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A LIFE CYCLE APPROACH TO MIGRATION: ANALYSIS OF THE PERSPICACIOUS PEREGRINATOR*

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INTRODUCTION

Current literature views migration from two vantage points. The first perspective considers the effect of migration on area economies while the second perspective examines the reverse question: the impact of spatial differences in area economies on migration decisions. Most studies have concentrated on this latter approach and have succeeded in identifying numerous factors affecting the migration decision.

Given the diversity of causal factors no one theory exists explaining migrant behavior. Instead numerous theories abound, each concentrating upon particular aspects of the problem. To date, the Sjaastad model, which treats migration as an individual investment decision, is the most general. However, even within the Sjaastad framework many patterns of migration remain unexplained. This paper can be viewed as laying the groundwork for a more general framework in which the Sjaastad model is a special subcase. Migration is viewed as a rational investment process carried out at *each* stage of the life cycle. Migrants are perspicacious in that they are assumed to seek and weigh information on locational characteristics. They are peregrinators in that their mobility need not be limited to one period, but instead occurs in a periodic fashion derived as the solution of an optimal control process. By considering location as a generalized commodity composed of certain sets of more basic characteristics, implications concerning geographic preference are obtained. Theorems of the effect of familial variables are generated by making the utility functions sufficiently general within the maximization process.

The implications of this model are tested using individual household data from the University of Michigan Income Dynamics Panel. By estimating a two equation simultaneous system using a technique asymptotically equivalent to maximum likelihood, we explicity consider the effect of expected monetary gains. To our knowledge this empirical approach is the first time *individual* data has been used to account for such potential migration gains. We find, for example, that a ten thousand dollar expected increase in the present value of husband's earnings increases the probability of interstate migration by 6 percent, while presumably because of intermittent labor force behavior, the effect of expected increase in wife's wages are negligible. In addition, the impact of past migration as well as household characteristics are taken into account. Unfortunately given the paucity of data little can be said about specific geographical choices. Thus those aspects receive brief and perfunctory treatment.

We feel that the importance of this paper lies not so much with the exact parameter estimates but rather with the methodology that was created. Locational choice and familial considerations were accounted for; but even more importantly, migration periodicity was analyzed within a nonstochastic framework. Whereas we readily admit that many of our implications are preliminary, we strongly believe that future work will provide more detailed specifications so as to produce more specific and directly estimable migration time paths.

Our paper is divided into 4 sections. The first provides an historical perspective that serves to motivate the analysis. Section 2 explores in detail the theoretical model, beginning in its most general form and later simplifying the analysis to explore certain key subcases. The empirical analysis is carried out in section 3. Section 4 concludes and summarizes.

I. HISTORICAL PERSPECTIVE

The analysis of population changes has long been of interest to social scientists. Demographers focus on migration as the dominant factor in studies of short-term shifts of population. These population shifts are of interest to the economist as indicators of the functioning of the market structure within an economy. Given the existence of spatial markets, migration is the force which should serve to bring about geographic wage and price equilibrium. For example, if wages in one area are high relative to those in another, then labor migration is the factor which should

restore equilibrium by lowering the higher wage and raising the lower one.

Analysis of migration presents numerous methodological problems. Timing, origin and destination, as well as the individual characteristics of migrants, are all factors requiring study. However, comprehending the vast quantities of needed data is not easy. Care must be taken with respect to definition and measurement. Migration is defined as the flow of people from one given point or set of points in space to another point or set over some finite time interval. Often a minimum distance crieterion, that need not be uniform for all inhabitants, is implicitly assumed. Methodological problems exist depending upon which definitions are chosen. For example, if one defines a migrant as one who changes his usual place of residence by crossing a county line (state line), then persons who leave a farm to migrate to the city are not defined as migrants as long as they remain in the same county (state). Yet under less restrictive definitions that, for example, may include occupational changes, such a person would be classified as a migrant. This paper does not explicitly deal with occupational changes but concentrates on geographic mobility.

Table 1 shows that about 20% of the total United States population moves to a new residence during each one-year period. Of these, close to 12% change their residence within a given county, about 7% cross county lines, and about 3½% cross state lines. The consistency of the relative percentages over the years is to be noted.

In view of the methodological problems with simply defining the point of interest in migration studies, conflicting theories and seemingly paradoxical facts abound. Most of the work done on migration has dealt with the question of migrant selectivity. Migrant selectivity is defined as the tendency for migrants to be nonrandomly distributed within the population at large. Characteristics distinguishing migrants are isolated and analyzed.

The most widely known and often repeated fact about migrant selectivity is that migrants tend to be younger than nonmigrants. Migration is highly concentrated in the 18–25 year age range. It is estimated that 24% of one's lifetime residential mobility (or 22% of all county mobility and 26% of all interstate mobility) occurs during this age bracket.[1]

Education, too, is frequently cited as a factor influencing the level of migration. It is felt that education increases one's awareness of opportunities in other areas, and exposes one to better forms of information. Schwartz points out that "as education increases, the market for individual occupations at each level of education tends to become geographically wider but quantitatively smaller."[2] Having invested in larger amounts of human capital in the form of schooling, the more educated migrant is also less willing to subject his larger investment to the whims of local business cycles. For all these reasons, then, it is usually hypothesized that the correlation between migration and education is positive, becoming even more strongly positive as the distance defining migration increases.

Table 1. Previous Residence Percentage of Total U.S. Population

ime Interval	Same House	Different House in United States: TOTAL	Same County	Different County TOTAL	Same State	Different State	Abroad at Beginning of Period
larch 65–March 66	80.2	19.3	12.7	6.6	3.3	3.3	0.5
larch 66–March 67	81.0	18.3	11.6	6.7	3.3	3.4	0.7
larch 67–March 68	80.5	18.8	11.8	7.0	3.4	3.6	0.7
larch 68–March 69	81.0	18.3	11.7	6.6	3.2	3.4	0.7
larch 69–March 70	80.9	18.4	11.7	6.7	3.1	3.6	0.8
'ensus dates- 1965–1970	53.0	40.3*	23.3	17.0	8.4	8.6	1.4

Does not include 5.2% who moved into 1970 residence since 1965, but place of 1965 residence not eported.

iources: Annual data from Department of Commerce, Bureau of the Census, *Current Population Reports*, Series P-20. Totals are for all individuals age one and over at the start of the period. 965–1970 figures from Bureau of the Census, *Detailed Characteristics U.S. Summary*, Final Report 'C(1)-D1 Table 196. Figures for population 5 years and older in 1970.

Closely connected with the differences in migration for the highly educated is the observed tendency for those in professional and skilled occupations to be more migratory than those in less skilled occupations. Lansing and Mueller note that the professional and technical workers are close to twice as migratory as other occupational groups.[3] Here again the amount of accumulated human capital is a factor in causing larger flows of those with more invested.

The volume of migration between areas falls uniformly with distance. This fact forms the foundation of the basic gravity model of migration, which states that the volume of migration between two areas is inversely related to the distance between them and positively related to the size of the two populations.[4] Distance has been proven very important in empirical tests of population movements.[5]

In an individual context, Schwartz tried to explain the relationship of distance to migration as a conditioner of information and psychic costs.[6] One's information about various areas was seen as a function of distance from the area. In addition, the psychic costs of breaking with family and friends increase with distance of migration.

The importance of psychic costs has long been recognized. Sjaastad posited that the nonmoney considerations were "probably far more [significant] than the money costs."[7] Greenwood's concept of the "migrant stock" was largely based on the tendency for former friends and relatives to channel information back to their place of origin and in so doing induce further migration to the new location.[8]

However, measurement of the psychic costs has always presented a substantial problem. Schwartz proposed that we could measure such costs by considering the expense of a certain number of return visits to place of origin so that the geographic separation from family and friends would be minimized in a psychological sense.[9]

Consideration of the nuclear family makes the argument for the inclusion of psychic costs even stronger. We observe a greater reluctance on the part of married people to move long distances. The number of children in the family and their ages may affect migration rates quite strongly. While the relationship between number of children in a family and migration is somewhat erratic, Long has shown that the *age* of children in the family exerts a consistent effect: families with school-age children are only about 50 to 60 percent as mobile as families with preschool age children.[10] Apparently parents are very reluctant to introduce discontinuity into their child's educational experience.

The influence of the family goes beyond psychic costs. With increasing numbers of women entering the labor force, the family is no longer economically dependent on the head alone. The likelihood of migration should be affected by the potential earnings changes of all working members of the family. Akin and Polachek,[11] DaVanzo,[12] Kaluzny,[13] Mincer[14] and Sandell[15] have all extended consideration of migrant selectivity to the family as a whole. In addition, Long has introduced evidence that, to a certain extent, families with a working wife are less likely to experience long-distance migration. The probability of the wife remaining in the labor force upon moving decreases over all ages.[16]

Perhaps the strongest determinant of migration behavior is migration itself. Morrison[17] and Land[18] have shown that the probability of moving is a function of length of residence in a community. This so-called axiom of cumulative inertia together with the dichotomization of the population into two basic groups—one of habitual movers and the other of continuous stayers—have provided the basis for Markov chain models of migration. The exact magnitude of higher order migration is not known. However, some estimates of the volume may be obtained by considering Table 1. If in each year the interstate migrants were composed of persons making their initial move in the period dating from 1965, the five year total would amount to 17.3% of the population. The Census tabulation lists only 8.6.% migrating within the period, sugge[illegible] roughly 50% of all interstate moves in the yearly totals were repeat movers.

The transition from documentation of migra[illegible] [illegible]erentials to a unified testable theory of migration has been a most difficult process. Most empirical tests to date have dealt with aggregate [illegible] [illegible] locations such as states or counties. These aggregate studies are necessarily based upon some notion of directionality. They must discuss migration in gross and net terms.

Gross migration is the *one way* flow from area i to area j. Net migration is the *difference* between the two one-way flows. In an aggregate study of net migration, variables which exert an equal effect on flows in both directions will wash out;

variables with opposite effects will be magnified. To support a hypothesis concerning migrant selectivity it is necessary to show differences in migration by *area* characteristics. For example, areas with large fractions of young people should show larger volumes of migration than areas with older inhabitants. Low income areas should show migration to high income areas. The problem, as Sjaastad pointed out, is the high correlation between in- and out-migration in a given area. For example, while the 272,000 in-migrants to a high wage state such as Connecticut in 1965–1970 may support theories of individuals moving to increase their incomes, the 250,000 out-migrants are "against the grain." This correlation tends to be the case for most states. In-migration is the best single predictor of out-migration from a given area. The small differences between in- and out-migration confounds empirical analysis using aggregate data.

High rates of in-migration coupled with high rates of out-migration are not necessarily paradoxical, however. The problem involved is the relation of aggregate data to an individual model. The human capital model of migration first proposed by Sjaastad has the potential to deal with this issue. Later in the paper, we shall concentrate on generalizing the Sjaastad model so as to encompass many of these aspects of migrant selectivity.

As it is usually advanced, the Sjaastad model is as follows: When considering whether to move from area i to area j the migrant may be thought of as computing the following present value of the move:

$$PV(t) = \sum_{\tau=0}^{T-t} \frac{Y_{j\tau} - Y_{i\tau}}{(1+r)^{\tau}} - C \approx \int_{0}^{T-t} (Y_{j\tau} - Y_{i\tau}) e^{-r\tau} \, d\tau - C \qquad (1)$$

where Y_j^{τ} is the earnings in area j at time τ, $Y_{i\tau}$ is earnings in area i at time τ, T is the individual's working life assumed to be known with certainty, r is the discount rate the individual applies to the earnings stream, and C represents the direct costs involved in the move.

The money returns to migration ($Y_j - Y_i$) should not be quickly dismissed. The use of area mean-income levels and summary migration rates was never intended by Sjaastad.[20] Rather, the point was that individuals were incomparable especially with regard to the amounts of human capital invested in themselves. Such a model implies that migration occurs when a positive rate of return exists. If achievement of this rate of return involves moving from the highest income state to the lowest, there is no paradox involved. The human capital model of migration is basically an *individual* model, not necessarily tied to aggregate measures.

