lambda(w,x,t,\mu)$. The example given above thus illustrates $\lambda[E(Q^{\alpha}),0,0,0] = ½$. When the conditioning involves a smaller set of variables, only those variables will appear as arguments in $\lambda(\cdot)$.

It is worth considering what is begin done when predictions on $\lambda(\cdot)$ are derived. The evolution of the exogenous variables -- experience and random effects in production -- induces a joint distribution of all the endogenous entities in the model, wages, tenure, etc. Characterization of $\lambda(\cdot)$ in terms of its dependence on w, x, t, and μ is one way to extract the restrictions theory places on this joint distribution. It should be emphasized that $\lambda(\ )$ is the relevant probability from the viewpoint of the analyst. Under some circumstances, depending on the set of variables appearing as arguments in $\lambda(\cdot)$, it will also be the relevant probability as far as the agents in the model are concerned as well. The more important point is that irrespective of what the agents in the model observe and do, the Propositions derived are what the model implies that an analyst will see if he has access to the specified data.[7]

The analysis of $\lambda(\cdot)$ proceeds as follows. First, some useful notation is introduced. $\lambda(\cdot)$ is then constructed and the results stated.

3.1 Some Notation

Every worker works in each period, in which case an observation on Q^{α} or Q^{β} is obtained. Given the interaction of production technologies and worker traits set out above, $Q^{\alpha} = q_2$ or $Q^{\beta} = 1$ is an indication that the worker is a type A, $Q^{\alpha} = 1$ or $Q^{\beta} = q_2$ suggests a type B, and $Q^{\alpha} = q_1$ or $Q^{\beta} = q_1$, yields no new information. Construct a new random variable I as follows:

$$I = \begin{cases} 1 & \text{if } Q^{\alpha} = q_2 \text{ or } Q^{\beta} = 1 \\ 0 & \text{if } Q^{\alpha} = q_1 \text{ or } Q^{\beta} = q_1 \\ -1 & \text{if } Q^{\alpha} = 1 \text{ or } Q^{\beta} = q_2. \end{cases}$$

Let $S(x)$ be the sum of the worker's realizations of I when his experience is x, and define $S(0) = 0$. $S(x)$ can take thus on values $s(x) \in \{-x,\ldots,x\}$, where $x \in \{0,1,\ldots,4\}$.

It is straightforward to check that $S(x)$ is a sufficient statistic for the workers' history, and that

$$\begin{aligned} \Pr[A|S(x) = s(x)] &\equiv \Pr[A|s(x)] \\ &= \{1 + [\theta/(1-\theta)]^{-2s(x)}\}^{-1} \\ &\gtreqless \tfrac{1}{2} \Leftrightarrow s(x) \gtreqless 0. \end{aligned} \qquad (6)$$

Thus, workers for whom $s(x) > 0$ work for firms of type α, those for whom $s(x) < 0$ work for type β firms, and the rest are evenly divided between firm types.

$s(x)$ will be referred to as the workers' <u>information class</u>. New entrants to the labor force, in their first period of work, are therefore all members of information class 0; those in their second period occupy one of classes -1, 0, or 1; and so on. The complete list of information classes is denoted $\sigma \equiv \{-4,-3,\ldots,4\}$, with typical element s.

Note from (6) that $s(x)$ can change by at most one unit per period. An immediate implication is that if $S(x) = s(x)$, $S(x+1) \in \{s(x)-1,\ s(x),\ s(x)+1\}$; the maximum absolute rate at which a workers can change information classes is one per period.

3.2 <u>Construction of $\lambda(w,x,t,\mu)$</u>

The probability with which a worker having given characteristics will quit is most readily derived by computing the probability of a quit given any information class, along with the distribution of workers across information classes, given characteristics.

To proceed in this manner, let ϕ_s be the probability of a quit given information class s, and $\xi_s(w,x,t,\mu)$ denote the fraction of workers having characteristics (w,x,t,μ) who occupy class s. Then

$$\lambda(w,x,t,\mu) = \sum_{s\in\sigma} \phi_s \xi_s(w,x,t,\mu). \tag{7}$$

The next steps are the derivations of ϕ_s and $\xi_s(\cdot)$.

