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MIGRATION UNDER UNCERTAINTY ABOUT QUALITY OF LOCATIONS

Gautam BHATTACHARYA*

University of Kansas, Lawrence, KS 66045, USA

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This paper develops a search-theoretic framework for analyzing migration decisions of workers who can only observe the quality of a location by migrating to the location after accepting a job there. After learning the location quality, the worker can stay at the current job, search locally at the same location, or search for a job at another location (leading to repeat migration). This paper develops the properties of optimal search, migration, and repeat migration decisions, and finds how revealed location quality influences the tradeoffs between local search and repeat migration. The effects of search costs and better job opportunities on the reservation levels of wages and revealed quality levels are also determined.

1. Introduction

Most modern studies of migration have explained migration by individuals as a one-time migration decision. Many individuals, of course, are observed to migrate several times in their lives. If employment opportunities, wage rates, and qualitative characteristics of all locations in the economy are known to the individual and if the individual expected the relevant parameters to be stationary over time, then he will choose a job in a location that will maximize the present value of his lifetime utility. However, the individual usually does not have complete information about the availability of jobs at different locations; furthermore, he usually has to incur search costs in order to search for a job at different locations.

Thus a more appropriate analysis of migration will be of sequential costly sampling type (as in search theory) where an individual searches for jobs at different locations. He decides to migrate when he accepts a job at a location different from his current location because the expected value of searching again for jobs at any location does not exceed the stream of income from his accepted offer net of migration costs. Even with this view of migration,

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however, if the distribution of job offers across locations is stationary over time, one would expect an individual to migrate only once, i.e., hold the same job forever (if the search process takes a relatively small amount of time). Therefore, there should be other reasons why individuals migrate several times during a period when the distribution of job offers remains stationary over time. Three such reasons are discussed below.

First, after migrating for the first time and joining a new job, improvement in skill from experience or from on-the-job-training can induce the worker to search for opportunities for a better match with a new employer, possibly at a new location. If a satisfactory offer is obtained at a new location the worker may migrate again. Mortensen (1984), Miller (1984) and others have developed theoretical search models that analyze this phenomenon in the context of job quits and turnover. Although this framework may be used to analyze repeat migration, I have employed a different framework in this paper.

The second reason for repeat migration is related to nonwage characteristics of a worker's job. The working conditions of a job and the attractiveness of the area where the job is located are usually unknown or partially known to the worker while he is searching for a job. Only after a job is accepted and he migrates to the new location that the nonwage attributes associated with the job and location become known. Therefore, if the quality of the new location is unsatisfactory, the worker may resume search again and may migrate again. Repeat migration resulting from disappointment with locations has been analyzed empirically by Herzog and Schlottman (1983), DaVanzo (1983), Morrison and DaVanzo (1987), etc. Wilde (1979) and others have developed search models for job quits that can be applied to analyze migration behavior in this context. The framework used in my paper uses Wilde's (1979) set-up as a first step.

Finally, there is a third reason for repeat migration that does not have an analogue in the theory of search. When an individual is searching for a job across locations, he is essentially searching for a sample over a two-dimensional distribution of wage offers and locations. Each sample consists of a wage offer in a particular location and, if the job is accepted, the individual migrates to that location and eventually finds the true quality of the location. This process can be thought of as migration resulting from global or *national job search*. On the other hand, the individual has another option of searching for a job at his current location whose quality is already known to him. This type of search may be called *local job search*, it usually has a smaller search cost but covers a smaller set of opportunities because the searcher is searching on a conditional distribution of the two-dimensional distribution of wages and locations. Of course, if the characteristics of the current location are thought to be desirable, the searcher will forego national search and will search locally instead. Thus, the migration behavior of individuals will depend on the tradeoffs they face between national and local search.

In this paper, I have attempted to analyze the migration and job-search decisions of an individual by incorporating the second and third reasons mentioned as above in a model of search both across locations and jobs. The searcher looks for jobs that have two characteristics, wage and a location index. The quality of the location, a function of the location index, is unknown to the searcher and is revealed only after the job is accepted.

The worker first searches for a job in one among several alternative locations in the usual way, except he does not know the quality characteristics of any of the locations. If a job is accepted, the worker migrates to the particular location associated with the job. He finds the quality of the location after working at the new job and living in the new location for one period. At that time, he has the option of (a) not searching at all or (b) searching for a job locally at his current location or (c) searching for a job nationally, i.e., across all locations with the quality of other locations being unknown at the time of search. The objective of this analysis is to determine the nature of optimal migration decisions. I have shown that under rather mild assumptions, there exist reservation sets of wage and revealed location qualities that completely specify under what conditions the individual will search locally, search nationally, or not search at all in the second stage of the search process. Further, the first stage of the search process also follows a simple reservation-wage policy. Finally, I can answer questions about parameter changes, i.e., how local and national search costs, distribution of wages, and location quality, etc. affect the search and migration decisions both in the first and the second stages.