Sjaastad's model is important not merely as an explantation of simultaneous in- and out-migration, but in addition as a unifying framework to explain many of the observed differentials in migrant selectivity. In particular, age is important not

simply because it reduces the length of time over which lifetime earnings strean are discounted, but also because it is often an indication of the amount of trainin and experience an individual may have accumulated. To the extent that educatic represents general training which reduces the cost of search, the gain fro migration is enhanced. On the other hand, job tenure which involves specif training may reduce potential gains to migration.

Given the diverse characteristics of migrants, many of these patterns do not a yet fit coherently within a unified theory. In this paper, we wish to generalize th investment approach originally set out by Sjaastad so as to lay the groundwork fo embedding several problem areas of migration into the theory. Specifically w view one's long-term notion of each location as hedonically composed of certai sets of characteristics. Changes in characteristics made by an individual impl locational change hence migration. Thus such locational change can be taken as control variable within an individual life cycle allocation process. As such, a individual chooses locations at each point in the life cycle so as to maximize th present value of lifetime utility. By characterizing mobility as the life cycle proce of choosing optimal locational characteristics at each point in time, sever previously unexplained patterns can be studied within a cohesive framework. I particular, if locational characteristics can indeed be mapped into geograph areas, then theorems pertaining to locational choice can be obtained. Further, investment in information precedes moving, and moving entails a certain depreci tion of knowledge, then theorems can be derived concerning the periodicity migration. If household utility functions, as opposed to individual utility fun tions, are used, then both sets of implications concerning locational choice as we as periodicity of migration can be interpreted within a family context. Such is th approach of our paper.

Unfortunately, testing each of the implications is difficult. However, becau our generalized model can be simplified (in fact, to a version of the Sjaast model), various aspects are tested using *individual panel* data. Specifically, th effect of expected monetary gains of mobility is measured by means of a tw equation model, and estimated by a technique asymptotically equivalent maximum likelihood. To our knowledge this empirical approach represents th first time *individual* data have been used explicitly to account for expecte monetary gains from moving. Also measured are the impacts of past migration a well as family characteristics. As pointed out above, given the paucity of dat little can be said as yet about specific locational choices. Thus those aspects of th model concerning particular locational characteristics receive only brief and pe functory empirical treatment.

As noted above, the remainder of the paper is divided into 3 sections. Section outlines the theoretical concepts to be developed. It begins by describing the mod in its most general form, and later goes through various stages of simplification s as to illustrate how the Sjaastad model becomes a subcase. Section 3 deals wi empirical tests. First it is illustrated that monetary gains from mobility are indeed realized. Second a simultaneous equations system is devised to measure the impact of these gains on the probability of migration. Section 4 summarizes and concludes the paper.

II. AN ALTERNATIVE APPROACH TO MIGRATION

Since Sjaastad's article economists have viewed migration as an investment decision. As has been seen, migration occurs when discounted benefits exceed the costs of moving. Yet many other key issues can be analyzed only after thorough internal analysis and subsequent manipulation of the models. This paper attempts to generalize those models by embedding three such aspects into the migration framework. In particular, we consider (1) notions of locational choice, (2) questions of periodicity of migration and (3) effects of family considerations.

In current models, the mechanism used to explain location is complicated. Location *per se* is not dealt with. Rather, an individual is assumed to search for and choose the location that maximizes the present value of future wages. Such a process can be analyzed only by means of an economic programming scheme. Because of the cumbersome nature of integer programming, we depart from such a framework. Instead, by hypothesizing that each location can be described uniquely by a set of locational characteristics, and conversely that a given set of locational characteristics implies a unique location, one may obtain inferences about location choice.[21] If locational characteristics (*e.g.*, unemployment or price level) affect individual costs and gains, then these characteristics influence the probabilities of population flows. High unemployment and low wages tend to imply net out-migration, while high growth and lower price levels may imply in-migration. Further, the impact of these locational factors may differ across population subgroups. The well educated may be less affected by general unemployment rates than the less educated. Yet the more educated may be more sensitive to industrial composition. By incorporating these locational characteristics within the optimization process, one can arrive at implications of individual locational choice.

Questions of the periodicity of migration are also important. As we have shown, a great deal of all migration constitutes second-, third- or higher-order moves. Yet most current models of migration concentrate on moves within a single time period. Migration back to an original location is assumed to occur because expectations were not fulfilled. High order, or periodic migration, is assumed to take place either because expectations were not fulfilled or because of exogenous changes in locational or personal characteristics. We view such exogenous changes as unnecessarily strong assumptions. Instead, we claim that even in the absence of stochastic fluctuations, information as well as the search costs of accumulating knowledge of wage distributions play important roles. By describing the accumulation and depreciation of such information over the life cycle, one can

incorporate into the migration model implications concerning the periodicity of migration.

Finally, much of migration theory seems to treat migration as an individual investment decision. Family members other than the head are not always explicitly considered. However, other members are clearly influential in the migration decision. Working wives as well as school-age children are known to deter migration. It is the purpose of this paper to generalize the migration models presented so as to deal more explicitly with these factors within a unified framework. In order to incorporate these factors, we adopt the life cycle approach used in human capital theories of earnings accumulation.

A. *The Life Cycle Model of Earnings*

The human capital model can best be described as the process by which individuals invest in themselves throughout their lifetime.[22] Individuals invest by combining the scarce resource time with other factors of production at each stage of the life cycle so as to maximize the present value of their earnings stream.[23] In its simplest form, as outlined by Ben-Porath,[24] individuals choose the percent of time they invest, S_t, so as to maximize the present value of their earnings

$$\int_0^T (1 - S_t)\, W\, K_t\, e^{-rt}\, dt \qquad (2\text{-a})$$

where r is the discount rate and W is defined as a fixed wage rate per unit of human capital (K), subject to a production function describing the time rate of change of K:

$$\dot{K} = f(S_t, K_t, X) - \xi K_t \qquad (2\text{-b})$$

where X represents the commodities used in the production of new human capital, and ξ represents the annual rate of depreciation of human capital stock. By maximizing (2-a) subject to (2-b) for the finite life span T, one can easily prove that dollar investment WS_tK_t as well as time investment S_t decline monotonically with age.

Two types of refinements of this basic model have been made. First, modifications have served to be more rigorous in the specifications of functional relationships, thereby yielding precise and estimable forms of individual earnings over the life cycle.[25] Second, modifications have attempted to incorporate other decisions beyond that of simple investment. Polachek investigates the impact of intermittent labor-force participation on investment.[26] Blinder and Weiss[27] study the simultaneous determination of labor-force participation and investment, and later Rosen[28] and finally Polachek[29] consider occupational choice decisions within the investment framework. This paper proceeds in the latter vein by explicitly treating migration as a decision variable within an investment framework. We do so by first describing the migration process with three kinds of investment. Later we simplify to obtain a one-type investment model which results in a version of the Sjaastad framework as a special case.

B. Simultaneous Investment in Human Capital, Information and Location

The literature stemming from the "new consumer economics" treats commodities as composites of characteristics. Such a viewpoint implies that it is not commodities themselves that yield utility, but the combination of amorphous characteristics that forms an economic good. Such a hedonic framework has been important in understanding fertility decisions, investments in health, as well as the effects of changes of technology and product quality on demand for goods and services. Similarly, this paper views location as a composite of various locational characteristics.

Many locational attributes as well as their interaction with individual characteristics affect wages. For example, state occupational structure is correlated with income,[30] urban areas are noted for their high price levels,[31] and high unemployment levels may be associated with low expected wages. More specifically, Table 2 illustrates the correlation between location-specific quality of life variables and economic status. However, the magnitude of these correlations need not be constant for all individuals. Individual differences in education, age, health and family size may imply variations in the benefits attributed to the characteristics of any given locality. For example, the highly skilled may be less sensitive to regional variations in business cycles,[32] and families with children may be attracted to areas with high per capita governmental expeditures on education. Because of such individual variations, one can obtain derived demand curves for location based on shadow prices of locational attributes. This is the basic approach followed in our paper.

Specifically it is assumed that for the long-term horizon each location can be uniquely described by such sets of locational parameters. This implies an individual ordering of locations on the basis of locational characteristics. Thus at any point in time, an individual's desire to reside in a given location is reflected by a set of derived demand curves for locational attributes. Over chronological time, and hence over the life cycle, changes in the demand for characteristics can be interpreted as a demand for mobility.[33] Thus in the model presented, mobility represents changes in the quantity demanded of a set of locational attributes, and observed changes in these attributes imply mobility.

When viewed in a control theory framework, locational attributes become

***Table* 2. The effect of Locational Characteristics on Economic Status**

	Simple Correlation between Economic Status and Indicated Regional Characteristic
Overall Quality of Life	.93
Individual Status	.61
Individual Equality	.41
Living Conditions	.75
Agricultural Production	.65
Technology Development	.88
Education Development	.80
Health and Welfare	.64
State and Local Government	.97

Note: Points of observation are nine U.S. regions. Correlations were derived from data presented in B. Liu (August 1975), "Differential Net Migration Rates and the Quality of Life," *Review of Economics and Statistics*, p. 330. See the appendix of his article for precise definitions of locational characteristics and economic status.

instruments within the individual maximization process. Optimal attributes are chosen at each point in time so as to yield an attribute time path that maximizes the present value of utility. Via a mapping of locational attributes into specific locations, such a life cycle path of attributes translates into an optimal vector of geographic locations representing mobility paths. Implications may be obtained not only about whether one moves, but also about optimal location. Such mobility may raise individual well-being measured in terms of utility or income.

However, changing location is not free. There are direct and indirect costs. Actual moving expenses represent the former. These direct expenditures may be a function of distance or common locational characteristics, but could depend on individual attributes too. High education may imply certain efficiencies. Children in school, or proximity to friends and relatives may imply explicit extra costs.

Indirect costs are of two types. First, there are earnings foregone in the moving process. These include wages as well as specific human capital lost in the transition period. Second, there are costs of search. Such costs represent investments in information pertaining to optimal location. Search is related to possible gains from mobility. In fact, unless no possible current or future gain can be attributed to moving, some level of search would be incurred. The costs of such search occur whether or not one moves. We view search as another control in an individual's arsenal to maximize discounted utility or income over the life cycle.

Thus an optimal control model of life cycle locational choice is posited. Three types of controls are assumed available to any individual: (1) investment in human capital, (2) investment in information that provides knowledge of available wages in other locations *relative* to one's own location and (3) mobility investment measured by the degree to which a set of locational characteristics changes. Each of these control devices can be used by an individual to maximize his present value of utility over what is assumed to be a finite and known life. Thus one's objective is to

$$\text{Max} \int_0^T U(Z_t, \tau_t)e^{-\rho t}dt \tag{3}$$

where

$Z_t \equiv$ goods consumption,
$\tau_t \equiv$ percent of one's time spent in leisure
$\rho \equiv$ rate of time preference, and
$U \equiv$ utility function;

subject to human capital, information, wage and asset constraints:

$$\dot{K} = f(S, K, \dot{\ell}) \quad \text{such that} \quad f_s \geq 0 \quad f_{ss} \leq 0 \quad f_K \geq 0 \quad f_{KK} \leq 0 \quad f_{\dot{\ell}} \leq 0 \quad f_{\dot{\ell}\dot{\ell}} \geq 0 \tag{4}$$

$$\dot{I} = h(i, \dot{\ell}) \quad \text{such that} \quad h_{\dot{\ell}} \leq 0 \quad h_{\dot{\ell}\dot{\ell}} \geq 0 \quad h_i \geq 0 \quad h_{ii} \leq 0 \quad h_{i\dot{\ell}} = 0$$

$$\dot{W} = g(I, \dot{\ell}) \quad \text{such that} \quad g(I, 0) = 0 \quad g_{\dot{\ell}}(I, \dot{\ell}) \geq 0 \text{ if } \dot{\ell} > 0 \quad g_I(I, 0) = 0 \tag{6}$$

$$\dot{A} = W(1 - \tau_t - S_t - i_t - c(\dot{\ell}))K - P_Z Z - C(\dot{\ell}) + rA \tag{7}$$

where

$S \equiv$ percent of one's total time spent investing in human capital
$i \equiv$ percent of one's total time spentsinvesting in information
$c(\dot{\ell}) \equiv$ proportion of one's total time spent changing location
$C(\dot{\ell}) \equiv$ direct expenditures in changing location
$\ell \equiv$ vector of locational characteristics
$\dot{\ell} \equiv$ change in vector of locational characteristics (here taken as positive although negative values representing reverse migration can be handled equally well)
$K \equiv$ human capital stock
$I \equiv$ stock of information about the wage distribution of each location relative to the location in which one currently resides
$W \equiv$ wage rate, and
$A \equiv$ assets.

