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Graves, Philip E. and Linneman, Peter D.

University of Colorado, University of Pennsylvania

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Household Migration: Theoretical and Empirical Results

PHILIP E. GRAVES AND PETER D. LINNEMAN

Economics Department, University of Colorado, and Wharton School, University of Pennsylvania

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A consumption theory of migration is developed which supplements the traditional job search models. Migration, seen as an equilibrating reaction to an initially non-optimal location, is analyzed using standard demand theory. When one groups goods into those that are traded between areas and those that are not (weather, racial discrimination, crime rates, etc.) it is clear that only changing demands for the non-traded goods will result in changing optimal locations (assuming supplies are fixed). Illustrating, an increase in family income might lead to an increased demand for the non-traded good "personal safety." This might result, for example, in the substitution (through migration) of a lower crime suburban neighborhood for a higher crime central city neighborhood.

An empirically testable implication of the model is that the probability of migration should be positively related to changes in the absolute value of those exogenous variables which lead to altered demands for non-traded goods. This and other hypotheses were examined using cross-sectional data in a nonlinear maximum likelihood (probit) regression analysis. The results strongly support the model and its implications.

I. INTRODUCTION

Traditionally migration has been viewed as the response of labor movements which are the result of job search. We suggest that in addition to people moving to take new jobs, families also migrate in order to satisfy changing demands for location-specific goods. In an

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attempt to emphasize this second motivation the job search aspects of migration are not discussed here. Rather a simple model of consumption oriented migration is developed and tested.

In this model locational preferences are the result of some goods which are location specific. For example, only some localities are adjacent to an ocean. New York cannot sell its location on the ocean to say, Tulsa, Oklahoma. Hence location of the Atlantic Ocean is a good which is nontradable between areas. Many other examples of such non-traded goods (between areas) can easily be suggested.

We hypothesize that people demand these non-traded goods in the way they demand clothing, automobiles, etc. The main difference is that demands for non-traded goods can be satisfied only by people locating in an area which supplies the demanded quantity of each non-traded good. Any change in the demanded quantity of any non-traded good can, in a continuous world, be satisfied only by the household moving to a new area which provides the newly demanded quantities of the non-traded goods. Thus we conclude that migration should occur in the presence of changes in the quantities of the non-traded goods demanded.

In Section II a consumption related model of household migration is presented. The third section briefly considers the events which may cause locational preference to change. Empirical tests of hypotheses stemming from the model are presented in Section IV. The paper concludes with Section V which summarizes the model and findings.

II. THE MODEL

We assume that the household maximizes of its lifetime utility.[1] For simplicity we define the household or family unit as the people living in the same residential unit. The family's lifetime utility function, U, can be stated as a function of the utility the family achieves in each of the n years of its lifetime:

$$U = U(u_1, \ldots, u_i, \ldots, u_n), \tag{1}$$

where u_i is the family's utility in year i. For analytical convenience we assume the number of years is exogenously determined. Let utility in any period be a function of the quantities of goods and leisure which the household consumes in that period. Tolley (1974) has suggested that there are two broad categories of goods. The first is composed of those which are traded between areas and hence are not specific to particular locations. We refer to all such goods as traded goods, X_i. The

[1] Willis (1973) and Becker (1974) have argued that the household's maximation process may be described by a single utility function.

second category of goods is those which are location specific. We refer to them as non-traded goods, A_i.[2] Each point in global space has a set of non-traded goods associated with it (not necessarily unique). Non-traded goods are purchased by residing in a given area. Thus we can write the household's utility function in year i as:

$$u_i = u(X_i, A_i, L_i; B_i),^3 \tag{2}$$

where X_i and A_i are the traded and non-traded goods consumed in the ith year, L_i is the amount of leisure consumed in year i and B_i is a vector of taste and/or consumption efficiency shifters for year i.

The household also produces movements between residential locations, M_i, i.e., the act of migrating. Migration is a dichotomous variable which takes the value of one if the family moves and zero otherwise. Since moving involves diverting one's time from work and/or leisure the full cost of migrating in the ith year, π_{iM}, is a function of the value of the family's time as well as the monetary cost of moving,

$$\pi_{iM} = \pi_M(P_{iM}, w_i; B_i), \tag{3}$$

where P_{iM} is the monetary cost of moving in year i, w_i is the family's value of time in year i, and B_i is as previously defined. An example of B_i would be the psychic costs of movement emphasized in the migration literature.