2. A model of migration and search

There are n locations $i = 1, \dots, n$ and the worker knows the distribution of available jobs in each region as given by $F_i(w)$ when w is the wage rate and $f_i(w)$ is the probability density of receiving a job offer with wage w in location i. I adopt the standard assumption [for instance, Lippman and McCall (1976, p. 158)] that

$$\mathrm{E}(w) < \infty, \qquad \mathrm{E}(w^2) < \infty.$$

Every region has a set of characteristics that cannot be observed before a worker actually migrates and holds a job there. These characteristics are assumed to have a pecuniary value of q unknown to the worker; the distribution of q in a location is denoted by a probability distribution with density $a(q)$. Note that $a(q)$ is assumed to be the same for all locations and $a(q)$ is known to the worker before making any choices. I assume that the distribution over q is a subjective probability distribution expressing the migrant's uncertainty about the true quality of a location rather than an objectively given probability distribution of true quality of a region. As usual, it is assumed that the average quality $\mathrm{E}(q)$ is finite.

The search and migration problem is divided in two stages. In the first stage, the worker is assumed to be away from these n locations and he decides to search for a job in these locations. The search cost in each location i is c_i and we assume that search is instantaneous. If a job offer w_n at location n is accepted, then the worker migrates to location n, after incurring a migration cost of c_m. Every time the individual decides to migrate, he has to spend c_m for moving costs and other adjustments necessary for migration. The cost c_m is supposed to be the same for all locations. After working at this job at location n for one period, the value of the nonwage characteristics, q_n, is revealed. Now the worker enters the second stage of the migration process where he has three options.

The first option is to stay at the current job at the current location, which will give a payoff of $q_n w_n$ every year. I assume a multiplicative benefit accruing from q_n, rather than an additive form $q_n + w_n$ – the worker is also assumed to be risk-neutral. The second option is to search locally at location n. The wage distribution at location n is $F_n(w)$. Search costs are assumed to be equal to L, possibly lower than the national search costs c_i, $i = 1, \ldots, n$. The worker, however, assures himself of the revealed quality level q_n. The third option is to search for a job at the remaining locations, i.e., go back to stage one by deciding to migrate again in the event of a successful search.

The worker's objective is to maximize the expected value of his discounted lifetime income,

$$\sum_{t=1}^{\infty} \beta^{t-1} \mathrm{E}(w_t q_t - S_t), \tag{1}$$

when w_t is his wage rate in time t (not in location t), q_t is the value of the quality of the location at time t, and S_t is the amount spent on search in period t.

In the first stage, the worker's problem is to decide which locations should be searched and which job offers should be accepted. Although search is instantaneous, we will assume that the worker can search in one location only although he can select which location to search. Let $\boldsymbol{W}_i$ denote a stopping rule for location i for stage one, i.e., when quality of locations is unknown. If the worker has chosen to search at location i and

if $w_i \in \boldsymbol{W}_i$, he accepts an offer w_i and migrates to location i,

if $w_i \notin \boldsymbol{W}_i$, he continues search at i.

Let $V(i)$ be the expected value of the worker's discounted lifetime income from following $\boldsymbol{W}_i$ if he decides to search in location i in stage one. Then the expected value of his overall search–migration process is

$$V = \max(V(1), V(2), \ldots, V(n)). \tag{2}$$

Using the definition of $\boldsymbol{W}_i$, one can evaluate $V(i)$ as

$$\begin{aligned} V(i) &= -c_i - c_m + V(i)\left(1 - \int_{\boldsymbol{W}_i} f(w)\,\mathrm{d}w\right) \\ &\quad + \int_{\boldsymbol{W}_i} J_i(w) f_i(w)\,\mathrm{d}w, \end{aligned} \tag{3}$$

when $J_i(w)$ is the total expected optimal payoff to the worker if an offer w is accepted in region i.

Let $H_i(w, q)$ be the worker's payoff in the second stage, i.e., his total expected payoff from the second period onward if q is the revealed quality level of location i after the worker migrates to location i and accepts a job at wage w there. Then

$$J_i(w) = \int_0^\infty (q \cdot w + \beta H_i(w, q))\, a(q)\,\mathrm{d}q, \tag{4}$$

when β is the discount rate and $a(q)$ is the density of q.

To evaluate $J_i(w)$ and $H_i(w, q)$, consider the options in stage two:

(1) Stay in the current job with expected payoff $qw/(1-\beta)$.

(2) Search locally for a job with search cost L.

Let $V_L(i, q)$ be the optimum expected total payoff from local search at location i and $\boldsymbol{W}_{Li}$ be the optimal stopping rule for such search. Note that if the worker decides to search locally in this period with revealed quality level q, he will stay with a job at i if an offer is accepted through local search at i. Therefore, we can write

$$\begin{aligned} V_l(i, q) &= -L + \int_{\boldsymbol{W}_{Li}(q)} (q \cdot w/(1-\beta)) f_i(w)\,\mathrm{d}w \\ &\quad + V_L(i, q)\left(1 - \int_{\boldsymbol{W}_{Li}(q)} f_i(w)\,\mathrm{d}w\right). \end{aligned} \tag{5}$$

(3) The last option is to search for a job at any one of the remaining $(n-1)$ locations $1, 2, \ldots, i-1, i+1, \ldots, n$. Here, if he chooses to search at location j, he obtains an expected value of $V(j)$.