Equation (4) represents a human capital production function. One's human capital stock is enhanced by allocating time (S) and human capital (K) to the production of earnings power. Part of this human capital stock represents general training. Another portion represents training with greater amounts of specificity. In particular, some of one's earnings capacity is endogenous to location. Such earnings power is lost when a move occurs. Put differently, the greater the change in locational characteristics, the greater the loss of such location specific training. Thus it is assumed that $f_{\dot{\ell}} \leq 0$, $f_{\dot{\ell}\dot{\ell}} \geq 0$, and that the value of $f_{\dot{\ell}}$ represents the value of specific human capital earnings power lost during the transitional period.

Information pertaining to other locations is obtained by search (i). Such search enhances one's stock of knowledge (I) of wages available for each location relative to one's own location. Thus information is composed of two parts: knowledge of available wages within one's particular location of residence and knowledge of wage information associated with other locations. The specifications of equation (5) should be construed as measuring information pertaining to wages in *other* areas relative to one's own area. (Knowledge of one's own area is measured by K, and enhances current wage rather than stock of information.) Thus we assume that allocation of time (i) to search enhances information of possible wage gains in other areas relative to one's own location. Given that one moves to obtain higher wages (or utility), then upon moving *relative* knowledge would decline. Thus it is hypothesized that the "value" of information decreases the greater the extent of one's move (*i.e.*, $h_{\dot{\ell}} \leq 0$, $h_{\dot{\ell}\dot{\ell}} \geq 0$ and $h_{i\dot{\ell}} = 0$).[24] Note that information alone does not directly increase wages received. Instead, information serves to enhance increases in wage *only when mobility occurs*. Thus in equation (6), whereas wage growth is a function of I and $\dot{\ell}$, it is assumed that such wage growth is zero when no move occurs [$g(I,0) = 0$ and $g_I(I,0)$]. Further, with a given amount of information (I), wage growth increases with the extent of mobility [$g_{\dot{\ell}}(I, \dot{\ell}) \geq 0$].

Assets constrain expenditures (both direct and indirect) on each investment and consumption activity. Earnings equal the product of wages and time spent working. Percent of time at work equals one minus the percent of time spent in the postulated alternative activities of leisure, investments in human capital and geographic information, as well as the time foregone in changing one's location [$c(\dot{\ell})$]. The change in the value of assets equals earnings {$W[1 - \tau - S - i - \alpha(\dot{\ell})] + rA$} minus direct expenditures [$PX + C(\dot{\ell})$].

Maximization of equation (3) subject to equations (4) through (7) involves maximizing the Hamiltonian (H) in each time period given inequality constraints on the control variables τ, S, i and the sum [$\tau + S + i + \alpha(\dot{\ell})$]. If

$$\tau, S, i, c(\dot{\ell}) \geq 0$$
$$\tau + S + i + c(\dot{\ell}) \leq 1, \tag{8}$$

then one maximizes

$$H = U(Z, \tau)e^{-\rho t} + \lambda_1 f(S, K, \dot{\ell}) + \lambda_2 h(i, \dot{\ell})$$
$$+ \lambda_3 g(I, \dot{\ell}) + \mu\{WK[1 - \tau - S - i - c(\dot{\ell})] - P_Z Z - C(\dot{\ell}) + rA\} \tag{9}$$

for each time period. First-order conditions imply the traditional marginality conditions that in each time period consumption (Z), leisure (τ), human capital (K), locational change ($\dot{\ell}$) and information (i) are purchased so as to equate marginal utility with marginal price:[25]

$$e^{-\rho t}\frac{\partial U}{\partial Z} - \mu P_Z = 0 \tag{10-a}$$

$$e^{-\rho t}\frac{\partial U}{\partial \tau} - \mu WK = 0 \tag{10-b}$$

$$\lambda_1 \frac{\partial f}{\partial S} - \mu WK = 0 \tag{10-c}$$

$$\lambda_1 \frac{\partial f}{\partial \dot{\ell}} + \lambda_2 \frac{\partial h}{\partial \dot{\ell}} + \lambda_3 \frac{\partial g}{\partial \dot{\ell}} - \mu[WK\frac{\partial a}{\partial \dot{\ell}} + \frac{\partial C}{\partial \dot{\ell}}] = 0 \tag{10-d}$$

$$\lambda_2 \frac{\partial h}{\partial i} - \mu WK = 0 \tag{10-e}$$

where the shadow prices are governed by the following differential equation:

$$-\dot{\lambda}_1 = \frac{\partial f}{\partial K}\lambda_1 + \mu W[1 - \tau - S - i - c(\dot{\ell})] \quad \text{(11-a}$$

$$-\dot{\lambda}_2 = \lambda_3 \frac{\partial g}{\partial I} \quad \text{(11-b}$$

$$-\dot{\lambda}_3 = \mu[1 - \tau - S - i - c(\dot{\ell})]K \quad \text{(11-c}$$

$$-\dot{\mu} = \mu r \quad \text{(11-d}$$

The solution of equation system (10) is complex. In this paper no attempt is mac to specify particular functional forms to achieve a deterministic solution. Instea we trace out one particular feature of this model which distinguishes its implic tions from other models. The plausibility of this time path should appear mo viable later in the paper upon simplification of the model.

Most human capital models are relatively stable in that the human capi acquisition paths are monotonically declining over most of the life cycle. Henc barring depreciation and discontinous labor-force participation, earnings contin ously rise over the life cycle. The model we propose distinguishes between su earnings growth caused by human capital accumulation [$\dot{K} = f(S, K, \dot{\ell})$] and wa growth caused by mobility [$\dot{W} = g(I, \dot{\ell})$]. By introducing the possibility nonmonotonicity in the value of acquired information (I), cyclical migration pat can come about. Specifically information that enhances one's wage rate (i) accumulated over the life cycle. However, such information does not raise wag directly. Wages increase only when $\dot{\ell} > 0$. However, when location changes, t value of accumulated relative information declines [$h_{\dot{\ell}} < 0$]. With a smaller sto of information the gain from moving diminishes. Such a loss of informati implies both smaller moves (lower values of $\dot{\ell}$) and a lower probability of movi (higher probability that $\dot{\ell} = 0$). Informational stock is then replenished, increasi the gain to mobility and hence the extent to which one moves. While our mod does not guarantee that mobility be periodic, the set of differential equations (1 can yield such time paths. This scenario makes more sense when the movi decision is limited to the dichotomous choice of "move" or "not move. Hopefully simplification of the model will make this point more apparent.

C. *Simplifications of the Basic Model*

Let us assume first, that individuals maximize earnings, rather than utility, over the life cycle; second, that human capital stock is fixed and hence investment S_t is zero in all periods; third, that time spent in leisure (T_l) is fixed; and fourth, that there is no time cost in moving $[c(\dot{\ell}) = 0]$. Under such conditions maximization of equation (3) subject to equations (4) through (7) reduces to[36]

$$\text{Max} \int_0^T [(1 - i_t)W - C(\dot{\ell})]\, dt \tag{12}$$

subject to equations (5) and (6). Respecification of (5) and (6) more explicitly implies maximization of the following Hamiltonian:[37]

$$\underset{i,\ell}{\text{Max}}\ H = (1 - i)W(t) - C(\dot{\ell}) + \lambda_1 [i^{\alpha} - \beta\dot{\ell}] + \lambda_2 \dot{\ell} I$$

subject to

$$\frac{\partial H}{\partial I} = -\dot{\lambda}_1 = \lambda_2 \dot{\ell} \tag{14-a}$$

$$\frac{\partial H}{\partial W} = -\dot{\lambda}_2 = (1 - i) \tag{14-b}$$

$$\frac{\partial H}{\partial \lambda_1} = i^{\alpha} - \beta\dot{\ell} = \dot{I} \tag{14-c}$$

$$\frac{\partial H}{\partial \lambda_2} = \dot{\ell} I = \dot{W} \tag{14-d}$$

yielding first-order conditions

$$\frac{\partial H}{\partial i} = -W(t) - \lambda_2 \alpha i^{\alpha-1} = 0 \tag{15}$$

$$\frac{\partial H}{\partial \dot{\ell}} = -C'(\dot{\ell}) - \lambda_1\beta + \lambda_2 I = 0 \tag{16}$$

dictating the purchase of information (i) and locational change $(\dot{\ell})$ so as to equate their respective marginal products to their marginal costs. Even the solution of the equation system (14), (15) and (16) is difficult. Since we are mostly interested in migration, we restrict investment in information to be constant. Thus $i = \bar{i}$, and hence equation (15) need not hold. We are then left with analyzing equation system (14) and (16). If i is constant then (14-b) is easily solvable such that $\lambda_2 = (T-t)i^*$ where $i^* = (1-\bar{i})$. Solving for $\dot{\ell}$ in terms of λ_1 and I yields the following block recursive system:

$$\dot{W} = I(\lambda_1\beta + I(T-t)i^*) \tag{17}$$

$$\dot{I} = i - \beta(\lambda_1\beta + I(T-t)i^*) \tag{18}$$

$$\dot{\lambda}_1 = -[T-t]i^* [\lambda_1\beta - I(T-t)i^*] \tag{19}$$

Equations (18) and (19) are linear in λ_1 and I, and can be represented by the following nonhomogeneous differential equation system

$$\begin{bmatrix} \dot{\lambda}_1 \\ \dot{I} \end{bmatrix} = A(t) \begin{bmatrix} \lambda_1 \\ I \end{bmatrix} + \begin{bmatrix} 0 \\ \bar{i} \end{bmatrix} \tag{20}$$

where

$$A(t) = \begin{bmatrix} -(T-t)i^*\beta & [(T-t)i^*]^2 \\ -\beta & -\beta(T-t)i^* \end{bmatrix} \tag{21}$$

The solution of equation system (20) involves solving for the characteristic roots of matrix (21). If the characteristic roots are complex, then a periodic solution with dampened oscillations occurs.[38] If real roots are obtained, then the time path may converge or diverge depending on the sign of the characteristic root. For the above case, only when β is sufficiently small (and we assume a constant amount of search)[39] can the time paths diverge.[40] Thus we hypothesize converging λ_1 and I paths which imply that $\dot{\ell}$ and $\dot{W}$ are monotonically declining over the life cycle. Operationally this means that over the life cycle changes in locational characteristics diminish.

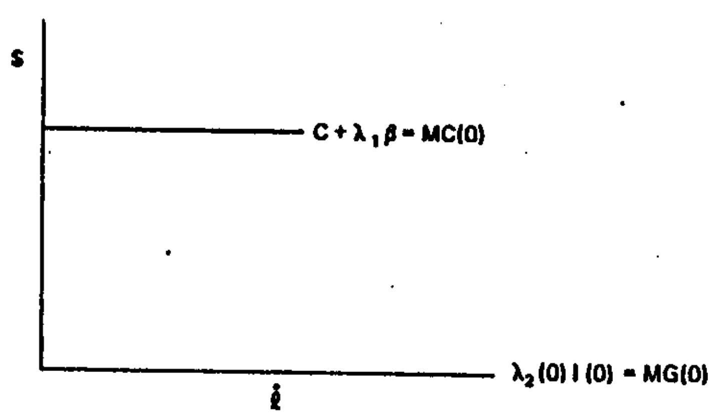
Because the impact of locational characteristics differs across individuals, the cost and gain functions $[C(\dot{\ell})$ and $\dot{W}(I, \dot{\ell})]$ should be specified in terms of individual characteristics (X). Thus $C(\dot{\ell})$ and $\dot{W}(I, \dot{\ell})$ can be defined contingent upon X (or a subset of X). $C(\dot{\ell})$ becomes $C(\dot{\ell}|X)$ and $\dot{W}(I, \dot{\ell})$ becomes $\dot{W}(I, \dot{\ell}|X)$. Individual characteristics then serve as an efficiency parameter implying that costs and gains from *specific* moves ($\dot{\ell} = \dot{\ell}^*$) are determined solely as functions of individual characteristics.[41] If $C(\dot{\ell}|X)$ and $W(I, \dot{\ell}|X)$ are defined independently of $\dot{\ell}$ but with linear interaction terms (*e.g.*, $C = \dot{\ell}X$ and $g = I\dot{\ell}X$), then the cost and gain of *any* move (*i.e.*, $\frac{\partial C}{\partial \dot{\ell}}$ and $\frac{\partial g}{\partial \dot{\ell}}$ depend only on individual characteristics. If such is the case for a given individual, the net gain of moving can be treated as a constant. Although little can be said about the exact nature of locational change, equilibrium equation (16) becomes an inequality and can be used to determine whether a move takes place. That is,

$$\begin{aligned} \dot{\ell} &> 0 \quad \text{if } C'(\dot{\ell}|X) + \lambda_1\beta < \lambda_2 g'(I\dot{\ell}|X) \\ \dot{\ell} &= 0 \quad \text{if } C'(\dot{\ell}|X) + \lambda_1\beta \geq \lambda_2 g'(I\dot{\ell}|X) \end{aligned} \tag{22}$$

Given such an assumption of the nature of C and g, mobility can be treated as dichotomous. If $\dot{\ell} > 0$, then a move occurs; if $\dot{\ell} = 0$, then no move occurs.