3.2.1 Construction of ϕ_s

Consider a worker in class 0, presently working for a type α firm. By (6), $P(A|0) = ½$. There are exactly two ways in which such a worker can become mobile. First, he might receive the uniformative data $I = 0$, in which case he remains in class 0 and will be mobile with probability ½ as a result of the coin toss. Alternatively he might receive data $I = -1$, causing him to enter class -1, and certainly to be hired by a type β firm. From (1), (2) and (6), the probability with which one of these events will occur is

$$P(A|0)[2\theta(1-\theta)\cdot½ + (1-\theta)^2] + [1-P(A|0)][2\theta(1-\theta)\cdot½ + \theta^2],$$

which, with minor manipulation, equals ½. Workers in class 0 who are presently employed by a type β firm face a symmetric situation. Thus

$$\phi_0 = ½ \tag{8}$$

Now consider a worker in class 1, hence employed by a type α firm. There is just one way he may become mobile, namely by receiving $I = -1$, thus entering class 0, and subsequently being reallocated as a result of the coin toss. The probability of this event is

$$P(A|1)(1-\theta)^2\cdot½ + [1-P(A|1)]\theta^2\cdot ½,$$

which simplifies to

$$\phi_1 = [\theta^{-2} + (1-\theta)^{-2}]^{-1}.$$

Again, symmetry yields $\phi_{-1} = \phi_1$. Also, since $\theta^{-2} > 1$ and $(1-\theta)^{-2} > 1$, $\phi_1 < ½$. It follows that

$$\phi_0 > \phi_1. \tag{9}$$

Since a worker can cross information classes no faster than one at a time, workers whose information places them outside classes 1, 0 or -1 will certainly be employed by the same firm type next period:

$$\phi_s = 0 \text{ for } s \notin \{-1,0,1\}.$$

In summary, only workers occupying classes 0 or ± 1 can be mobile in equilibrium, and those in class 0 are more likely to quit than those in class 1.[8]

3.2.2 Construction of $\xi_s(w,x,t,\mu)$

Let $N_s(w,x,t,\mu)$ be the number of workers who have characteristics (w,x,t,μ) and occupy class s. Then $N(w,x,t,\mu) \equiv \sum_{s\in\sigma} N_s(\cdot)$ is the number who have the required characteristics irrespective of information class, and since there is a continuum of workers

$$\xi_s(w,x,t,\mu) = N_s(w,x,t,\mu)/N(w,x,t,\mu) \tag{10}$$

When a smaller set of conditioning variables is desired -- for example (x,t,μ) -- $\xi_s(\ )$ is construced by removing the conditioning in the usual manner. In this case,

$$\xi_s(x,t,\mu) = \frac{\sum_w N_s(w,x,t,\mu)}{\sum_w N(w,x,t,\mu)} .$$

Subsequently, (10) is applied using the revised $\xi_s(\cdot)$. In the example $\lambda(x,t,\mu)$ is obtained.

To compute N_s it is necessary to derive the probability that a worker will, <u>without leaving</u> the firm at which he is presently employed, proceed from class s=i to class s=j in k periods (for i,j=0,...,3, and k=1,...,3. i,j=-3,...,0 are entirely symmetric).[9]

Denote the 4 X 4 array of these probabilities by $\pi(k)$, with typical element $\pi_{ij}(k)$. To construct $\pi(k)$, consider $\pi(k|A)$, the matrix of transition probabilities given the worker is of type A. The transition from class 0 to class 0 for example, requires $I = 0$, the probability of which is $2\theta(1-\theta)$, in conjunction with not being reassigned by the coin toss, which occurs with probability ½. Together then, $\pi_{00}(1|A) = \theta(1-\theta)$. Proceeding in this fashion yields $\pi(1|A)$.

Next, note that

$$\pi(k|A) = \pi(1|A)\pi(k-1|A), \tag{11}$$

which gives $\pi(k|A)$ for $k = 2,3$. $\pi(k|B)$ is constructed similarly. Finally, $\pi(k)$ is obtained using (6) and

$$\pi_{ij}(k) = P(A|i)\pi_{ij}(k|A) + [1-P(A|i)]\pi_{ij}(k|B). \tag{12}$$

In what follows, only the transition probabilities for paths beginning at class 0 and 1 are required (the top two rows of $\pi(k)$). These expressions are supplied in the Appendix Table 1 for $k \leq 2$.[10]

Also required in the computation of $N_s(\cdot)$ are the probabilities with which workers move, in one period, from class i in one firm type to class j in the other, written ψ_{ij}. Since workers can move at most one information class per period, only ψ_{00}, ψ_{01} and ψ_{10} (again ψ_{0-1} and ψ_{-10} are analogous) are positive.

As ψ_{10} is the probability of moving from class 1 in a type α firm to class 0 in a type β firm,

$$\psi_{10} = \phi_1, \tag{13}$$

the probability of mobility from class 1.