We can now evaluate his second-stage expected optimal payoff $H_i(w, q)$ as

$$H_i(w, q) = \max\left[q \cdot w/(1-\beta), V_L(i, q), V(1), V(2), \ldots,\right.$$
$$\left. V(i-1), V(i+1), \ldots, V(n)\right]. \tag{6}$$

Eqs. (1)–(6) specify my model of search and migration. Notice that the worker may migrate several times, and he can also change jobs while staying at the same location.

To analyze the nature of the worker's decisions, I further assume:

Assumption 1. $V(1), V(2), \ldots, V(n)$ *are all distinct, i.e.,* $V(i) \neq j$.

Assumption 2. Without losing generality, the locations are renamed according to the value of their expected lifetime payoffs from the search and migration process. Thus $V(n) > V(n-1) > \cdots > V(1)$, *or n is the most desirable location and* 1 *is the least desirable location.*

Assumption 3. Return migration is not allowed in my model. Thus, if the worker is currently in location i and finds the revealed quality level to be q_i, *he can stay in the current job, search locally, or look for a job in the next best location* $i-1$. *He cannot search in location* $i+1$ *where he already held a job before and observed the quality to be* q_{i+1}.

While Assumptions 1 and 2 are of a technical nature and are not restrictive, Assumption 3 rules out a possible fourth option in the second stage of the search–migration process. In another paper, Bhattacharya (1988), I have considered return migration in this framework to show under what condition return migration will or will not be chosen by the worker.

I can now prove the existence of reservation wages both for local search in second stage and for the overall search–migration process in each location in the first stage.

Proposition 1. (a) *For each revealed quality level q in location i the worker's local search has a reservation-wage property.* (b) *This reservation wage for local search* $w_{Li}(q)$ *is an increasing function of the observed quality level q and a decreasing function of the local search cost Li.* (c) *Further, the optimal value of local search* $V_L(i, q)$ *and the reservation wage* $W_{Li}(q)$ *can be obtained as a* *solution of*

$$L = \int_{W_{Li}(q)}^{\infty} \{ [q \cdot w/(1-\beta)] - V_L(i,q) \} f_i(w)\, \mathrm{d}w, \tag{7}$$

$$V_L(i,q) = q \cdot W_{Li}(q)/(1-\beta). \tag{8}$$

Proof. Note that the local search problem given by (5) above can be transformed to a standard, monotone search problem by defining

$$w' = qw/(1-\beta).$$

Thus the density functions of w' and w are related as follows:

$$f_i(w) = f_i(w') \cdot (q/(1-\beta)).$$

Following Lippman and McCall (1979), as $\mathrm{E}(w) < \infty$, $\mathrm{E}(w^2) < \infty$ implies that $\mathrm{E}(w') < \infty$, $\mathrm{E}(w'^2) < \infty$, there exists an optimal stopping rule. Further, the equation in $w'(Li)(q)$,

$$L = q/(1-\beta) \int_{w'_{Li}(q)}^{\infty} (w - w'_{Li}(q)) f_i(w)\, \mathrm{d}w,$$

which corresponds to the equation $H(\;) = c$ in Lippman and McCall (1989, eq. (3), p. 160), has a unique solution because the right-hand side is nonnegative and strictly decreasing in $w_{Li}(q)$ and lies between 0 and $\mathrm{E}(w')$ over the range of $w_{Li}(q)$ from 0 to ∞. Similar results are also proved in Chow, Robbins, and Siegmund (1971) and Weitzman (1979).

Thus there exists a reservation value $w'_{Li}(q)$ and hence a local reservation wage $w_{Li}(q)$ such that $w'_{Li}(q) = (q/(1-\beta)) \cdot w_{Li}(q)$. Using Bellman's 'optimality principle', then $w_{Li}(q)$ is the solution to

$$V_L(i,q) = \max_{w} \left\{ -L + \int_0^W V_L(i,q) f_i(w'')\, \mathrm{d}w'' \right.$$

$$\left. + \int_W^{\infty} (q \cdot w''/(1-\beta)) f_i(w'')\, \mathrm{d}w'' \right\}, \tag{9}$$

when w'' is the integration dummy variable. The first-order condition for maximum of the right-hand side of (9) gives (8); and (7) can be obtained from (5) and the fact that $w_{Li}(q)$ is the reservation wage. This proves (a) and (c).

Using (8) in (7), we get

$$L = q\int_{W_{L,i}(q)}^{\infty} (w - w_{Li}(q))/(1-\beta) f_i(w)\,\mathrm{d}w. \tag{10}$$

From (10) we can show that $\mathrm{d}w_{Li}(q)/\mathrm{d}q > 0$ and $\mathrm{d}w_{Li}(q)/\mathrm{d}L < 0$ which proves (b). Q.E.D.

Corollary 1. The expected value function of local search $V_L(i, q)$ is an increasing function of the observed quality q and a decreasing function of the search cost L.

The above results about local search correspond to standard results in search theory because the local search process is similar to a standard job-search process. The overall search and migration process in stage one, though, is not a standard search model. However, Proposition 2 shows that the reservation-wage property holds even in this case.