Hypothesizing such an equation structure implies periodic move/not-move paths, which are illustrated graphically.

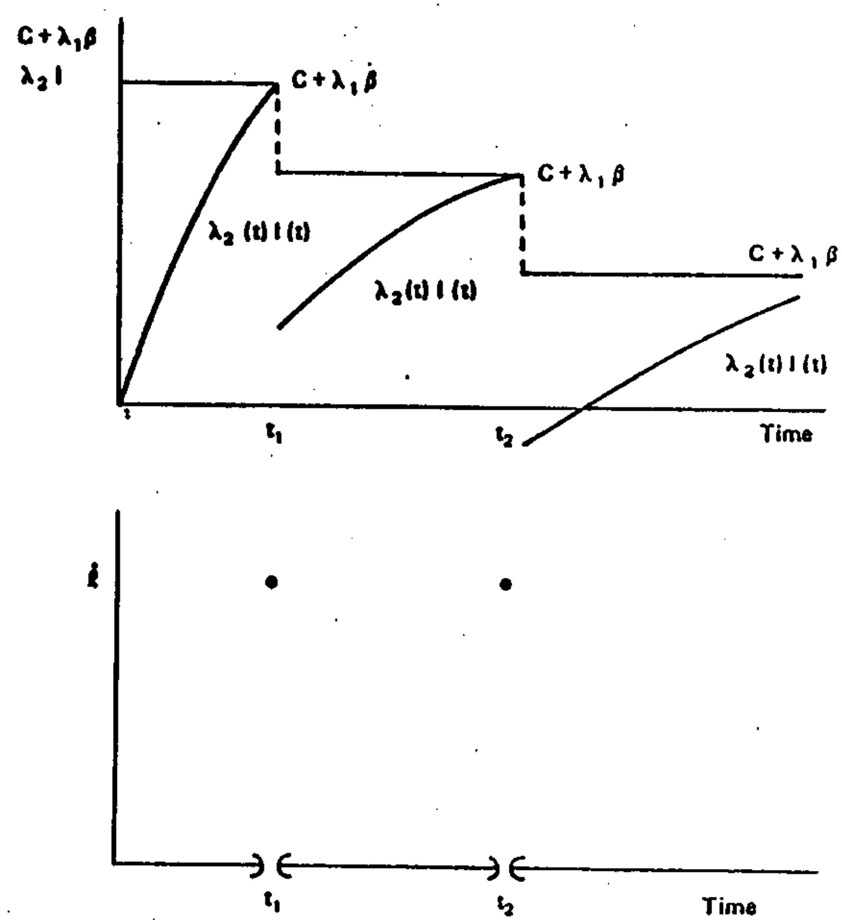
Figure 1.



Assume I = 0 at the initial time period ($t = t_0$). The marginal cost of a move can b[e] represented by $C + \lambda_1(0)\beta$ and the marginal gain by $\lambda_2 I(0) = 0$. In period one n[o] move occurs. Over time information is accumulated and the gain from movin[g] ($\lambda_2 I$) increases.[42] The cost ($C + \lambda_1\beta$) is constant as long as $\dot{\ell}$ is zero. When (and if) MG intersects MC (for example at t_1) then $\dot{\ell} > 0$, implying that mobility occurs.

Upon moving it is assumed that I diminishes by β. Thus $MG_{t_1+\delta} < MG_{t_1}$ implying a decline in marginal revenue; λ_1 diminishes, yielding a reduction o[f] costs; and the process begins again, illustrating a certain periodicity of migratio[n] (Figure 2). Under the appropriate dynamic conditions the periodicity increase[s]

Figure 2.



over the life cycle. In fact, if costs of moving increase with age (*e.g.*, family ties, children in school, specific training associated with an area) then this result would hold *a fortiori*.[43]

In summary we have considered a life cycle model which yields plausible paths of migration. Mobility depends on costs and benefits. Yet our point of departure from other models is that information is explicitly considered. Information is defined as the knowledge of wages in other areas relative to wages in one's own area. Thus if migration implies moving to an area where one believes wages are highest relative to other locations, then moving to what is perceived to be the highest wage location necessarily implies that perceptions of wages in other areas are lower relative to where one moved. Hence knowledge of potential gains from migration are "lost." Such losses are what we define as depreciation of the knowledge. Thus knowledge of wages is accumulated over time and serves to increase one's gains from mobility. When mobility occurs, wages in other locations must have been lower. Such losses in relative information imply a certain periodicity in migration. We believe such a result to be a plausible depiction of the migration process.

We realize that such an analysis of the periodicity of migration is still in its preliminary stages. We know of no other model that analyzes migration within such a framework yet still obtains the classic theorems regarding the probability of migration as well as implications for locational choice. Indeed we believe our model to be a generalization of current economic models of migration. In fact, if the rate of knowledge or information is eliminated and change of location is viewed as dichotomous, our model simplifies to the Sjaastad formulation. Under such circumstances objective function (13) becomes

$$\max_{\dot{\ell}} \int_0^T [W - C(\dot{\ell})]\, dt \tag{23}$$

subject to:

$$\dot{W} = g(\dot{\ell}|X) \tag{23-a}$$

Forming the Hamiltonian

$$H = W - C(\dot{\ell}) + \lambda g(\dot{\ell}|X) \tag{24}$$

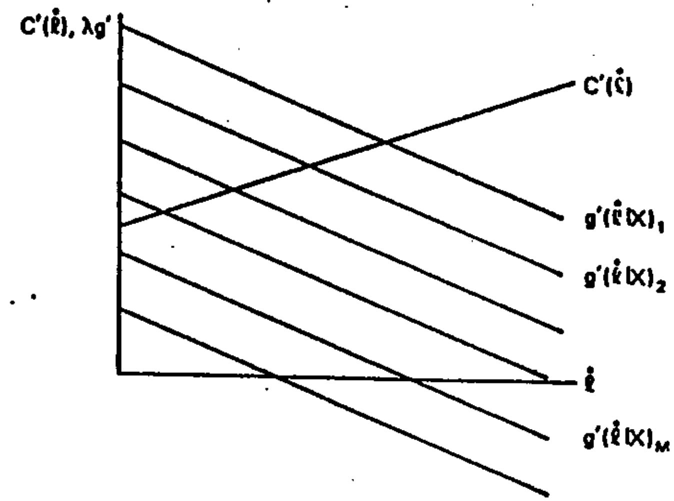
and maximizing with respect to $\dot{\ell}$, one obtains the following first-order conditions

$$\frac{\partial H}{\partial \dot{\ell}} = C'(\dot{\ell}) + \lambda g'(\dot{\ell}|X) = 0 \tag{25-a}$$

$$\frac{\partial H}{\partial W} = -\dot{\lambda} = 1 \tag{25-b}$$

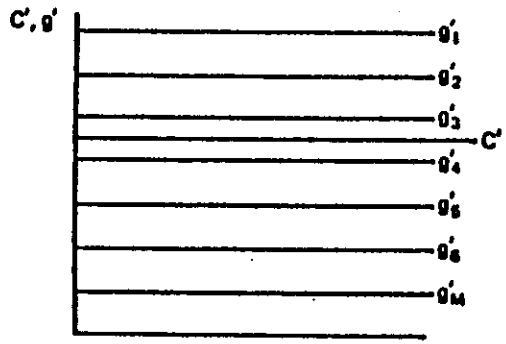
Thus according to (25-a) one changes locational characteristics to the extent that marginal cost equals discounted marginal gains. Because $\lambda g'$ is declining monotonically one expects the extent of locational change to diminish as indicated in Figure 3.

Figure 3.



If $C'(\dot{\ell})$ is constant and $g'(\dot{\ell}|X)$ is independent of $\dot{\ell}$, then we obtain a dichotomous "bang-bang" solution identical to the Sjaastad model. In such a case the MC and MG curves are horizontal and the $\lambda g'$ curve (MG) declines monotonically over time. Thus at young ages the probability of migration is high and at older ages the probability is low. To the extent that personal characteristics such as education, family background, occupation, etc. affect costs and gains, then the probability of migration is affected accordingly.[44]

Figure 4.



In either case the crucial equation predicting mobility is

$$C'(\dot{\ell}) + \lambda_1\beta \gtreqless \lambda_2 I \quad (16)$$

in the model with information, or equation

$$C'(\dot{\ell}) \gtreqless \lambda g'(\dot{\ell}|X) \quad (25\text{-a})$$

in the Sjaastad type model. In fact it is this kind of equation that most studies rely on when empirically analyzing migration.

Using equations (16) or (25-a) as a basis of analysis still has certain theoretical problems. As has recently been noted, the vantage point of such models clearly focuses on the individual. Yet the recent trends in economics recognize that decisions are often based on a household utility function that accounts for externalities between family members. More recently some have explicitly tried to incorporate notions of household maximization into the mobility decision.[44] Introducing household members can be achieved by either of two approaches. One possibility entails specifying equation (3) in terms of a family utility function. Such an approach is complex because of the difficulties involved in determining specification for family utility functions. A second approach avoids the question of household utility maximization by postulating an objective function to maximize the lifetime sum of husband and wife earnings.[46,47]

Assume the household maximizes the function set out in equation (23)

$$\text{Max} \int_0^T [W - C(\dot{\ell}|X_M, X_F, X_C)]\, dt \quad (23')$$

where $W = W_M + W_F$ such that M and F are subscripts for the husband and wife. the cost functions remain unchanged, then $C(\dot{\ell}|X)$ is the same as in equatic (25-a). However, account may be made of family characteristics that affect cos so as to transform X into the vector (X_M, X_F, X_C) where the vector X represen husband, wife and joint family characteristics. Included in X_C are number school-aged children and number of nearby relatives of the family. Further, t components of the $\dot{\ell}$ vector may be interacted with personal and family attribute For example, costs of moving to areas with low local governmental expenditur on public education may be higher for those families with children. Low-incor families may find access to public transportation important.

Similarly the specification of the W equation need account for personal chara teristics of the husband and wife as well as their interaction with each other a possible interactions with locational attributes. Families with both husband a wife working may find higher joint gains in locations with large labor marke Such gains may depend on occupational status of husband and wife as well as ot factors. For example, should migration have a deleterious effect on wives' ea ings, then the greater their earnings potential the higher the costs of migration terms of wives' foregone earnings, and hence the lower the probability of fam migration.

Maximization of (23') subject to

$$\dot{W}_M = g_M(\dot{\ell}|X_M, X_F, X_C), \quad (23\text{-a}$$

$$\dot{W}_F = g_F(\dot{\ell}|X_M, X_F, X_C), \quad (23\text{-a}$$

and the cost function

$$C = C(\dot{\ell}|X_M, X_F, X_C) \quad (23\text{-a}$$

implies

$$C'(\dot{\ell}) = \lambda[g'_M + g'_F] \quad (25$$

$$\lambda = -1 \quad (25\text{-}$$

Thus household models of migration can be analyzed within the same ba framework as was postulated. Equations similar to (16) or (25-a) still serve a basis for the migration decision. All that changes is the adjusted magnitudes gains and costs.