From class 0 in a type α firm there are two possible destinations: class 0 and class 1, both in a type β firm. Mobility to class 0 requires new information I = 0, occurring with probability $2\theta(1-\theta)$, plus allocation to the β firm via the coin toss, having probability ½. Accordingly

$$\psi_{00} = \theta(1-\theta). \tag{14}$$

Mobility to class 1 requires information I = -1, which has probability $(1-\theta)^2$ for A workers and θ^2 for B workers. Using (6) yields

$$\psi_{01} = \tfrac{1}{2}\,[\theta^2 + (1-\theta)^2]. \tag{15}$$

Note that since ϕ_0 does not distinguish between destination information classes,

$$\phi_0 = \psi_{00} + \psi_{01}. \tag{16}$$

Making use of the $\pi_{ij}(k)$ and ψ_{ij}, $N_s(w,x,t,\mu)$ can be constructed. Letting w_s be the wage earned by workers in class s, Appendix Table 2 provides the relevant expressions, for $x \leq 2$.[11]

As an example of the method by which the N_s are constructed, consider $N_0(w_0,2,0,1)$. $N_0(w_0,2,0,1)$ comprises workers with two periods of experience who, having started their working life in class 0, find themselves again in class 0 having just joined the firm (t=0) without a move prior to that which brought them to their present employment. Consider firms of type α. Each firm type begins with ½ (recall the labor force is of size 1) workers of experience 0 in class 0. After one period the fraction $\pi_{00}(1)$ remain in class 0 and π_{01} have entered class 1 within that firm type. At the end of the next period, the fraction ψ_{00} (ψ_{10}) of the $\frac{1}{2}\pi_{00}$ ($\frac{1}{2}\pi_{01}(1)$) in class 0 (1) move to a type β firm (creating μ=1 and t=0), and in particular, enter class 0 in the other firm type. The number of workers involved is thus $\frac{1}{2}[\pi_{00}(1)\psi_{00} + \pi_{01}(1)\psi_{10}]$. Treating type β firms symmetrically yields the expression for $N_0(w_0,2,0,1)$ given in Appendix Table 2. Finally, $\xi_0(w_0,2,0,1)$ is obtained from (10).

3.3 Results on $\lambda(w,x,t,\mu)$

Given the set of conditioning variables, there is a large number of experiments that might be considered, and a correspondingly large number of results. The organization of the propositions is as follows. First, one fairly strong restriction is presented. This restriction is informative about the outcome to be expected from many of the potential experiments. Subsequently, wage, experience, tenure and past mobility effects are considered.

3.3.1 A Basic Restriction

A worker's information class is a sufficient statistic for his work history. All workers in any given information class are equally likely to quit, and do so with probability ϕ_s. Also, in equilibrium, the wage received by a worker is equal to his expected value of output given his history, or equivalently, given his information class. From (3), this expected value varies with history, in which case the wage varies with information class. In particular, workers in class 0 earn w_0, those in class 1 earn, $w_1 > w_0$, and so on. Also due to the symmetry of the problem, $w_s = w_{-s}$ $\forall$ $s \in \sigma$.

Taking these facts together, all workers earning a given wage are in either information class s or -s, for some $s \in \sigma$. Since $\phi_s = \phi_{-s}$ for all $s \in \sigma$, these workers are equally likely to quit. This argument establishes the following result.

<u>Proposition 1</u>

For any w, $\lambda(w,x,t,\mu)$ <u>does not depend on</u> x, t, <u>or</u> μ.

Proposition 1 is a special case of a general result on finite state space general equilibrium economies proved in MacDonald (1986). The intuition underlying it is that the probability of a quit is completely determined by the worker's history, which is captured in all relevent aspects by the equilibrium wage. Experience, tenure and past mobility may be correlated with, or proxy, elements of the worker's history. But given the wage they offer no new information about history and therefore cannot influence the probability of a quit.

An obvious Corollary to Proposition 1 is that experience, tenure and past mobility can only have an impact on the probability of a quit if the wage is not held constant. Experiments of this sort are considered below.

Note that this result contrasts with the Jovanovic-Mortensen-Topel Proposition. Therein the wage does not summarize all relevant information. At first blush this disagreement appears to be a result of the absence of direct costs of mobility in the present model. This impression is incorrect. The difference resdides in the fact that in the present model there are finitely many possible types of workers and finitely many possible outputs; countable infinities would do as well. Provided individual output is well defined, it is possible to show that the ability of the equilibrium wage to identify the relevant information is a generic property of all finite state space economies of the type being considered. See MacDonald (1986). Thus the different implications would seem to hinge on the fact that in Jovanovic-Mortensen-Topel, because there are a continuum of both worker types and outputs given type, a single value of the wage will be associated with many different information sets. Generically, no finite (or countably infinite) state space model will have this feature.

3.3.2 Wage (w) Effects

Workers occupying information class 0, hence earning w_0, are more likely to quit than those in class ±1, earning $w_1 (=w_{-1})$. Those workers earning

still greater wages are even less likely to quit. Indeed, in this simple setting, they certainly will not quit. Overall, experience, tenure and past mobility
constant, the higher the wage, the lower the probability of a quit.

Proposition 2

For all x, t and μ, $\lambda(w_0,x,t,\mu) > \lambda(w_1,x,t,\mu) > \lambda(w_s,x,t,\mu)$ for $s \notin \{-1,0,1\}$.

3.3.3 Experience (x) Effects

The influence of experience on the quit probability depends greatly on the nature of the experiment; that is, what other variables are held fixed.