Proposition 2. The worker's search and migration decision in stage one follows a reservation-wage property. This reservation wage is also a decreasing function of the national search cost at the corresponding location.

Proof. It is sufficient to show that, for every location i, the worker's search will follow a reservation-wage property. I will show this for the best location n, and the same proof will go through for every other location except for the least attractive location 1 where obvious modifications of the proof will be needed. First, given an accepted offer w_n in location n and given the revealed quality of q_n in location n, the second-stage optimal value function [see (6) and (8) above] is given by [using, from Assumptions 1 and 2, $V(n-1) > V(n-i)$ for all $i > 1$]

$$H_n(w_n, q_n) = \max(q_n \cdot w_n/(1-\beta), q_n w_{Ln}(q_n)/(1-\beta), V(n-1)). \tag{11}$$

Therefore, since $V(n-1)$ and $q_n w_{Ln}(q_n)/(1-\beta)$ do not depend on w_n, we can conclude that $H_n(w_n, q_n)$ is a nondecreasing function of w_n for every q_n. Recall from (4) that the optimal total return from a job offer at location n before its quality is revealed is $J_n(w_n)$,

$$J_n(w_n) = w_n\int_0^{\infty} q a(q)\,\mathrm{d}q + \beta\int_0^{\infty} H_n(w_n, q) a(q)\,\mathrm{d}q. \tag{12}$$

Thus $J_n(w_n)$ is a monotonically increasing (nondecreasing) function of w_n. Therefore, applying the same arguments as in Proposition 1, it can be shown that there is a reservation wage for the first period, w_{nr}, such that w_{nr} is the solution to

$$V(n) = \max_{w_n}\left[-c_n - c_m + V(n)\int_0^{w_n} f_n(w)\,\mathrm{d}w + \int_{w_n}^{\infty} J_n(w) f_n(w)\,\mathrm{d}w\right]. \tag{13}$$

From (13), we can easily show that w_{nr} and $V(n)$ are obtained by solving

$$V(n) = J_n(w_{nr}) = w_{nr}\int_0^{\infty} qa(q)\,\mathrm{d}q + \beta\int_0^{\infty} H_n(w_{nr}, q) a(q)\,\mathrm{d}q, \tag{14}$$

$$c_m + c_n = \int_{w_{nr}}^{\infty} (J_n(w) - V(n)) f_n(w)\,\mathrm{d}w. \tag{15}$$

From (14) and (15) we can show that $\mathrm{d}w_{nr}/\mathrm{d}c_n < 0$. Q.E.D.

Eq. (14), of course, indicates that the optimum value of starting the job search at location n is the expected return obtained after the job is obtained $(w_n \cdot q)$ plus the expected second-stage return from following an optimal policy when both these returns are evaluated at the first-stage reservation wage. Eq. (15) indicates that the search cost c_n for an additional search will be equal to the expected increase in total payoff from an additional search.

In the last part of this section, I will try to characterize the worker's search and migration policies. First, in the second stage, given w_n and q_n, his choice among the three options will depend on which option determines the value of $H_n(w_n, q_n)$. Recall that the second-stage optimal value is given by

$$H_n(w_n, q_n) = \max(q_n \cdot w_n/(1-\beta), q_n w_{Ln}(q_n)/(1-\beta), V(n-1)). \tag{16}$$

Define q^* by

$$(q^* \cdot w_{Ln}(q^*))/(1-\beta) = V(n-1). \tag{17}$$

Thus q^* is that value of revealed quality in location n such that, if the worker decides to search locally with revealed quality q_n, his expected lifetime income from local search is exactly equal to his expected lifetime income from migrating to the next best location, $(n-1)$.