What is important about these models is that they serve as a generalization of current migration theories. While traditional results pertaining to the migration decision are obtained, implications are also developed concerning migration patterns that have long been observed, yet not modeled. Specifically, when $\hat{\ell}$ is an all-or-nothing decision,[48] equation (16) reduces to the Sjaastad model, thus implying that at any point in the life cycle migration occurs when gains outweigh costs. When one views migration within such a dynamic system implications on the periodicity of migration can be discerned. As in the Sjaastad model the young have a higher probability of migration. However, within these models the occurrence of remigration is not clear. Either one moves to the optimal location and does not move again (see footnote 44), or remigration occurs continuously until the marginal revenue from moving falls below costs (see Figure 4). By introducting search for locational information (of wage distributions in other areas relative to one's own area), account can be taken of the frequency with which remigration occurs. Our model predicts greater remigration at younger ages with the period between moves steadily increasing.

By introducing additional constraints on costs and wage changes as well as an additively separable objective function, the optimization process can be defined within a household context. Within this framework, account can be taken of such factors as employment status of the wife and the existence of school-age children.

Further, by describing locations in terms of characteristics, dynamic derived demand equations can be obtained. If these characteristics could be mapped back into geographic areas, then implications concerning life cycle locational choice can be discerned.

Several techniques exist to test these models. The ideal is to estimate each structural equation and solve the resulting system. Such techniques are possible but difficult. Another approach is to estimate a reduced form of particular time paths of $\hat{\ell}$. Such is the procedure of Haley and Heckman in estimating life cycle earnings functions. However because the exact functional form depends crucially on initial assumption of the parameterization of each function, and because little data currently exists on the exact functional specifications, we choose more basic but indirect tests on the efficacy of the model. Hopefully our results may motivate the future performance of more detailed tests.

III. EMPIRICAL ANALYSIS

Most migration models are based on the premise that individuals change locations when discounted gains from moving exceed costs. Inferences on the plausibility of such models are obtained from aggregate data. Migration rates are measured as the percent of population within a given area that move. Distance often serves as a proxy for costs, and the difference in mean area wages as a measure of net gains. The simplest form of our model (equation 25-a) is no

different. It states that optimal locational change is functionally dependent on net economic gains (*i.e.*, $\hat{\ell} = f(C_{\hat{\ell}}, g_{\hat{\ell}}, \lambda)$. Yet our model can be buttressed in several important ways. First, if cost and gain functions can be defined for changes in locational characteristics, then specific inferences can be obtained about individual characteristics and area preferences. Second, if costs and gains are viewed in a family context, then implications can be discerned concerning both the probability of moving and locational choice dependent on such family characteristics as the labor-force behavior of the wife and the presence of school-age children. Third, when search of perceptual wage information is allowed, motivations exist for migration to occur in a periodic fashion. We make no pretentions about including each of these modifications within our empirical work. Relating locational preferences to individual attributes is difficult. Thus we concentrated mainly on the latter two aspects, remigration and family characteristics. Given that this migration model focuses on the individual household, it is appropriately tested using micro data rather than the aggregate information that has been used in past studies.

Unfortunately many problems exist in attempting computations based on individual family data. Most micro data sets explicitly deal with a single time period. A knowledge of who within the sample has moved in the past (as given in the U.S. Census of Population micro data sample) yields no information whether *changes* in variables have occurred in moving, but rather can only indicate existing *levels*. Cross-sectional evidence based on these levels has been inconclusive.[49] For example, as described below, we find that while *levels* of earnings for migrants may remain lower than nonmigrants, the *change* in earnings for migrants is significantly greater.

Only recently have time series data become available. The Michigan *Panel Study of Income Dynamics*, the *National Longitudinal Surveys*, as well as the *Continuous Work History of the Social Security Administration* have all been used in connection with migration studies. However, even with such longitudinal data, difficulties exist in estimating potential wage gains. Records of annual income over consecutive years provide no knowledge of wages that would have been earned had these households not moved. Analogous problems exisit in estimating the potential wage gains of nonmovers. In addition, individual families do not remain stable over time, as marriage, divorce, births and deaths dramatically change the way households respond to their environment. In the remainder of this paper we attempt an application of equations (16) and (25-a) by estimating a two-equaiton system of expected wage gains and the probability of migration for those families which retain the same husband and wife over the time period studied.

A. The Data

In our analysis we concentrate on the University of Michigan *Panel Study of Income Dynamics*. This longitudinal data set is the largest available (5,000 households) containing an annual history of each state of residence as well as information on the necessary familial variables for a sample representing the entire U.S. population. To avoid questions of the impact of changes in family structure on migration, as well as migration on family structure, we concentrate on a subsample of about 1,500 husband-wife families which remained intact over the 1971–1975 period.[50] Migrants are defined as those who have crossed state lines in the 1971–1972 year. The sample shows significant differences between movers and nonmovers in many of the characteristics discussed above (Table 3). We find movers to be younger on average than nonmovers. In the year before the move, movers generally have less experience on their current job, and are much more likely to have moved in the preceding year. A surprising 45% of nonmovers live within walking distance of relatives as compared to only 14% of the movers.

While not always statistically significant, other variables suggest some interesting relationships. We find the male mover in the family to have more education than the male nonmover, while the opposite holds for the female. Children under 17 appear to act as a deterrent to movement, with school-age children an even stronger restraining force. Earnings variables show some highly interesting patterns. We find the earnings levels of male migrants to be lower than that of nonmigrants in the year preceding the move, but the four-year adjusted change in present value of earnings to be over twice as large for the migrants. This contrasts sharply with the significant decrease in earnings observed for the women in the family. While nonmigrant women compiled slight increases in earnings over the four-year period, migrant wives experience very sharp losses. We observe, however, that the gain in husband's earnings is larger than the female loss, suggesting a net gain in family income. Some indication of migration directionality may be obtained by observing the budget indexes in the years before and after the move. We find a trend for mobility to low-price-level areas representative of urban-rural and north-south moves. These patterns are similar to those illustrated in other migration studies. The differences that exist may be attributed to the fact that we limit our analysis to husband-wife families over time.

B. The Decision to Migrate

The control model developed represents a life cycle model of individual behavior. As indicated, several techniques are available to test the model. Rather than specifying precise functional forms for each aspect of the life cycle process, we concentrate on qualitative implications. Given that our emphasis centers on the very simplest of the models developed, namely the equations governing the move/not-move decision, our empirical tests are similar to other research at least in

Table 3. Migrant and Nonmigrant Characteristics

	Nonmovers	Movers	t-value
Age Head	38.19	34.34	2.22
Age Wife	35.39	31.40	2.31
Education Head	11.99	12.53	0.86
Education Wife	12.11	12.03	0.17
Children under 17	1.86	1.63	0.79
Children in School	1.46	1.00	1.62
Percent Living within Walking Distance of Relatives	0.45	0.14	3.60
Area Budget Index, First Year	98.27	98.51	0.21
Area Budget Index, Second Year	98.24	95.86	2.66
Percent Interstate Migrants Previous Year	.03	.31	9.00
Adjusted Income Head	8381.18	7248.70	1.41
Adjusted Income Wife	1485.96	1527.96	0.11
Adjusted Present Value of Income Changes Head	1647.95	4254.23	1.52
Adjusted Present Value of Income Changes Wife	159.58	−1715.91	−2.21
Adjusted Wage Head	3.81	3.26	1.47
Adjusted Wage Wife	1.24	1.54	1.08
Adjusted Present Value of Wage Change Head	0.55	3.30	3.10
Adjusted Present Value of Wage Change Wife	0.14	−.2.14	−2.69
Tenure on Current Job Head	8.27	4.29	2.99
Percent with Professional Head	.16	.23	1.12
Percent with Wife in Low Skill Job or Not Working	.57	.44	1.60

Source: Random Sample from University of Michigan Income Dynamics Panel I Base year 1971.

spirit. On the other hand, our estimates differ from past research in that we a simultaneous equations techniques to obtain statistically consistent and asymp ically efficient estimates of factors affecting the probability of migration *individual* panel data. We procede first by analyzing whether changes in earn are realized when migration occurs, and second by analyzing the probabili migration within a simultaneous equations setting.

1. *Mobility: An Earnings Enhancing Investment*

To determine whether earnings are increased by mobility, we have performed regressions on a sample of families (both spouses present) that remained intact for the period 1968 through 1974.[51] Relative changes in the earnings paths of those who moved in 1968 compared to nonmovers were estimated. We initially present results using several definitions of mobility, but later concentrate only on those that change their state of residence. To determine the effects of mobility on earnings, we regress *change* in earnings on various standardizing characteristics, as well as a dummy variable for the kind of move. Thus[52]

$$Y_{pq} = \delta_0 + \delta \underline{X} + \delta_2 M \qquad (26)$$

where

Y_{pq} ≡ the *change* in earnings between year p and year q (*i.e.*, $Y_q - Y_p$)
X ≡ a vector of standardizing variables including education of husband and wife, hours worked, age of the husband, family size, relatives nearby and the number of neighbors known, and
M ≡ a dummy variable equaling one for move and zero for no move.

The coefficients for M, given in Table 4, indicate the differences in the change of earnings between movers and nonmovers for pairs of years between 1968 and 1974. State moves unambigously increase earnings. Local moves generally do not entail job changes, and hence such movers do not exhibit any significant change in earnings. Family income similarly increases after mobility. However, because of the loss in earnings usually experienced by wives, there appears to be an initial drop in family earnings which are not recouped for several years.[53]

2. *The Probability of Migration*

Given that mobility appears to affect the changes in income, we now propose to analyze the impact of these potential changes on the probability of migration. Equation (25-a) implies that the probability of moving depends on relative costs and gains. As was discussed, expected costs and gains for each household are unobservable variables. We can observe the acutal change in earnings due to migration only for those who do in fact move, and the acutal change in earnings which takes place without migration only for those who remain in their current location. However, if our equation for an individual's change in income includes a

Table 4. The Effect of 1968–1969 Migration on the Subsequent Change In Earnings (t-values in parentheses)

	DEH69	DEH70	DEH71	DEH72	DEH73	DEH74
MOVESC	−588.99	−317.42	−414.00	−138.55	252.27	856.43
	(1.71)	(.72)	(.76)	(.22)	(.36)	(.95)
MOVECNTY	−969.66	−3046.53	−2703.52	−2683.61	−3532.11	−3925.20
	(.85)	(2.12)	(1.51)	(1.26)	(1.53)	(1.33)
MOVESTAT	1166.78	2762.53	2916.60	4463.65	3931.31	4683.64
	(1.53)	(2.86)	(2.43)	(3.27)	(2.52)	(2.36)
MOVEDWEL	−353.34	−26.42	−52.96	429.45	587.23	1170.74
	(1.14)	(.10)	(.10)	(.75)	(.92)	(1.45)
	DFI69	DFI70	DFI71	DFI72	DFI73	DFI74
MOVESC	−1978.22	−484.01	−1439.53	−1260.92	−2192.46	−1236.44
	(3.22)	(.73)	(1.74)	(1.18)	(1.78)	(.88)
MOVECNTY	−987.60	−1276.92	−1454.57	−2059.27	−1925.70	−3593.08
	(.45)	(.53)	(.49)	(.53)	(.42)	(.70)
MOVESTAT	−2420.07	81.26	2640.53	6749.27	4738.32	4851.39
	(1.85)	(.10)	(1.50)	(2.97)	(1.85)	(1.67)

Note: The dollar change in earnings are coefficients of the dummy migration variables taken from separate regression equations where the dependent variables are the different measures of earnings change. Each equation is adjusted by education of the husband and wife, family size, age of the husband, and original earnings at origin. In this table earnings are not adjusted by price indices.

Key: DEHi ≡ first difference in husband's earnings between year i and 1968.
DFIi ≡ first difference in family earnings between year i and 1968 (includes earnings of husband, wife and other members).
MOVESC ≡ moved in same county
MOVECNTY ≡ moved to different county
MOVESTAT ≡ moved to different state
MOVEDWEL ≡ moved to different dwelling

dummy variable reflecting whether the individual moves or not, and if this dummy variable is interacted with at least some of the other explanatory variables, we can estimate the potential gains of mobility, *for both movers and nonmovers*. These potential gains can then be used as an explanatory variable in the equation determining the probabily of moving.