Proposition 3

i). $\lambda(x) > \lambda(x+1)$;

ii). $\lambda(x,\mu) > \lambda(x + 1,\mu)$;

iii). $\lambda(x,t) < \lambda(x+1,t)$ for $x > t$;

iv). $\lambda(x,t,\mu) < \lambda(x+1,t,\mu)$ for $\mu + t < x$;

and v). $\lambda(w,x,t,\mu)$ is independent of x.

In part (i), all conditioning on variables other than experience is removed. Because information is useful for matching workers and firms, and more experienced workers have had more time to accumulate information, such workers are on average less likely to quit. This effect continues to hold, fixing past mobility behavior (part (ii)). The reason is that although the information accumlated by workers who have changed jobs more often is typically less conclusive regarding the quality of the match, within a group of workers who have changed jobs a given number of times, the logic of part (i) still applies. But not so holding only tenure fixed. Holding tenure constant, an increase in experience implies on average a longer portion of working life spent in the other firm type; i.e. prior to the current match. The information available at that time must have indicated that that assignment was more likely to be the productive one. Since this earlier information is part of the current history, there is greater uncertainty about the efficacy of the current match, and therefore a higher probability of its dissolution, part (iii).[12] Holding past mobility constant along with tenure generates the same result (part (iv)), the argument being essentially unaltered, but applied within groups having given past mobility. Finally, part (v) is merely an immediate implication of part (i).[13]

Overall, then, the impact of experience on the probability of a quit first depends on (a) whether experience contains any information not already accounted for -- i.e. whether the wage is held constant --; and (b) whether greater experience indicates a stronger attachment to the present firm -- as it does when no other conditioning is imposed or only past mobility is held fixed -- or a weaker one -- as it does when tenure alone, or tenure and past mobility, are held constant.

3.3.4 Tenure (t) Effects

The impact of tenure on the probability of a quit is less sensitive to the nature of the experiment than is the effect of experience.

Proposition 4

i). $\lambda(t) > \lambda(t+1)$;

ii). $\lambda(x,t) > \lambda(x,t+1)$ *for* $x > 1$;

iii). $\lambda(t,\mu) > \lambda(t+1,\mu)$;

iv). $\lambda(x,t,\mu) > \lambda(m,t+1,\mu)$;

and v). $\lambda(w,x,t,\mu)$ *is independent of* t.

Part (i) is straightforward -- workers with longer tenure are simply more likely to have found an appropriate match. In part (ii), greater tenure, given experience, implies less experience prior to the current match, and thus a smaller influence of information accumulated prior to the current match. Thus holding experience constant reinforces the effect of tenure.[14] Fixing past mobility also supports the tenure effect, part (iii). Greater tenure forces a given amount of past mobility into shorter period of experience prior to current job. As a consequence the likelihood of a firm attachment (in the sense of an extreme value of $P(A|H)$) to a firm of the other type prior to the present match is reduced. This reduction supports the tenure effect since any such strong prior attachments remain part of the current history and work to render it more likely to dissolve. Part (iv) simply combines the reinforcing effects of experience and past mobility, and part (v) is, again, a simple implication of Proposition 1.

3.3.5 Past Mobility (μ) effects.

The influence of past mobility, like that of experience, varies with the nature of the experiment.

<u>Proposition 5</u>

i). $\lambda(\mu) \leq \lambda(\mu+1)$ <u>for</u> $\mu \geq 1$;

ii). $\lambda(x,\mu) \leq \lambda(x,\mu+1)$;

iii). $\lambda(t,\mu) \gtrless \lambda(t,\mu+1)$;

iv). $\lambda(x,t,\mu) \geq \lambda(x,t,\mu+1)$;

and v). $\lambda(w,x,t,\mu)$ <u>is independent of</u> μ.

Part 1 holds because workers who have quit more often are less likely to have acquired a history that generates a solid attachment to a firm of any one type, in the sense that on average a relatively small amount of data would be required to generate a quit. This effect is reinforced by the fact that workers who have quit more often in the past are likely to have shorter tenure. Moreover it overcomes the fact that they are also more experienced on average. Part (ii) removes the latter effect,[15] and thus supports part (i). Part (iii), on the other hand, eliminates the former effect, allowing the impact of greater experience to become important enough to generate an ambiguous outcome. In part (iv), greater past mobility is confined to a given amount of experience prior to the current match. This change renders information gathered prior to that match less informative on the average, and thus makes it more likely that the information gathered during the current match is dominant -- much like a decline in experience, holding tenure and past mobility constant. The likelihood of a quit declines correspondingly. Finally, Proposition 1 implies part (v).

In brief, greater past mobility operates in a manner similar to reduced experience prior to the current match.