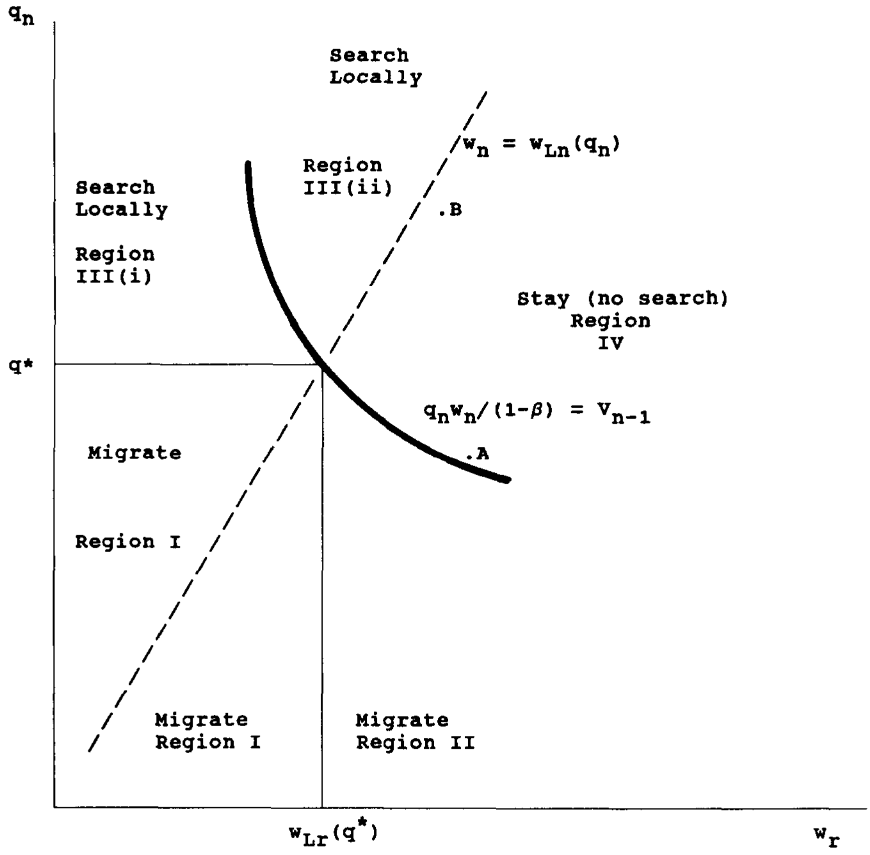

Fig. 1. Migration under uncertainty about quality of locations.

As $w_{Ln}(q)$ is an increasing function of q, the curves

$$q_n \cdot w_n/(1-\beta) = V(n-1), \tag{18}$$

$$w_n = w_{Ln}(q) \tag{19}$$

intersect at $q_n = q^*$, $w_n = w_{Ln}(q^*)$ because of (17). Fig. 1 shows how the search and migration decisions are made in the second stage with the current offer w_n and observed quality q_n.

Notice that the migration decisions in second stage are all repeat migration decisions.

Fig. 1 is divided into four regions:

Region I (low wage, low observed quality): If $q_n < q^*$ and $w_n < w_{Ln}(q^*)$, then the optimal policy is to search for a job at location $(n-1)$ and migrate to that location.

Region II (very low level of observed quality relative to the current wage level): If $w_n > w_{Ln}(q^*)$ but q_n is low enough such that $(q_n \cdot w_n/(1-\beta)) < V(n-1)$, the optimal policy again is to search in another location and migrate. Here, even though the current wage rate could possibly be high, the observed value of q_n is so low that it is worthwhile to find a job in another location whose quality is unknown.

Regions III(i) and III(ii) (high quality, relatively low wage): If $q_n > q^*$ but $w_n < w_{Ln}(q^*)$, the optimal policy is to search locally for a better job. Note that $w_{Ln}(q_n)$ is an increasing function of g_n, i.e., given a higher value of observed quality the worker will decide to search locally and quit his present job even though the current job pays a higher wage rate. This is because, with an assured level of high quality, even a moderate chance of finding a better job is worth the local search cost.

Region IV (high wage and moderate quality level): If $w_n > w_{Ln}(q^*)$ and $q_n w_n/(1-\beta) > V(n-1)$, the worker decides not to search at all either locally or outside location n. The decision to stay may arise even at very low levels of quality (point A in fig. 1) if the wage rate is high enough. From a point like A, if the observed quality level becomes a little lower, the worker will try to migrate to another location in spite of the high wage rate. On the other hand, the worker might decide to stay in the current job at a point like point B in fig. 1 where wage is high and quality level is moderate. Were the quality level a little higher, he would have searched locally for a better job. Although this conclusion may appear to be surprising, it is expected in this model because a higher assured quality level makes the search for an even better job (paying a higher wage than the currently well-paying job) justified. Thus a higher quality level will make local search more attractive even if the current job pays well.

This model, therefore, has some very interesting implications for job quits and migration behavior. First, for a relatively low quality location ($q < q^*$), an increase in wage will discourage both migration to other locations and local job turnovers, but an increase in location quality may increase turnover in the local job market because more workers will start searching locally. Second, for jobs with moderate wages, the quit rate will increase sharply if the observed location quality rises or falls by relatively small amount. If the quality level rises, the workers quit and search locally, and if the quality level falls, they will migrate.

For every $w_n > w_{Ln}(q^*)$, the probability $Q(w_n)$ that the worker will quit his present job can be calculated as follows. Let $q_n'(w_n)$ be defined as

$$q_n'(w_n) = V(n-1)/[w_n/(1-\beta)]. \tag{20}$$

Then $Q(w_n)$ is given by

$$Q(w_n) = 1 - \int_{q_n'(w_n)}^{q_n} a(q)\,\mathrm{d}q. \tag{21}$$

Obviously, $Q(w_n)$ is a decreasing function of w_n. Further, for wage rate w_n close to $w_{Ln}(q^*)$, $q_n'(w_n)$ is close to q_n (see fig. 1) and $Q(w_n)$ is large.

Third, the first-period reservation wage, w_{nr}, can possibly be below the critical wage rate in the second period, $w_{Ln}(q^*)$. In this case, we may observe workers accepting jobs where they know that after migrating to location n and accepting a job that pays w_n [between w_{nr} and $w_{Ln}(q^*)$], they will certainly quit after working for one period. Indeed, these jobs can be characterized as 'one-period jobs' and the workers accept these jobs in order to migrate to a particular location. After working at such a job for one period, if the revealed quality of the location turns out to be low (less than q^*), he quits to migrate to another location, whereas if the quality level turns out to be high, he quits to search locally. Note that if a location has a large number of these jobs, any economic policy that improves location quality will not change the quit rate substantially; it will only reduce outmigration and increase local job turnovers.