The family's utility maximization is constrained by an expected time constraint as well as an expected money income constraint. If we assume that the household is never at a corner solution with respect to the time it supplies to the labor market, and that the value of the household's time is the market wage rate, these two constraints may be combined into a single expected full income constraint (see Michael and Becker (1973)):

$$S \equiv \sum_{i=1}^{n} T_i w_i R_i + \sum_{i=1}^{n} V_i R_i = \sum_{i=1}^{n} (w_i L_i + P_{iX} X_i + P_{iA} A_i) R_i + \sum_{i=1}^{n} \pi_{iM} M_i R_i, \tag{4}$$

[2] Which goods are traded or non-traded will to some extent depend on the society's level of technology. This is because goods will be traded between areas as long as the benefits exceed the costs of trade. The costs of trade will, in general, be negatively related to technology. Thus, as technology improves relatively fewer goods will be categorized as non-traded goods. This must be remembered if one attempts to apply this model to time series data.

[3] For simplicity the text of this paper treats all variables as scalars. A more appropriate interpretation is to view all variables in the paper as vectors (i.e. A_i could be a vector of non-traded goods).

where S is defined as the family's lifetime expected full income, T_i is the total amount of time available to the family in year i, w_i is the household's expected wage rate in the ith year, $R_i \equiv P_i^{-1}(1 + r_i)^{-i}$ is the family's real discount factor for year i when r_i is the marginal rate of time preference in i, and P_i is the appropriate price index for year i, V_i is non-labor income, P_{iX} is the expected relative price of the market consumption good (X_i) in year i, and P_{iA} is the expected relative price to the non-traded good.[4]

The first order conditions of the system may be expressed as

$$\frac{\partial U}{\partial u_i}\frac{\partial u_i}{\partial L_i} = \lambda w_i R_i, \tag{5a}$$

$$\frac{\partial U}{\partial u_i}\frac{\partial u_i}{\partial X_i} = \lambda P_{iX} R_i, \tag{5b}$$

$$\frac{\partial U}{\partial u_i}\frac{\partial u_i}{\partial A_i} = \lambda P_{iA} R_i, \tag{5c}$$

$$\sum_{i=1}^{n} \frac{\partial U}{\partial u_i}\frac{\partial u_i}{\partial A_i}\frac{\partial A_i}{\partial M_i} = \lambda \pi_{iM} R_i, \tag{5d}$$

where λ is the marginal utility of expected full income (assumed to be invariant over time) and $i = 1, \ldots, n$. The first three first order conditions (5a, 5b, and 5c) state the usual conditions that the monetary equivalent of the marginal utility of leisure (L_i), traded good (X_i), and the non-traded good (A_i) must be equal to the discounted present value of their respective marginal costs (w_iR_i, $P_{iX}R_i$, and $P_{iA}R_i$ respectively). The first order condition with respect to migration states that the discounted value of the expected cost of migrating in period i is equal to the monetary equivalent of the gain in utility obtained by migrating. The gains from migration are the value of the increased amounts of the non-traded good which can be consumed over all future periods as a result of the family's moving to a new location. These gains to moving are the result of changes in the system's exogenous variables offering different potential utility levels to the family depending on where they locate. We turn now to the analysis of how the system's exogenous variables determine where people decide to live.

The first order conditions can be used to solve for the respective demand functions. Since leisure and traded good consumption are

[4] This price may be unobservable in the market. Hence prices we are discussing are the coefficients which would emerge from a properly specified hedonic land price index (see Rosen (1974)).

mobile between areas their demand functions are not of interest to the analysis of migration.[5] The demand function for the non-traded good is the essence of the migration phenomenon. This follows from any change in the quantity of the non-traded good demanded being satisfied, by definition, only by the household changing its location to a new area. The demand function for the non-traded good can be stated in general form as:

$$A_i^d = f(\{w_iR_i\}, \{P_{iX}R_i\}, \{P_{iA}R_i\}, \{T_i\}, \{V_iR_i\}, \{B_i\}, n) \quad (6)$$

for $i = 1, \ldots, n$ and where $\{\ \}$ is read "the set of all values of the bracketed term." This equation reveals the quantity of the non-traded good demanded for given values of the exogenous variables.