3.4 Summary of Section 3

This Section has developed the implications for equilibrium job mobility yielded by the model presented in Section 2. The major results are (i) workers earning greater wages are less likely to quit; (ii) wages constant, none of experience, tenure or past mobility influence the probability of employment; (iii) permitting wages to vary, irrespective of whether past mobility is held constant, workers with greater experience are less likely to quit if tenure not held fixed, but more likely to if tenure is a conditioning variable; (iv) again letting wages vary, greater tenure redues the probability of a quit whether experience and/or past mobility, or neither, is held constant; (v) greater past mobility has approximately the same effects as reduced experience.

4. DISCUSSION OF EMPIRICAL PROCEDURES, SOME COMPLICATIONS, AND ILLUSTRATIVE DATA

The theory set out above implies a set of restrictions on the conditional probability of a quit for a diverse set of conditionings. In this Section, testing procedures are discussed along with the impact of allowing accumulation of general skills or a non steady state economy. A small amount of data from the literature is also examined.

4.1 Testing Procedures

The theory implies that in equilibrium, whether a worker quits can be modelled correctly as a binomial random variable with success probability $\lambda(w,x,t,\mu)$. Restrictions are also placed on $\lambda(\cdot)$.

Testing hypotheses of this variety has traditionally been approached using parametric regression techniques such as the linear probability model or probit. Although the strong additional (and essentially untestable) restrictions required for these techniques to be valid are well known (see for example, Kagan, Linnik and Rao, 1973) that the number of conditioning variables is usually large has, at least until fairly recently, rendered infeasible those methods which are more appropriate from the standpoint of econometric theory.

More explicitly, the theory refers to the shape of the conditional distribution of the random event "quit". A straightforward nonparametric procedure simply involves calculating the empirical frequency distribution, and checking whether it has the specified properties. Given the sample sizes usually available to labor economists, the central limit theorem implies such small standard errors that the exercise is barely statistical.

When the number of conditioning variables is small, this procedure can be undertaken very easily. Consider, as an illustration, Proposition 3(v) -- $\lambda(x) > \lambda(x+1)$. With $N(x)$ being the number of workers having given experience, the Central Limit Theorem gives

$$\hat{\lambda}(x) \overset{A}{\sim} N\{\lambda(x), \frac{\lambda(x)[1-\lambda(x)]}{N(x)}\},$$

where $\hat{\lambda}(x)$ is the fraction of the $N(x)$ workers who are observed to change jobs during the sample period. Under the null hypothesis H_0: $\lambda(x)=\lambda(x+1)$.

$$\hat{\lambda}(x) - \hat{\lambda}(x+1) \overset{A}{\sim} N(0,\sigma^2),$$

where

$$\sigma^2 = \sum_{j=x}^{x+1} \frac{\lambda(j)[1-\lambda(j)]}{N(j)} .$$

σ^2 is consistently estimated by replacing $\lambda(x)$ with $\hat{\lambda}(x)$.

Mincer and Jovanovic (Table 1.2) provide enough information to illustrate the procedure. Data from the National Longitudinal Survey of Young Men, 1967-73, are partitioned into two groups depending on whether experience is 0-4 years or 5-9, (which will be called x=0 and x=1). Using these data the fractions of workers moving in the period 1971-3 are $\hat{\lambda}(0) = .47$, $\hat{\lambda}(1) = .38$. Also $N(0) = 2246$ and $N(1) = 1197$. It follows that $\hat{\lambda}(0) - \hat{\lambda}(1) = .09$ and $\hat{\sigma}^2 = .3077 \times 10^{-3}$, in which case the asymptotic normal statistic is 5.13, soundly rejecting H_0.

When the number of conditioning variables is larger, a nonparametric procedure strictly analagous to that just presented is obviously not helpful. However, techniques which enable direct nonparametric estimation of the joint distribution of many variables, from which the conditional distributions studied above are easily obtained, have now been developed and constitute the appropriate way to confront the mobility results. For an applications-oriented presentation, see Ullah and Singh (1986).

It should be emphasized that the preceding emphasis on nonparametric techniques is not simply a matter of taste. In contrast to demand studies, for example, the economic theory presented above makes all its predictions in terms of the joint distribution of the variables in the model. Parametric econometrics places strong restrictions on exactly that part of the model and so may actively interfere with testing of the theory's implications.

4.2 Two Complications

The theory set out above ignores two important elements which may well confuse empirical work: accumulation of general skills, and a non steady state economy. What is the impact of these omissions, and can they be overcome? If so, can any new results emerge?

Accumulation of general skills makes for wage differentials that are not due solely to differences in information sets, as in the model of Section 3. The possibility of equal wages but different information sets also arises. Thus, at a minimum Propositions 1 and 2 may be in jeopardy. However, at least in a simple extension of the model, accumulation of skills creates no difficulty, and in fact, more results can be obtained.