We use a two-equation model which has been developed elsewhere.[54] One equation represents the change in earnings, while the other represents the probability of migration. The probability of moving equation can be written as

$$\ln \frac{P(M_i = 1)}{P(M_i = 0)} = Q_i\gamma + \alpha[\,(Y_i|M_i = 1) - (Y_i|M_i = 0)\,]\,. \qquad (27)$$

where the log of the odds ratio of moving (M) equals a function of cost factors (Q) and the potential gain in earnings if a move occurs. That is, Y_i represents the change in earnings, and $[\,(Y_i|M_i = 1) - (Y_i|M_i = 0)\,]$ represents the potential additonal change in earnings if a move occurs. The change in earnings equation is

$$Y_i = X_i\delta_1 + (M_iX_i)\delta_2 + \epsilon_i\,, \qquad (26')$$

where X_i is a vector of factors affecting the increase in earnings (including the usual constant term). Interacting M_i with X_i means that the gains to moving, $[\,(Y_i|M_i = 1) - (Y_i|M_i = 0)]$, are equal to $X_i\delta_2$. Computing $X_i\delta_2$ for each individual yields an estimate of the effect of migration on this future earnings stream. The disturbance ϵ_i is assumed to be independent of X_i and M_i. This is a reasonable assumption since the structure of the model is essentially recursive; see the paper just referred to for details.[55]

The simplest way to estimate the earnings equation (26') is by ordinary least squares. In light of the assumed independence of the disturbances (ϵ_i) and regressors (X_i and M_iX_i), the resulting estimates of δ_1 and δ_2 are consistent. Using $\hat{\delta}_2$, we can then form a consistent estimate of the earnings differential

$$(Y_i|M_i = 1) - (Y_i|M_i = 0) = X_i\hat{\delta}_2\,,$$

insert this in (27), and estimate by the usual maximum likelihood technique for a simple logit equation. The resulting estimates of γ and α are also consistent, since a *consistent* estimator $\hat{\delta}_2$ was substituted for δ_2 to form the earnings differential $X_i\delta_2$ in (27).

While these simple estimators are consistent, they are not efficient. To obtain efficient estimates of the parameters, we can use the method of maximum likelihood. It can be shown that the (concentrated) log likelihood function is of the form

$$\log L^* = \frac{-N}{2}[\log(2\Pi) + 1]\,\frac{-N}{2}\log\Big[\frac{1}{N}\sum_{i=1}^{N}(Y_i - X_i\delta_1 - M_iX_i\delta_2)^2\Big] \qquad (28)$$
$$+ \sum_{i=1}^{N} M_i(Q_i\gamma + \alpha X_i\delta_2) - \sum_{i=1}^{N}\log[1 + \exp(Q_i\gamma + \alpha X_i\delta_2)].$$

This can be maximized numerically to obtain the maximum likelihood estimates of α, γ and δ_1 and δ_2. These estimates are consistent *and* asympototically efficient. Althernatively, starting from the initial consistent OLS-logit estimators, we can perform a single Newton-Raphson iteration to obtain two-step estimators which are consistent, and which are asymptotically equivalent to maximum likelihood in the sense that they have the same asymptotic distribution as the maximum likelihood estimates. Again, see Schmidt's paper cited in footnote 54 for details.

We present estimates using both the OLS-logit method and the efficient two-step method. Simply for semantic reasons we will refer to the efficient estimates as maximum likelihood estimates, even though they are only asymptotically equivalent to maximum likelihood estimates.

First, we indicate in more detail the components of the Q and Z vectors of equations (26') and (27). To motivate the discussion, recall that mobility results from a control process derived from the maximization of lifetime income. Mobility occurs if $C' < \lambda g'$. Thus we analyze factors affecting gains and costs.

Given that much evidence exists that levels of earnings are governed by such human capital variables as schooling and experience, changes in earnings levels likewise should be determined by changes in these human capital variables. Unfortunately most changes in human capital variables are uniform over the population. For example, education and experience change equally for most individuals. Thus we postulate that changes in earnings are in part determined by the levels of human capital variables. Such an approach is sensible in that the levels of these variables in part represent particular phases of an individual's life cycle. That is, we would expect the younger, the more skilled and the more educated to experience more rapid wage growth. To distinguish between wage growth patterns between movers and nonmovers, interaction terms are included between all variables and the dummy mobility variable. Alternative specifications for husbands and wives are present in Table 5.

The change in earnings is measured in three ways. In its simplest form, we choose the first difference in earnings (ΔY) between 1971 and 1972. However because earnings paths become steeper upon moving, changes in the present value of earnings and wages over a four-year period are used. These four-year changes have the effect of smoothing out transitory fluctuations in income often mentioned in other studies using individual observations. Note that unless indicated otherwise, earnings have been adjusted by different price levels between locations and over time.

The signs of interest are the interaction terms in each equation. They represent differences in potential earnings between movers and nonmovers. Professional males achieve high gains from mobility. Those with the most job tenure and the highest levels of income face the greatest losses. Utilizing these coefficients, one can derive an instrument measuring the potential gains in earnings. For the entire male population, the one-year gain in earnings is −$282. For movers the gain is

Table 5. OLS Equations for Earnings Change (Males)

	Dependent Variable: ΔY	PVEARN	PVWAGE
AGE	−37.0215	−101.6099	−.0233
	(5.66)	(3.96)	(−1.79)
YH	−.0923	−.80919	−1.2178
	(8.90)	(15.26)	(−21.85)
TENURE	41.4952	61.1559	0.0539
	(4.39)	(1.85)	(3.24)
PROF	309.4893	1095.2705	1.1008
	(1.48)	(1.69)	(3.37)
MOVE7172	996.2286	1707.3028	5.4951
	(0.69)	(0.33)	(2.08)
M*AGE	2.6832	−155.6943	0.01453
	(0.08)	(0.93)	(0.20)
M*YH	−.1627	0.8414	−2.0142
	(1.27)	(1.18)	(−3.27)
M*TENURE	−13.3383	−270.2617	−.1711
	(0.16)	(1.07)	(−1.33)
M*PROF	2323.1130	835.3419	15.0769
	(1.47)	(0.16)	(7.88)
CNST	2570.7394	11624.5364	5.4597
R^2	0.05	0.15	0.29
N	2544	1538	1509
DY	−282.4110	693.4134	−.5905
DYM	416.7917	1422.6623	2.1307
DYNM	−295.9174	677.9830	−.6537

OLS Equations for Earnings Change (Females)

YW	−0.06866	−0.72905	−1.57588
	(−6.23)	(−13.03)	(−22.15)
AGEW	−0.46995	10.94289	−0.00034
	(−0.19)	(0.98)	(−0.03)
CH	26.84202	246.71553	−0.01541
	(1.51)	(3.53)	(−0.24)
EDUCW	53.3255	170.90551	0.25558
	(5.26)	(4.07)	(6.36)

Table 5. OLS Equations for Earnings Change (Females) (*continued*)

	ΔY	PVEARN	PVWAGE
MOVE7172	1836.50946	5525.65067	6.72476
	(1.96)	(1.23)	(1.60)
MV·YW	−0.43154	−2.39466	−2.47101
	(−5.54)	(−4.49)	(−4.82)
M*AGEW	−22.67815	−128.32282	−0.05432
	(−1.49)	(1.84)	(−0.83)
M*CH	−285.03309	−1139.97900	−0.32907
	(−2.12)	(2.32)	(−0.71)
M*EDUCW	−54.13967	207.66896	−0.19272
	(−0.95)	(0.76)	(−0.77)
CNST	−375.71294	−1617.94587	−0.93571
R^2	.04	.15	.27
DY	−948.49152	−2137.7833	−1.22408
DYM	−652.18602	−1360.5292	−1.63043
DYNM	−955.78034	−2154.3695	−1.21417

Key to Table 5:

ΔY	One year unadjusted change in earnings 1971–1972
PVEARN	Sum of change in earnings over period 1971–1975, discounted at 6%
PVWAGE	Sum of change in wages over period 1971–1975, discounted at 6%
AGE	Age of male
YH	Male earnings (or wages) in year 1971
TENURE	Male years on current job, 1971
PROF	Whether male is in a professional occupation
MOVE7172	Dummy variable; 1 if moved between states 1971–1972, 0 otherwise
M*AGE	Interaction of move in 1971–1972 with Age
M*YH	Interaction of move in 1971–1972 with Income (wages)
M*TENURE	Interaction of move in 1971–1972 with Tenure
M*PROF	Interaction of move in 1971–1972 with Prof
YW	Female earnings (or wages) in year 1971
AGEW	Age of wife
CH	Total number of children
EDUCW	Education of wife
M*YW	Interaction of move in 1971–1972 with female Income (wages)
M*AGEW	Interaction of move in 1971–1972 with age of wife
M*CH	Interaction of move in 1971–1972 with number of children
M*EDUCW	Interaction of move in 1971–1972 with wife's education
DY	Predicted change in earnings due to moving computed via substitution of mean values for entire population
DYM	Predicted change in earnings due to moving computed via substitution of mean values for movers
DYNM	Predicted change in earnings due to moving computed via substitution of mean values for nonmovers

\$416, while for nonmovers the potential gain is −\$295. Over the four-year period, even the nonmovers show a positive return, albeit of lower magnitude than those who move.

Similar results are obtained for women. Wives with high earnings face large potential losses upon moving. Such losses are intensified for those that are old and those who have children. Consistent with the findings described in Tables 3 and 4, the instrumental variable representing expected gain from mobility reveal a large loss (−\$652) *even for movers*. However, as is expected this loss is less than that faced by the nonmovers.

The rationality of family migration depends upon the sum of husband-wife expected gains. It is therefore reassuring to find that expected family gains for movers are in general positive while being strongly negative for nonmovers. The fact that the family expected gain in the first year (ΔY column) is negative, while positive for the more long-run definition may be indicative of the time horizon in which plans are made.

Factors affecting costs of migration are implicit within the move/not-move equation. Unambiguous to the control process is that λ declines with age. Thus a negative correlation is postulated between age and the gain from mobility. To the extent that non-neutrality exists within the optimization process; costs of migration would also increase over the life cycle thereby accentuating the effect of age. Thus age is included in vector Q of equation (27).[56]

If equation (25′) of the Sjaastad type model is assumed, then those who have moved recently ($g_t^i > c_t^i$) would have a higher probability of remigration. Therefore a variable representing recent migration is included, and is expected to enhance the probability of migration. If equation (16) is presumed to govern migration, and if the solution to the migration path is periodic with increasing amplitudes, then the interaction of age and the remigration variable should be negative. That is, younger families remigrate with a higher probability. We thus postulate the Q vector to be composed of age, family characteristics and a measure of past migration.

Table 6 contains logit regressions for the migration decision. Age of the head, number of school-age children and number of nearby relatives always imply a negative effect on the probability of migration. Having a wife in a nonprofessional occupation increases the probability of migration relative to those with professional wives. Similarly the higher the educational level of the wife, the lower the probability of migration. Recent migration invariably increases the probability of remigration. The interaction of age and past migration is weak, but at times negative.

The instruments reflecting the expected change in earnings of movers versus nonmovers for the most part are consistent with expectations. Both the expected gains in wages for males (α_M) and the expected gains in wages for females (α_F) are positive. If male and female gains were weighted equally in the household decision

to migrate, one would expect α_M and α_F to be roughly the same magnitud However, the magnitude of α_M far exceeds that of α_F, thereby indicating tl expected gains in male earnings have a higher probability of inducing fami migration. Given the intermittent nature of female life cycle labor-force particip tion, such a result is expected.

Maximum likelihood estimates of equations (26′) and (27) are presented Table 7. Both because of the weak magnitudes of the expected gain in w earnings and the intractability of the required likelihood function, equation (2 refers only to male expected gains (and female expected gains are left out). M coefficients do not change appreciably by applying maximum likeliho techniques. However, for the most part the statistical significance increases. Su increases in t-values can be noted for the expected gain variables.