In equilibrium the quantity of the non-traded good demanded must equal the quantity supplied. Recall that the quantity of the non-traded good supplied is location specific. This means that each location supplies a certain quantity, not necessarily unique, of the non-traded good. We assume that there is a continuum across locations of the quantity of the non-traded good supplied.

Let the supply function of the non-traded good, A_i, be expressed as

$$A_i^s = g(H_i), \quad (7)$$

where H_i is a vector of supply parameters for A_i which varies over global locations.[6] Thus equilibrium in the non-traded good market may be stated algebraically as:

$$A_i^d = A_i^s \quad (8)$$

$$f(\cdot) = g(H_i), \quad (8')$$

where $f(\cdot)$ is the right hand side of (6). The first order condition of the migration decision of year i, M_i, tells us that it is changes in the quantity of the non-traded good, A_i, consumed by the family which cause the household to migrate. However, since the leisure and traded goods inputs are mobile between locations, migration only occurs as the result of a change in the quantity demanded by the household of the non-traded good and/or as the result of a change in the quantity

[5] This does not mean that the quantities demanded of traded goods and leisure are invariant with respect to the migration decision but rather that changes in the quantity demanded of these mobile utility sources may be satisfied without the household changing its location. The presence of "semi-traded goods" (goods traded across cities having very large transport costs) modifies the analysis in that such partially non-tradable goods may also affect migration. For notational simplicity these semi-traded goods are to be considered non-traded in the text discussion.

[6] The employment opportunities in the area for any level and type of human capital may be viewed as a non-traded good with a negative price.

supplied of the non-traded good at the household's current location. In either case the family no longer consumes its optimal quantity of the non-traded good. In the absence of moving costs the household always chooses the location which offers the exact quantity of the non-traded good it demands. Any change in the quantity of the non-traded good supplied to or demanded by the family can be satisfied only by the family's moving to a new location which offers the newly optimal quantity of the non-traded good.

The equilibrium condition (8) for the non-traded good market stated in its elasticity form gives:

$$d \ln A_i^d = d \ln A_i, \quad \text{or alternatively} \tag{9}$$

$$N_w d \ln \{w_i R_i\} + N_{pX} d \ln \{P_{iX} R\} + N_{pA} d \ln \{P_{iA} R_i\} + N_T d \ln \{T_i\} + N_V d \ln \{V_i R_i\} + N_B d \ln \{B_i\} + N_n d \ln n = \epsilon_H d \ln H_i, \tag{9'}$$

where ln indicates the natural logarithm, N_q is the vector of partial elasticities of the demand for A_i with respect to the independent variable $\{q\}$, with an elasticity element corresponding to each of the periods contained in $\{q\}$, and ϵ_H is the vector of supply elasticities of A_i^s with respect to H_i.

We have already seen that a family tends to migrate as the result of divergences between desired and actual quantities of non-traded goods. Divergence may be due to either supply or demand shifts. Furthermore, this tendency to migrate is the same whether the shifts in supply or demand are positive or negative.[7] Thus we may write the family's derived demand for migration in year i as:

$$M_i = h(|\{d \ln A_i^d\}|, |\{d \ln A_i^s\}|, \pi_{iM} R_i) \tag{10}$$

or using (3) and (9′)

$$M_i = m(|d \ln \{w_i R_i\}|, |d \ln \{P_{iX} R_i\}|, |d \ln \{P_{iA} R_i\}|, |d \ln \{V_i R_i\}|, |d \ln \{T_i\}|, |d \ln \{B_i\}|, |d \ln n|, |d \ln H_i|, w_i R_i, P_{iM} R_i, B_i, n). \tag{10'}$$

where M_i takes either the value zero (the family does not move in period i) or one (the family migrates in period i). These migration equations simply state that the family's decision of whether or not to move in year i is a function of the absolute value of the change in the quantities of the non-traded good demanded, the absolute value

[7] This does not mean that the family will tend to migrate to the same particular location as the result of either a positive or negative shift but rather that its tendency to move is related to the absolute value of the shift.

of change in the quantities of non-traded good supplied and the full cost of moving.[8]

The partial derivative of the probability of migration with respect to all of the absolute value of the change terms is expected to be positive. This is the case as a change in any of these independent variables leads to a change in either the quantities of non-traded good demanded or supplied. As discussed earlier any such changes tend to cause the family to move as it attempts to equilibrate the supply and demand for the non-traded good. Thus the probability of the household migrating in the year i is positively related to the absolute value of all of these change variables.