3. Search costs, job opportunities, and repeat migration

This section will illustrate the effects of parameter changes on optimal search and migration policies. Recall that there are two types of search costs here. The first type is c_i, $i = 1, \dots, n$, which is the cost of searching for a job in location i from outside location i. The second type of search cost is L, which is the search cost for local search, assumed to be the same for all locations. All the following propositions are proved for the best location n. However, they are valid for any other location $i \geq 2$. For the worst location 1, some obvious modifications will be necessary. Proofs of all propositions in this section are in the appendix.

Proposition 3. (a) *An increase in the cost of search c_{n-1} for location $n-1$ will reduce the range of wage offers in region n (the best region ex ante) which the worker considers as a range of one-period jobs.* (b) *Further, even with lower revealed quality, for some jobs with low wages the worker will be encouraged to search locally in location n instead of migrating to location $(n-1)$.* (c) *Similarly, for some jobs with high wages but lower revealed quality, the worker will stay at the current job at location n, rather than choosing to migrate to location $(n-1)$.*

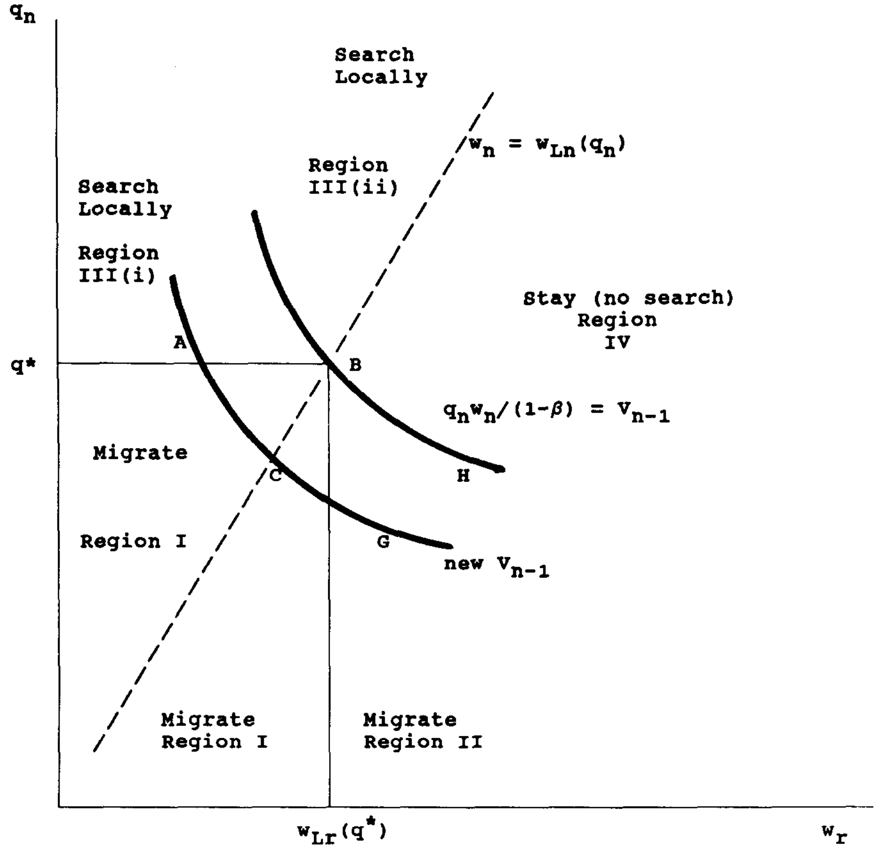

Fig. 2. Migration under uncertainty about quality of locations.

The implications of Proposition 3 can be explained with fig. 2. As $c_{(n-1)}$ goes up, $V(n-1)$ falls, so the curve marked $V(n-1)$ shifts to the left. Thus in the region $BCGH$, where the individual initially would decide to migrate because the revealed quality of the location was low, he would now decide to stay at the present job at the present location because the search cost at the other location has gone up. Similarly, in the area ABC, where the wage rate and location quality are relatively low, the individual would initially choose to quit the present job and migrate, in favor of searching locally for a job. However, with the increase in c_{n-1}, the individual would decide to search locally instead of migrating to another location.

Similarly, if there is an increase in the once-for-all migration cost that the individual incurs every time he decides to migrate there will be a fall in all the

$V(i)$'s, $i = 1, \ldots, n$. Thus the effects of this on the second-stage migration decisions will be similar to Proposition 3 above.

Corollary 2. The effects of a rise in migration cost c_m on the second-stage migration decisions will be the same as in Proposition 3.