These results are admittedly preliminary. Not all specifications were used a not all years were analyzed. Yet the data seem consistent with certain of o hypotheses. Expected gains from migration appear to motivate population flow Gains in husband's earnings are more important in family migration than expec gains in wife's earnings. Past migration is highly related to current migrato behavior thereby implying that remigration is important. However, it is difficult discern whether the periodicity of migration increases with age. The interacti term between age and remigration is for the most part insignificant. On the oth hand, nearby relatives, school age children, and labor market oriented wives ra costs of migration and strongly serve as deterrents to the family migration proce

C. Locational Choice

When locational characteristics are explicitly embedded into the model so th marginal costs and benefits are functionally related to these characteristics a their interaction with familial variables, then $\hat{\ell}$ has a solution governed by equati set (10) and (11) [or (14) and (15) or (25) depending on the restrictiveness of tl model]. Theoretically, if the optimal time path $\hat{\ell}$ is known, and if a uniq mapping between locational characteristics and particular locations can be asce tained, then life cycle patterns of locational choice can be determined. Unfort nately, the existence of such a mapping between ℓ and specific locations is diffic to illustrate. Trying to identify such a mapping is especially hard given the pauci of data, and is far beyond the scope of this paper. Yet despite the difficulties o would encounter in trying to implement the notions of locational change to obta time paths of particular locational choices, certain implications remain testable. particular we wish to explore (at least in a cursory manner) the relationsh between certain individual characteristics and change in locational attributes. W realize that such analysis is preliminary, but hope it serves as illustrative of tl need to refine current analysis of locational change. Our point is that in addition studying the factors that influence the probability of moving, an understanding the role these factors play in the determination of locational choice is also require

	ΔY	PVEARN				PVWAGE	
CNST	−1.321	−2.2822	−1.1598	−1.3393	−1.1598	−2.6753	−2.0374
	(−1.74)	(−1.80)	(−.90)	(1.02)	(1.79)	(2.35)	(−1.62)
MV7071		1.5119	2.1830	1.6740	2.1830	1.7908	2.3923
		(1.10)	(4.65)	(1.20)	(1.32)	(1.36)	(5.70)
MV7071*AGE		0.0212		0.0149	−.05200	0.0145	
		(0.51)		(0.36)	(−.91)	(0.38)	
REL	−1.1153	−1.1125	−1.0752	−1.0411	−1.0750	−1.4021	−4.159
	(−3.43)	(−2.46)	(−2.37)	(−2.31)	(−3.60)	(−2.81)	(−2.93)
SCHKID	−.2315	−.2328	−.2574	−.2500	−.2570	−.0483	−.0601
	(−1.88)	(−1.40)	(−1.53)	(−1.48)	(−2.48)	(−.37)	(−.47)
OCCW	0.8293	0.8420	0.6563	0.6472	0.6560	0.5687	0.5014
	(2.93)	(2.02)	(1.63)	(1.60)	(2.41)	(1.52)	(1.36)
EDUCH	−.0515	−.0495	−.0520		−1.01670	−.0332	0.0245
	(−1.34)	(−.83)	(−.89)		(−.39)	(−.65)	0.43)
AGEH	−.0386	−.0300	−.0167	−.0208		−.02216	−.0159
	(−3.13)	(−1.32)	(−.69)	(−.78)		(−1.00)	(−.88)
EDUCW				−.1449	−.1190		−.1242
				(−2.22)	(−2.42)		(−1.75)
DIFH	0.00344	0.005265[1]	0.00676?	0.005428[2]	0.006760[2]	0.4663	0.5139
	(2.61)	(1.75)	(1.06)	(0.88)	(1.95)	(1.70)	(1.91)
DIFW	0.00242	0.0001533	0.000129	0.0003784	0.0001290	0.0358	−.1772
	(1.74)	(0.04)	(0.03)	(0.09)	(0.05)	(0.08)	(−.40)

CNST = constant
MC7071 = moved in past year
MV7071*AGE = interaction between age and past year's migration
REL = nearby relatives (dummy variable)
SCHKID = number of school aged children
OCCW = wife in menial occupation (dummy variable)
EDUCH = husband's level of education
AGEH = husband's age
EDUCW = wife's level of education

DIFH =
- (1) ΔY_H = first different of *expected gain* in earnings (in 100's of dollars) occurs for *husband* (*not* price adjusted)
- (2) PVEARN = present value of expected gain in *earnings* (in 100's of dollars) for husband if move occurs (adjusted for price level changes)
- (3) PVWAGE = present value of expected gain in *wages* (in 10's of dollars) for husband if move occurs (adjusted for price level changes)

DIFW =
- (1) ΔY_W = first different of *expected gain* in earnings (in 100's of dollars) for *wife* if move occurs (*not* price adjusted)
- (2) PVEARN = present value of expected gain in earnings (in 100's of dollars) for wife if move occurs (adjusted for price level changes)
- (3) PVWAGE = present value of expected gain in wages (in 10's of dollars) if move occurs for wife (adjusted for price level changes)

Table 7. Simultaneous Equation Determination of Mobility and Present Value of Wage (Earnings) Gain

	PVWAGE								PVEARN			
	Logit	t-value	Maximum Likelihood	t-value	Logit	t-value	Maximum Likelihood	t-value	Logit	t-value	Maximum Likelihood	t-value
CNST	−1.676	−1.40	−1.697	−1.41	−1.321	−1.06	−1.373	−1.20	−1.308	1.00	−1.786	−1.29
MV7071	2.379	5.51	2.375	5.50	1.708	1.29	1.716	1.38	1.559	1.12	1.513	1.09
MV7071*AGE	—	—	—	—	0.021	0.54	0.0200	0.57	0.018	0.44	0.019	0.45
REL	−1.474	2.95	−1.472	−2.94	−1.480	−2.96	−1.476	−3.28	−1.042	−2.30	−1.030	−2.27
SCHKID	−.058	−.44	−.056	−.43	−.056	−.43	−.057	−.49	−.240	1.45	−.240	−1.44
OCCW	0.521	1.43	0.523	1.43	0.503	1.37	0.507	1.52	0.637	1.66	0.638	−1.66
EDUCH	−.0109	0.19	0.010	0.18	—	—	—	—	—	—	—	—
AGE+1	−.021	−1.08	−.020	−1.02	−.027	−1.21	−.025	−1.23	−.025	1.01	−.014	−.51
EDUCW	−.130	−1.88	−.130	−1.88	−.128	−2.04	−.128	−2.22	−.143	−2.23	−.144	−2.22
DIFHI	0.051	1.80	0.052	1.82	0.051	1.86	0.054	2.05	0.080 X10⁻³	0.78	0.175 X10⁻³	1.41
	OLS	t-value			OLS	t-value			OLS	t-value		
CNST	5.460	NA	5.463	11.50	5.460	NA	5.463	11.50	11600.3	NA	11593.0	12.23
YHP71	−1.218	−21.85	−1.218	−21.92	−1.218	−21.85	−1.218	−21.93	−.805	15.22	−.804	−15.26
AGEH	−.023	−1.79	−.024	−1.81	−.023	−1.79	−.024	−1.81	−101.88	−3.97	−102.43	−4.00
TENURE	0.054	3.24	0.055	3.29	−2.014	−3.27	−1.966	−3.32	60.97	1.83	62.65	1.90
PROFHD	1.101	3.37	1.106	3.39	1.101	3.37	1.106	3.39	1079.91	1.66	1159.88	1.79
MV7172	5.495	2.08	5.560	2.12	5.495	2.08	5.556	2.12	3620.05	0.73	3681.89	−.75
MYP71	−2.014	−3.27	−1.970	3.29	−2.014	−3.27	−1.966	−3.32	—	—	—	—
MAGE+1	0.015	0.20	0.015	0.21	0.015	0.20	0.014	0.20	−51.99	−.36	−25.16	−1.79
MTENURE	−.171	−1.33	−.209	−1.68	−.171	−1.33	−.209	−1.69	−213.24	−.86	−285.88	−1.23
MPROFHD	15.077	7.88	14.860	7.81	15.077	7.88	11.856	7.81	3709.40	0.84	−151.82	−.04

The exact nature of the solution of $\dot{\ell}$ has not been specified. However, certain unambiguous conclusions hold concerning these paths. Given the existence of such paths, they must be related to stages of the life cycle. In particular, whether $\dot{\ell}$ be oscillatory or monotonic, it should be related to age. To the extent that cost and gain functions of particular locational characteristics differ by other individual attributes, then mobility patterns would likewise differ, and would be reflected in life cycle $\dot{\ell}$ paths. Thus, for example, if for families with children the gain of mobility is higher in areas with high per capita public-school expenditures, then given mobility, families with school-aged children would be inclined to choose such areas.[37]

We do not attempt to postulate all the possible interrelationships between changes in locational characteristics and individual attributes. Yet we feel that it may be informative to illustrate that certain patterns exist in life cycle locational choices. The Income Dynamics Panel contains limited locational information on place of residence for 1968 and 1974. By regressing individual characteristics on changes in locational attributes for those who moved between these years, some

Table 8. Relation Between Change in Locational Characteristics and Premigratory Individual Attributes

Standardized Regression (β) Coefficients

Locational Characteristic	Family Size	Age Husband	Wage of Wife	Wage of Husband
A. Interstate Movers (N=95)				
Percent Females in Labor Force	0.123	−.022	0.220	−.235
Population Density	−.183	−.002	−.151	0.199
Net Migration into Area	−.008	0.047	0.084	−.160
Median Education	0.066	−.019	−.057	−.094
Unemployment Rate	−.075	−.171	−.087	0.115
Government Services	−.061	−.130	−.122	0.170
Expenditures on Education	0.155	0.043	0.195	−.104
B. All Movers (N=579)				
Percent Females in Labor Force	0.002	−.038	0.115	−.024
Population Density	0.032	0.041	−.010	−.062
Net Migration into Area	−.030	−.012	−.114	−.062
Median Education	0.005	−.028	−.038	−.040
Unemployment Rate	−.041	−.079	−.024	0.051
Government Services	−.200	−.056	−.052	−.009
Expenditures on Education	0.055	0.005	0.104	0.038

indication can be obtained of the effects of these attributes on locational aspects the migration decision.

Table 8 contains a summary of the results of these regressions. Beta coefficie (standardized regression coefficients) are given for two sets of migrant groups (: definitions of populations in the table). We concentrate on the relationship betw age, family size and initial husband-wife wages on various aspects of locatio change. By and large, older migrants tend to exhibit *smaller* changes in locatio characteristics. Thus, as is predicted, even for movers, the extent of migrati diminishes with age. Other family characteristics have different effects. Fam size is correlated with moves to areas with higher per capita expenditures education, lower levels of unemployment, areas of lower population density, a areas with greater amounts of women in the labor force. Families with husba receiving high wages tend toward areas with fewer women in the labor force, wh families in which the wife has a high wage tend toward areas with higl opportunities for women (*i.e.*, higher percentages of women in the labor force a lower unemployment rates).

The purpose of this exercise is not to discuss each correlation, but rather illustrate that the decision to move is more complex than the simple dichotomo decision to move or not. While it is obviosuly easier to measure whether or r moves take place, we believe that we have illustrated that the nature of moves : also important. Locational changes measured in terms of locational characteristi vary according to family attributes. We believe that such decisions are made addition to the simple migration decision. If such is the case, locational attribu are important in governing the migration process and hopefully can be used identify optimal sorting of migrants to particular locations.

IV. SUMMARY AND CONCLUSIONS

Analysis of migratory behavior has long been the concern of many soci scientists. Economists have a special interest in migration because populati flows are at least theoretically related to market phenomena. On the one hand, n migration seems to shift the supply of labor, thereby affecting wages; on the oth hand, existing spatial differences in wages are catalytic in stimulating migratio By and large, it is this latter problem which most have considered. In fact, ma studies exist concerning the identification of pecuniary and nonpecuniary facto influencing migrant behavior. Such studies of migrant selectivity are diverse, a multiple factors have been singled out as correlated with the migration process. F example, migrants tend to be younger, more educated, in lower income bracket and to have families with fewer school-age children, and wives in less profession occupations.