Consider a pure schooling model of general skill accumulation. Suppose general human capital (K) augments all outputs equally, in which case $Q^f = 1$, q_1 or q_2 becomes $Q^f = K$, Kq_1 or Kq_2 for any K and all f. Assume that a fraction S of the first period of work is devoted to schooling, that schooling is the only source of general skill, and that S generates K according to $K = k(S,\gamma)$ where γ is a learning efficiency parameter; $k_s > 0$, $k_{ss} < 0$,

$k_\gamma > 0$ and $k_{S\gamma} > 0$.[16] Let V be the expected wage earnings per unit of K, beginning after the first period. V does not depend on K, and is computable from the analysis above using the probabilities with which the worker will find himself in any given information class at any date, and the wages w_s (now per unit of K) attached to these information classes. Ignoring discounting, expected wealth is

$$[(1-S)w_0 + V]k(S,\gamma),$$

and maximal schooling S* solves

$$-w_0 k(S,\gamma) + [(1-S)w_0 + V]k_S = 0.$$

The sign of $\partial S^*/\partial\gamma$ depends on the magnitude of $k_{S\gamma}$, with $\partial S^*/\partial\gamma > 0$ for large $k_{S\gamma}$; $dK/d\gamma > 0$ always holds.

Given this setup, it is easy to show that Propositions 3-5 are unaltered simply because the level of K does not effect the relative values of expected output from given matches. Put differently, when wages are not held constant, schooling has no effect on mobility. Next, assuming $\partial S^*/\partial\gamma$ has the same sign for all γ, holding schooling fixed implies a single value of γ and hence a single value for K. Thus Propositions 1 and 2 apply immediately, but within schooling groups, since any two workers within a given schooling group again earn the same wage ($w_s K$) if and only if they occupy the same information class (actually class s or -s). Furthermore, another result can be obtained. Consider two individuals earning the same wage but having different schooling levels. Suppose $k_{S\gamma}$ is such that $\partial S^*/\partial\gamma > 0$. Then the worker having the greater schooling level also is a more efficient learner (higher γ) and has greater general skill. It follows that (to hold the wage fixed) this worker must be earning less on each unit of skill (w_0 versus w_1), which translates into his occupying an information class from which quitting is more likely (class 0 versus class $\pm$ 1). Consequently, for a given wage rate, the probability of a quit is rising in schooling.[17] Moreover, holding the wage fixed, schooling levels are associated one to one with information class, and operate much like different wage levels in the model of Section 3. Thus the result does not depend on the other possible conditionings (age, tenure, etc.), and the other conditioning variables are irrelevant given the wage and schooling level, which now jointly identify information class.

The issue of how to deal with a non steady state economy is less straightforward. In the model of Section 3 the relative prices of goods were fixed. Mobility was a result of individual level events, consonant with the literature discussed above. However, any empirical analysis is going to have to face the fact that there are aggregate events which may influence individual mobility, and which can raise havoc in the empirical analysis.

To see why such problems occur, recall that in the model of Section 3, all agents knew to which information class any given worker belonged, and hence his probability of a quit; and this probability was independent of age, tenure etc. The investigator's situation is different. For a fixed wage, although the investigator does not know any given worker's information class, the theory reveals that the wage varies if and only if the quit probability varies. Hence Proposition 1. When the investigator does not know the wage, individuals having identical observed non-wage attributes are distributed across information classes in a way that depends on those attributes; Propositions 3-5 follow.

If there are aggregate disturbances--which might be modelled as randomly varying relative prices of consumption goods, perhaps intertemporally correlated--there is no additional complication for the agents in the model if they observe prices along with everything else they are already assumed to observe. Again the agents know which information set any worker occupies, and along with knowledge of the stochastic structure of prices, could compute the probability of a quit much as before. But consider an investigator in the extreme case of having access to only the number of jobs each worker in the sample has had. Proposition 5(i), for example, can be made to fail easily simply by supposing the existence of a series of periods, relatively far in the past, of extreme aggregate volatility. For then workers having large μ typically will have started their working lives earlier, during the period of volatility, but have long total experience and then be very unlikely to quit.

This problem is evidently a serious and comparatively difficult one. A complete solution would of course involve a full integration of the two kinds of approaches. A second, but partial, solution restricts the set of experiments. For example, if the investigator is assumed to have access to the wage then Propositions 1 and 2 continue to hold, the argument being just as before. Parts of Propositions 3-5 can also remain valid, depending on the auxilliary information the investigator is permitted. A third type of solution is purely econometric. Unless the aggregate random variables are sufficiently highly intertemporally correlated, it is possible to utilize the average value of $\hat{\lambda}(\cdot)$, calculated from samples taken at different dates, to estimate consistently the expected value of $\lambda(\ )$ induced by the aggregate stochastic process.

4.3 Existing Data

The literature presents very little data in a form suitable for even the simplest kind of nonparametric analysis discussed above. Moreover, what is available is presented as descriptive evidence preceding more in depth analysis. As a consequence the definitions of variables and description of sample construction samples are less complete than would be typical. Therefore, the following material should be viewed solely as illustrative.

Mincer and Jovanovic, and Topel and Ward provide some frequency information. Unfortunately, the example given in Section 4.1 above is the only instance for which there is sufficient information to compute standard errors.