If there is an increase in local search cost L in all locations, then it can be shown that the value of the search migration program in stage one, $V(i)$, $i = 1, \ldots, n$, falls for all locations. Also, for each observed quality, the second-stage reservation wage for local job search $w_{Ln}(q)$ and hence the second-stage local search value $V_L(n, q_n)$ will also decrease. Therefore the net effect on the first-stage reservation wage, w_{nr}, is ambiguous. However, if we assume that an increase in local search cost affects the expected value of local search $V_L(n, q_n)$ for all q_n in location n more than the expected value of the entire first-stage search and migration program for other locations, $V(n-1)$, $V(n-2)$, etc., and also the ranking between the locations remains unaffected by the change in L, then we can conclude:

Proposition 4. An increase in local search cost will reduce the range of 'one-period jobs' by reducing the value $w_{Ln}(q^*)$. For some high-quality low-wage jobs the worker will be induced to migrate again rather than search locally, and for some high-quality high-wage jobs the worker will be induced to stay at the current job rather than search locally at the same location.

Let $F_{n-1}(w)$, the wage distribution in location $(n-1)$, be parameterized as $F_{n-1}(\cdot\,|\alpha)$ when $n \geq 2$. Then we can show the effect of an improvement in job opportunities in location $(n-1)$ on the search and migration decisions when n is the current location.

Proposition 5. Let $F_{n-1}(\cdot\,|\alpha)$ stochastically dominate $F_{(n-1)}(\cdot\,|\alpha')$. Then, for some high-quality low-wage jobs (region $III(i)$), the worker will decide to search locally at a higher quality for $\alpha_{n-1} = \alpha$. For some low-quality high-wage jobs (region II), the worker will decide to stay at the current job (instead of migrating again) at a higher quality when $\alpha_{(n-1)} = \alpha$. Finally, the range of 'one-period jobs' will be greater for $\alpha_{(n-1)} = \alpha$.

Proposition 5 above considers the effects of an improvement in job opportunities at the 'next-best' location $(n-1)$, on the search–migration decisions in the best location n. I now consider the effect of an improvement in job opportunities at the current location n $(n \geq 2)$. If $F_n(\cdot\,|\alpha)$ stochastically dominates $F_n(\cdot\,|\alpha')$, the effects will be as follows:

Proposition 6. An improvement in the job opportunities in the best location with job opportunities at the other location remaining unchanged will increase the *range of one-period jobs by increasing $w_{Ln}(q^*)$, will cause a shift from repeat migration to local search for some low-quality low-wage jobs, and a shift from no search to local search for some high-quality high-wage jobs. It will also raise the first-period reservation wage in location n.*

If there is an improvement in job opportunities in all locations simultaneously, then it is difficult to characterize the effects on the search and migration decisions because, during the second period, for each q_n there will be an increase in the value of local search $V_{Ln}(n, q_n)$ and an increase in the value of repeat migration $V(n-1)$. If the former effect dominates, then the net effects will be just as in Proposition 6 above, while if the latter effect dominates, the net outcome will be as in Proposition 5 above.

4. Concluding remarks

The conclusions obtained in sections 2 and 3 show that a few important testable hypotheses may be derived from my model about the relationships between repeat migration, local and national reservation wages, and local search and remigration decisions. One can also use the model for analyzing how job quits and migration rates are affected by changes in local or national search costs and job opportunities at different locations. This model also brings into focus the existence of 'one-period jobs' which the worker is certain to quit after working for one period only. Finally, policies that improve location quality can be shown to have specific effects on job-turnover rates and migration rates by using the framework of this model.

I conclude this paper with the following remarks:

(a) The model can be easily modified for workers who currently hold jobs in locations with known location quality, simply by starting the analysis from the second stage. All the conclusions obtained in sections 2 and 3 about second-stage decisions will continue to be valid in this case.

(b) Apart from the fact that the model in this paper does not consider return migration, there are other important elements of the search–migration process that are ignored here. The job-search process is supposed to be instantaneous, and according to some well-known results in Optimal Stopping, the migrant will be always successful in finding a job. However, the migration process in real life is greatly affected by the time it takes to search for a job in different locations. Therefore, both the sequence of migratory moves and the reservation wages for different locations may be affected by the time–cost of search. This important problem will be investigated in another paper in the future.

(c) There are two types of papers published recently that have employed the sequential sampling procedure used in this paper. On the one hand, there are recent papers on job search with incomplete information [Berninghaus (1986), Lippman and McCall (1981), McCall and McCall (1981), Weitzman (1979), Wilde (1979)], on the other hand, there are papers on the analysis of purchase of experience goods [Wilde (1978), Hey and McKenna (1983), etc.]. However, the new element in my migration and search model is the searcher's option of searching on a conditional distribution with lower search cost but with complete information or searching on the entire distribution with incomplete information. Therefore, belated information [see Lippman and McCall (1981)], even if favorable, can cause the worker to quit his job and to search locally in my model, while this option does not exist in the papers cited above. This feature, therefore, results in significantly different conclusions. Of course, this paper uses a model with a discrete number of locations, whereas most of the above papers analyze search with a continuous two-dimensional distribution where only one random variable is observable in the first stage of search.