Given the wide variation of such characteristics identifying migrant attribute no one theory exists to explain each factor governing migrant selectivity. Instead, numerous theories exist, each concentrating on narrow aspects of the problem. Of these, the Sjaastad model is most general. Migration is treated as an investment. In any time period, if the present value of the gains of migration exceed the costs, then migration occurs. To the extent that such factors as age, education and price levels affect costs and benefits, then these factors affect individual decisions to move. Given distributions of such attributes within the population, inferences can be made concerning aggregate migration probabilities.

As general as is the Sjaastad model, many aspects of migration selectivity do not fit directly within such a framework. This paper can be viewed as laying the groundwork for a more general model (in which the Sjaastad framework is a subcase) so as to incorporate many factors of migrant selectivity not currently explained into a unified theory of migration. By viewing the mobility process within a life cycle framework, we propose a means of analysis of several such factors. In particular, locational choice, periodicity of migration and the impact of household characteristics are considered within such a generalized framework.

Location is introduced by assuming the existence of a one-to-one mapping relating physical (locational) characteristics to a particular geographical area. Thus location is viewed as a hedonic index determined by the inverse mapping of the optimal locational characteristics obtained from maximizing a lifetime utility function. By making the utility function sufficiently general, we obtain implications concerning the household.

More importantly periodicity is explicitly introduced. It is determined that remigration *can* occur *without* exogeneous stochastic changes indigenous in current models. Specifically introducing informational search of wages in each location relative to wages in one's current location (a "perception" function), we obtain implications regarding the periodicity of migration. Even if simplifications are made so as to eliminate the search concept, remigration *remains an endogeneous variable* with a higher probability of occurrence at younger ages of the life cycle process.

Although powerful in principle, several key qualifications are necessary in implementing the model to obtain precise results. Locational characteristics are difficult to define. In fact, even if such characteristics could be defined, the existence of mappings relating them to specific areas would be hard to ascertain. Consequently functional forms are simplified so as to obtain only implications regarding locational attributes. Thus rather than concentrating on location *per se*, most of the analysis deals with mobility in a dichotomous move/not-move framework.

Introducing search (as well as investment in human capital) as a control leads to complex sets of differential equations for which simple solutions do not exist. Further, the solution of such equation systems crucially depends on functional forms as well as initial conditions for which little data is available. Consequently

specific solutions are not obtained, thereby forcing us to rely only on qualitative implications.

Despite these caveats precise empirical implications evolve from the theoretical framework. Rather than go through a detailed estimation of particular life cycle paths, we choose to test certain key implications of the model within a cost-benefit framework. Specifically the probability of migration is analyzed as dependent upon gains and costs of migration computed by means of a simultaneous two-equation model estimated with individual panel data. It is found that expected monetary gains affect migration decisions. A ten-thousand-dollar expected increase in the present value of husband's earnings increases the probability of interstate migration by 6 percent. A one-dollar increase in the present value of expected wages increases the probability of migration by 0.7%. Yet not surprisingly, presumably because of intermittent labor-force participation, expected increases in wife's wages are estimated to have a negligible effect. Further, past migration strongly influences current migration. Those that changed states within the last year have been a 10 and 20 percent greater probability of changing states again within the current year. Family characteristics are also important. Nearby relatives, children in school, wife's occupation and education influence mobility. Less evidence exists that the periodicity of migration increases with age. Contrary to the findings of other studies (based on aggregate data), the effect of head's age and education on the probability of migration (once adjusting for the impact of these variables on expected gains) is statistically insignificant.

We feel that the importance of this paper lies not with the exact parametric estimates that were obtained, but instead with the methodology that was created. Theoretically, a general model of migration was developed incorporating many factors heretofore exogenous in migration models. Specifically, locational choice and household considerations were accounted for; but even more importantly, migration periodicity was analyzed within a nonstochastic framework. Remigration was endogenously explained. Whereas we readily admit that many of our implications are preliminary, we strongly believe that our framework can be used to obtain more precision. Only future work will enable a more detailed equation specification so as to obtain specific and directly estimatable migration time paths.

FOOTNOTES

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1. Long, (March 1973), pp. 37–43.

2. Schwartz, (September/October 1973), p. 1160.
3. Lansing and Mueller (1967), p. 63.
4. This model was first proposed by Zipf (December 1946), pp. 677–686.
5. For example, see the sources listed in Shaw (1975), pp. 81–83.
6. Schwartz, (September/October 1973), p. 1160.
7. Sjaastad (October 1962), p. 84.
8. Greenwood (May 1969), pp. 189–194.
9. Schwartz (September/October 1973), p. 1160.
10. Long (August 1972), pp. 371–382.
11. Akin and Polachek (1975).
12. DaVanzo (December 1972).
13. Kaluzny (August 1975), pp. 269–274.
14. Mincer (January 1976).
15. Sandell, (December 1975), pp. 141–160.
16. Long (March 1974), pp. 342–348.
17. Morrison, (1967), pp. 553–561.
18. Land (May 1969), pp. 133–140.
19. There is some slight inaccuracy introduced in that the yearly totals are for those age 1 and over, while the census five-year figures are for those 5 and over.
20. Sjaastad states: "My goal will be to determine the return to investment rather than to relate rates of migration to income differentials." Sjaastad (October 1972), p. 80.
21. Such an assumption is not as heroic as it may seem. Given the number of characteristics that can be used to describe location, it is highly probable for the intersection of the set of optimal locational characteristics to contain one and only one location. However, even if it is not possible to identify specific locations, the theory applies to identifying locational characteristics that influence the migration decision.
22. More complicated models also consider physical capital investment (*e.g.*, Ben-Zion and Ehrlich, forthcoming) and the effect of riskiness within the investment process (*e.g.*, Levhari and Weiss, December 1974, pp. 950–963).
23. If earnings and utility are monotonic transformations, then the same optimal path is obtained either if utility or earnings is maximized.
24. Ben-Porath (August 1967), pp. 352–365.
25. Heckman (1975), "Estimates of A Human Capital Production Function Embedded in a Life Cycle Model of Labor Supply," pp. 227–258. Haley (forthcoming).
26. Polachek (June 1975), pp. 451–470.
27. Blinder and Weiss (forthcoming).
28. Rosen (Summer 1972), pp. 326–342.
29. Polachek (August 1975).
30. Hanna (1959).
31. Bahr, Meiners and Nakayama (August 1972), pp. 3–8.
32. Oi (December 1962), pp. 538–555.
33. Note that locational characteristics are viewed in a nonstochastic manner. Such characteristics represent long-run locational attributes. Thus, in contrast to other models we need not assume that mobility occurs only upon stochastic changes in earnings power. Thus while recognizing the possible influence of stochastic changes, we view migration in a deterministic fashion. Individuals may move at various stages of their life cycle even when relative locational attributes are viewed in a long-run setting.
34. Similarly information could be defined more broadly to include amenities available in each location. If such is the case, information (I) would enter as an efficiency parameter in the utility function (U).

35. It is assumed that the inequality constraints are not binding.
36. Note we express the functional in undiscounted terms as a simplification. If [W C($\dot{\ell}$)] is multiplied by e^{-rt}, then $\lambda = -e^{-rt}$ and $\lambda = 1/r(1 - e^{-r(T-t)})$ as in the Sjaas case.
37. Equations (5) and (6) become

$$\dot{I} = i^{*} - \beta\dot{\ell} \text{ where } 0 \leq \alpha \leq 1 \text{ and } \beta \geq 0, \text{ and} \quad (\ $$

$$\dot{W} = I\dot{\ell}. \quad (\ $$

In equation (5′) α represents a production parameter converting time spent searching i relative information. The β coefficient represents the absolute loss of relative informati attributed to moving. Equation (6′) implies that the gain in wage rate from moving (increases the greater one's stock of information. Similarly for this specification of (6′), t greater the change in locational characteristics the greater the change wages. This latter effect ($\frac{\partial I}{\partial \dot{\ell}} > 0$) was chosen to simplify the specification. Howev

If lack of *a priori* knowledge of the exact relationship with respect to $\dot{\ell}$ exists, then $\dot{W}$ can redefined. However, our point is that when $\dot{\ell} = 0$, $\dot{W}$ must also equal zero. That knowledge of wage distribution in other areas yields no current monetary benefit unles move takes place ($\dot{\ell} > 0$).
38. A(t) diminishes over time.
39. If we relax the assumption about i* fixed then this would not necessarily be the ca because of the diminishing returns over the life cycle of additional search.
40. Specific solutions can be obtained alternatively by converting differential equati system (20) into a single second order differential equation. By substitution, the solution each time path can be then obtained.
41. In a sense such a specification is comparable to the Sjaastad case. For in the Sjaast model costs and gains are usually defined solely on the basis of individual characteristic
42. Actually λ_2 is decreasing and I is increasing. We assume

$$\frac{d\lambda_2 I}{dt} = \lambda_2 \dot{I} + \dot{I}\lambda_2 > 0$$

during this period. If it is not, then no move would ever occur. Perhaps for some this is t case.
43. Such would be the case if the original function to be optimized were

$$\int_0^T [(1 - i - \alpha(\dot{\ell})] W - C(\dot{\ell})] dt$$

where $\alpha(\dot{\ell}) \equiv$ the indirect time costs of moving.

As W increases then for a given $\alpha(\dot{\ell})$ marginal costs would rise. Such an assumption is akin to nonneutral marginal cost curves in Ben-Porath's model of human capital accumulation.

44. Another interpretation of the Sjaastad model is that all information is lost after the initial move. That is, one moves to the "best" location and thereafter discontinues search. Such a viewpoint can also be interpreted in our framework of the maximization of equation (12) subject to (5') and (6'). In such a case if *all* "relative" information is lost and *no* search (i) is pe[illegible] once-in-a-lifetime move-not move situation would result.

45. N[illegible] April 1974), pp. S200–S218. Becker (November/December 1974), pp. 1063–1093. Polachek (Spring 1975), pp. 205–229.

46. For good examples, see Akin and Polachek (1975); Kaluzny (August 1975), pp. 269–274; Mincer (January 1976).

47. Such a model is akin to assuming additively separable husband and wife utility functions. If interdependencies exist, that is if the husband's wage change is a function of wife's change, or more realistically if wife's wages are a function of those of the husband, then specification becomes more complicated. Similar complications would arise if the costs are also interdependent.

48. By all or nothing decision we mean that C and g are independent of $\dot{\ell}$ and are only functions of individual and family characteristics so that only a deviation of $\dot{\ell}$ from zero is determined.

49. Regressions of the form

$$Y = Z\alpha + \beta(\text{Move/Not Move})$$

where Y represents current income have yielded conflicting results. For example, using moves within the past five years, Masters (1975) finds negative β coefficients. For lifetime migration, he finds positive β's while Gallway (1969) finds higher earnings for regional movers.

50. See Mincer (1976) for a discussion of the impact of migration on family dissolution.

51. We later concentrate on those who moved during the 1971–1972 period. Thus we can obtain wage-growth paths through 1975 as well as information on past migration. Also our later analysis explicitly adjusts for price differences across regions and over time.

52. In terms of the notation developed in the model, note that M is defined to equal one when $\dot{\ell} > 0$ and zero when $\dot{\ell} = 0$.

53. Borjas, (October 1975) essentially finds similar results by applying the segmented earnings function developed by Mincer and Polachek (March/April 1974, pp. S76–S108) to analyze the change in earnings attributed to job mobility.

54. Schmidt presents the formal statistical analysis of the model about to be used here. Schmidt (1976).

55. Note the difference in functional form between equation (26) and equation (26'). Equation (26) measures the difference in changes in earnings between movers and nonmovers solely as the coefficient of a dummy variable representing move behavior. This specification is comparable to that used by Fuchs (May 1971, pp. 9–15) in measuring sex differences in earnings. Such a measure therefore represents mean differences in changes in earnings adjusting for the X characteristics. However, as indicated in Polachek (Spring 1975, pp. 205–229), there may be reason to believe that differences in functional form exist between the two groups. Further, such a specification provides the necessary identification requirements to estimate the system.

56. A negative effect of age could also result if biases or specification error with respect to age exist in equation (26').

57. In this context such hypotheses are similar to that of Tiebout (October 1956, pp. 416–424). However, his model considers the direct relationship between individual preferences and kinds of government expenditures, while our model treats kinds of government expenditures as only one form of locational attributes.

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