The hypotheses which may be illustrated are the experience effects 3(iii) and 3(v), tenure effects 4(ii) and 4(iii), and past mobility effect 5(iii).

Experience effect 3(v) was examined above. 3(iii) states that, tenure constant the probability of a quit rises in experience, Table 1 provides Mincer and Jovanovic's data (NLS Young Men) on separations for $x > t$. Topel and Ward's data--from the Longitudinal Employer- Employee Data (LEED) file based on the U.S. Social Security Administration's Continuous Work History Sample--are contained in Table 2. Experience is defined as "previous" so $x>t$ is implicit.

The positive effect of experience on quit probability given tenure is clear, if not large, in the NLS data, except at long tenures. In the LEED data, the effect is rare at low tenures, more frequent at longer tenures, but overall found in only about one third of the possible positions in Table 2.

The negative effect of tenure, given experience, on quit probability is apparent in both Tables 1 and 2. Table 3 presents the LEED data on quit frequencies by tenure and previous mobility. Therein Proposition 4(iii) is well illustrated.

Proposition 5(iii) states that the effect of past mobility on the quit probability given tenure is in general ambiguous. The data in Table 3 suggest that additional past mobility lowers the likelihood of a quit for those workers who have had few jobs, but raises it for workers who have been more mobile; an outcome neither excluded nor necessarily implied by the theory.

TABLE 1

Percent of Workers Moving in 1971-73*
(NLS Young Men 1967-73)

Experience (years)	All Tenures**	Tenure (Years) 0-1	1-3
0-4	47	73	58
5-9	38	77	60

* From Mincer and Jovanovic (Table 1.2)
** May include workers for whom x < t.

TABLE 2

Percent of Workers Moving within One Quarter
(LEED, 1957-72)

		Tenure (years) 0-1/4	1/4-1	1-2	2-3	3-5	5-8	8+
Experience prior to Current Job (years)	0-½	54.9	25.6	14.7	10.8	6.3	5.4	2.3
	½-1	49.2	21.8	14.9	12.1	9.3	3.8	2.6
	1-2	35.2	23.7	10.8	9.3	5.4	5.3	4.3
	2-3	34.4	19.4	12.1	6.2	6.7	4.7	2.8
	3-5	34.6	17.7	12.1	7.5	3.9	5.9	0
	5.8	26.2	15.5	10.2	6.9	4.0	2.3	0
	8+	20.7	16.6	6.2	4.4	3.2	5.9	0

TABLE 3

Percent of Workers Moving Within One Quarter
(LEED, 1957-72)

		Tenure (Years) 0-1/4	1/4-1	1-2	2-3	3-5	5-8	8+
Number of Previous Jobs	0	54.3	24.4	14.6	13.2	7.3	6.1	0.6
	1-3	43.7	21.8	12.0	8.1	5.6	4.9	3.3
	4-6	31.5	19.2	11.4	7.6	5.0	4.5	*
	7+	41.3	21.7	14.6	8.8	4.2	*	*

* Not available. Less than 100 in cell.

In sum, as might be anticipated, the illustrative data available in the literature offer neither refutation nor corroboration of the model set out above. Stronger conclusions will have to wait for more thorough econometric investigation utilizing tools which extract the information in quit data without imposing strong and arbitrary restrictions on those entities which are the focus of the theoretical analysis.

5. Summary

The paper developed a model in which stochastic job mobility is part of the equilibrium of the economy. The model simplified and extended MacDonald (1982) in the spirit of Jovanovic (1984), Mortensen and Topel.

A body of hypotheses were developed, the centre of attention being the probability with which an investigator, having access to certain data on a given worker, would observe a quit. Due to the simplicity of the model, it was possible to derive a strong and specific set of restrictions concerning the effect of the current wage, experience, tenure, and past mobility (as well as subsets of that group alone) on the probability of a quit. Subsequently, appropriate econometric techniques, some practical issues associated with the impact of simplifying assumptions on testing, and some illustrative data were presented.

APPENDIX TABLE 1

$$\pi(1) = \begin{pmatrix} \theta(1-\theta) & \frac{1}{2}[\theta^2+(1-\theta)^2] & 0 & 0 \\ \frac{\theta^2(1-\theta)^2}{\theta^2+(1-\theta)^2} & 2\theta(1-\theta) & \frac{\theta^4+(1-\theta)^4}{\theta^2+(1-\theta)^2} & 0 \end{pmatrix}$$

$$\pi(2) = \begin{pmatrix} \frac{3}{2}\theta^2(1-\theta)^2 & \frac{3}{2}\theta(1-\theta)[\theta^2+(1-\theta)^2] & \frac{1}{2}[\theta^4+(1-\theta)^4] & 0 \\ \frac{3\theta^3(1-\theta)^3}{\theta^2+(1-\theta)^2} & \frac{11}{2}\theta^2(1-\theta)^2 & \frac{4\theta(1-\theta)[\theta^4+(1-\theta)^4]}{\theta^2+(1-\theta)^2} & \frac{\theta^6+(1-\theta)^6}{\theta^2+(1-\theta)^2} \end{pmatrix}$$