(d) Recent empirical work on migration [Herzog and Schlottman (1983), Schlottman and Herzog (1982), DaVanzo (1983), Allen (1979), etc.] has shown that repeat migration is an important part of the aggregate migration flow in any given year and the worker's disappointment with location characteristics is one of the main reasons for suchy migration. Recent empirical work on search models, job quits, labor turnover, etc. also demonstrate that attractiveness of the current location and/or the current job is an important part of the job-search process. I have developed a model where both these issues can be analyzed in terms of a search and migration model with uncertainty about locational characteristics.[1]

Appendix

I will prove Propositions 3 and 6 only in this appendix. Proofs of other propositions can be constructed on similar lines.

[1]A recently published paper by McCall and McCall (1987) considers the same problem of sequential search–migration decisions in multi-armed bandit framework. Roughly speaking, in their paper, the individual faces a choice of migrating to one of the n locations. In a typical location i, there are a *finite* number of wage offers $w_{i1}, w_{i2}, \ldots, w_{ig}$. The individual spends a search cost c_i to search for a job in a location. If an offer is acceptable, he migrates to i, works for one period, earns w_i, and finds the quality of the location to be either of the *two* possible values α_i or $-\alpha_i$ (each with probability 1/2). At this stage he has *three* options – stay at the current job, migrate onward, or return to a previously visited location. This model also has a moving cost k_i to be paid every time a migration occurs. In my model, although I do not consider an explicit moving cost, I consider *infinitely many* values of both wage and location quality. More importantly, however, I consider the option of local search which is ignored in their paper. Finally, there are a large number of testable conclusions obtained in my paper (see sections 2 and 3), whereas McCall and McCall (1987) obtain very few of these results.

A.1. Proof of Proposition 3

From (13), if we substitute $(n-1)$ for n,

$$V(n-1)=\max_{w_{n-1}}\left[-c_m-c_{n-1}+V(n-1)\int_0^{w_{n-1}}f_{n-1}(w)\,\mathrm{d}w\right.$$

$$\left.+\int_{w_{n-1}}^{\infty}J_{n-1}(w)f_{n-1}(w)\,\mathrm{d}w\right]. \tag{22}$$

Further, if $\bar{w}$ is the first-period reservation wage for location $(n-1)$, we can write equations corresponding to (14) and (15):

$$V(n-1)=\bar{w}\int_0^{\infty}qa(q)\,\mathrm{d}q+\beta\int_0^{\infty}H_{n-1}(\bar{w},q)a(q)\,\mathrm{d}q, \tag{23}$$

$$c_{n-1}=\int_{\bar{w}}^{\infty}(J_{n-1}(w)-V(n-1))f_{n-1}(w)\,\mathrm{d}w. \tag{24}$$

As $H_{n-1}(w,q)$ is a nondecreasing function of w and $J_{n-1}(w)$ is an increasing function of w (see proof of Proposition 2), we can employ the usual comparative statics technique to show that

$$\mathrm{d}V(n-1)/\mathrm{d}c_{n-1}<0. \tag{25}$$

Coming back to location n, note that

$$H_n(w_n,q_n)=\max\{w_nq_n/(1-\beta),V_L(n,q),V(n-1)\}. \tag{26}$$

As c_{n-1} goes up, $V(n-1)$ falls, hence q^* as defined by

$$V_L(n,q)=w_{Ln}(q^*)q^*/(1-\beta)=V(n-1) \tag{27}$$

will fall as c_{n-1} goes up, and $w_{Ln}(q^*)$ will also fall.

Fig. 2 shows that as there is a downward shift in $V(n-1)$, the region of 'one-period jobs' will become smaller as $w_{Ln}(q^*)$ falls. This proves part (a) of Proposition 3. For jobs in the area *ABC* in fig. 2, the second-stage decision will shift from repeat migration to local search. This proves part (b) of Proposition 3. Similarly, for jobs in the area *BCHG*, the worker will shift from migration to no search in the second stage. This proves part (c). Q.E.D.

A.2. Proof of Proposition 6

I will treat α as a continuous variable, assuming that $F_n(\cdot\,|\alpha)$ stochastically dominates $F_n(\cdot\,|\alpha')$ whenever $\alpha > \alpha'$. From (7) and (8), by using partial integration we can write (taking $i = n$)

$$L = q/(1-\beta)\int_{w_{Ln}(q)}^{\alpha}(1 - F_n(w|\alpha))\,\mathrm{d}w, \tag{28}$$

$$V_L(n, q) = qw_{Ln}(q)/(1-\beta). \tag{29}$$

By using comparative statics methods and noting that $\delta F_n(w|\alpha)/\delta\alpha < 0$ because of stochastic dominance, we can show

$$\mathrm{d}V_L(n, q)/\mathrm{d}\alpha > 0, \qquad \mathrm{d}w_{Ln}(q)/\mathrm{d}\alpha > 0. \tag{30}$$

It is now routine to show from (11) and (12) that $\delta H_n(w_n, q_n)/\delta\alpha \geq 0$ and $\delta J_n(w_n)/\delta\alpha \geq 0$. From (14) and (15), we can again show that $\delta w_{nr}/\delta\alpha \geq 0$ or the first-period reservation wage rises as α rises. The rest of the results about second-stage decisions can be obtained by examining (11) and observing that in fig. 1, there is a rightward shift in the curve $w_n = w_{Ln}(q)$ given by (19). Q.E.D.

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