APPENDEX TABLE 2*

$N_s(w,x,t,\mu)$, $x \leq 2$

$N_0(w_0,0,0,0) = 1$

$N_0(w_0,1,0,1) = \psi_{00}$

$N_1(w_1,1,0,1) = \psi_{01}$

$N_0(w_0,2,0,1) = \pi_{00}(1)\psi_{00} + \pi_{01}(1)\psi_{10}$

$N_1(w_1,2,0,1) = \pi_{00}(1)\psi_{01}$

$N_0(w_0,2,0,2) = \psi_{00}^2 + \psi_{01}\psi_{10}$

$N_1(w_1,2,0,2) = \psi_{00}\psi_{01}$

$N_0(w_0,1,1,0) = \pi_{00}(1)$

$N_1(w_1,1,1,0) = \pi_{01}(1)$

$N_0(w_0,2,1,1) = \psi_{00}\pi_{00}(1) + \psi_{01}\pi_{10}(1)$

$N_1(w_1,2,1,1) = \psi_{00}\pi_{01}(1) + \psi_{01}\pi_{11}(1)$

$N_0(w_0,2,2,0) = \pi_{00}(2)$

$N_1(w_1 2,2,0) = \pi_{01}(2)$

*$N_{-1}(\ ) = N_1(\ )$ for all (w,x,t,μ).

NOTES

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[1]See Becker (1964, Ch. 2). Hall's (1972) paper is an early and insightful survey, and Parsons (1977) gives a good account of the theory and data available up to the mid 1970's.

[2]This literature is a large one. Thus references to follow are primarily intended to be illustrative. The reader may also wish to consult Johnson (1978), Flinn (1986) and Miller (1984).

[3]Jovanovic (1979,a,b) is an exception. Therein, a new opportunity arrives if and only if a match is dissolved.

[4]The reader who is familiar with MacDonald (1982) will note that the worker-specific information is generated in a different manner herein. The analysis to follow can be reproduced exactly using the earlier setup.

[5]This material is treated at greater length in MacDonald (1983).

[6]This inference argument is developed in detail for a more general economy in MacDonald (1986).

[7]The parallel with the classic pure schooling version of human capital theory (Rosen, 1973) may prove helpful. Suppose individuals vary only by age and unobservable (to the analyst) learning ability. Given age, variation in ability induces a joint distribution of schooling duration and earnings. Under assumption about the distribution of ability a specific schooling-earnings distribution is implied, whose features constitute the predictions of the model.

[8]Observe that ϕ_s does not depend on worker characteristics. This independence occurs because information class is a sufficient statistic for the complete worker history, which includes all relevant information that is available.

[9]These probabilities involve the joint event of proceeding from i to j without changing firms. In particular they do not represent the probability of proceeding from i to j <u>given</u> no change of firm type.

[10]The expressions for $k > 2$ are somewhat lengthier, and available in MacDonald (1983).

[11]Like $\pi_{ij}(k)$, the $N_s(w,x,t,\mu)$ expressions are cumbersome and supplied in MacDonald (1983). Therein N( ) is labelled T( ).

[12]The exclusion of the x=t case in part (iii) is purely an artifact of the assumption that there is no worker-specific information at the outset of working life. Thus workers for whom x=t are only trivially distributed across information classes. All are in class 0 and are therefore relatively likely to quit, reversing, for x=t the stated inequality.

[13]All workers for whom $\mu+t=x$ occupy class 0, with the same effect as explained in Note 12.

[14]For x=1, t=0 or 1. Since the initial allocation of workers to firms was on the basis of a coin toss, those who were assigned the other firm type and move to the current one subsequently (and hence have t=0) are no more likely to be a good match for their current firm than are workers whose first period history indicated they should stay in their present employment (in which case they have t=1). Thus the inequality becomes an equality for x=1.

[15]All workers who have just entered the labor force have $\mu=0$. Again, as a result of the scarcity of initial information such workers are relatively likely to quit. Thus for $\mu=0$ the inequality is reversed. Like the effects discussed in Notes 12 and 13, this result is a red herring. Similarly, equality holds only for $\mu=0$ in part (ii). This result arises because $x=t$ is implied by $\mu=0$, and the logic of Note 12 applies.

[16]For simplicity, it is assumed that the information generation process in the first period is not hindered by schooling. With slight modification, the information process can be initiated in the first period of work instead.

[17]Formally, given the restricted information process, for any given level of schooling there is exactly one other level of schooling which yields both the same wage and a positive probability of mobility. Thus the experiment has limited scope in this specific instance. However, it has broader application if the information generating process is enriched.

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