The full price of migration, π_{iM}, is negatively related to the likelihood of a household's decision to migrate. This is because, for a given benefit stream, the higher is the full cost of moving the more likely it is that the costs of moving will exceed the benefit stream from moving. Since the household migrates only if the benefits stream is greater than or equal to its full cost, the full price of moving is negatively related to the probability of household migration. Since the full cost of migration is a positive function of $P_{iM}R_i$ and w_iR_i, these variables will also be negatively related to the probability of migration.

An increase in the number of remaining periods, n, will increase the probability of migration as for a given benefit per period and full cost of migrating a larger life horizon implies the benefits are summed over a large number of periods. The effects of the taste and/or consumption efficiency variables (the vector B_i) depends upon whether these variables increase or reduce the full relative cost of migration.

A digression is perhaps in order at this point on the nature of the equilibrating mechanism in the "migration market." In equilibrium the utility levels obtained by identical families from living in any two places must be equal. Otherwise movement from the area yielding the lower level of satisfaction to the more preferred area will take place. Thus, for families in the same group, those living in areas having low

[8] The cost of moving in the year i, π_{iM} will in general consist of a fixed component as well as variable costs. The presence of fixed costs helps explain why people do not respond to infinitesimal changes in quantities demanded and supplied with infinitesimal moves. Infinitesimal moves will also not occur if the movement opportunity set is non-continuous (see footnote 10 below). In either case the qualitative results remain uneffected.

For simplicity we have assumed the functional form of Eq. (3) to be the same for all potential sites. This assumption allows separation of the decisions of whether and where to migrate. As pointed out by an anonymous referee, failure to account for the "where" in the model is unfortunate, but consideration of the where decision is beyond the scope of the present paper.

levels of the non-traded good must receive off-setting compensation to achieve the required locational indifference.

We shall refer to this off-setting compensation as "a compensating differential." They may take one of the two forms: higher expected income levels or lower rental prices.

This concept leads to a better understanding of how changes in the exogenous variables of our model work themselves out in the market. By way of illustration, let the non-traded good, A_i, be "unpolluted air." Further, if we assume A_i is a normal good, we expect an increase in the quantity of A_i demanded as income rises. Thus, rising incomes over time would, ceteris paribus, lead to movement toward less-polluted areas, say the suburbs. But not all families will move even if they are identical as a result of the rising income. This is because the relative price (compensating differential) begins changing as the migration to the suburbs ensues. That is, as families begin moving suburban rental prices rise and center city incomes will experience a relative increase until indifference again holds. Hence, at the new relative price of the non-traded good (reflecting a revised equilibrium compensating differential) many families continue to live in the city.

It becomes apparent then that we cannot say, even ignoring moving costs, that all households will move due to exogenous changes which shift their demands for the non-traded good. Nor can we say among similar families which will move. However, for equilibrium to be re-established some movement must occur. The migration will continue until identical families are spatially indifferent at the final non-traded good relative price. If such movement cannot make the utility levels the same for a particular family cohort the low-level area will lose all of its inhabitants of that group. Should this condition hold for all family cohorts, the area will become completely depopulated, one explanation for the "ghost town" phenomenon.

In what follows we will, following standard partial equilibrium analysis, assume that families are price taking agents. The preceding discussion is intended to clarify the broader view of migration inherent in our model.

The migration decision for any individual household is portrayed graphically in Figs. 1 and 2. In Fig. 1 we present the case where the full cost of migration is the same for all new locations. We have indifference curves U_0, U_1 and U_2 which represent the trade off between A_i and the present value of all other expenditures. The original budget constraint is S_0. Each point on this budget constraint represents a different location. The constraint as shown is non-linear which represents the fact that the relative price of the non-traded good may vary among locations due to the presence of compensating differentials. The family

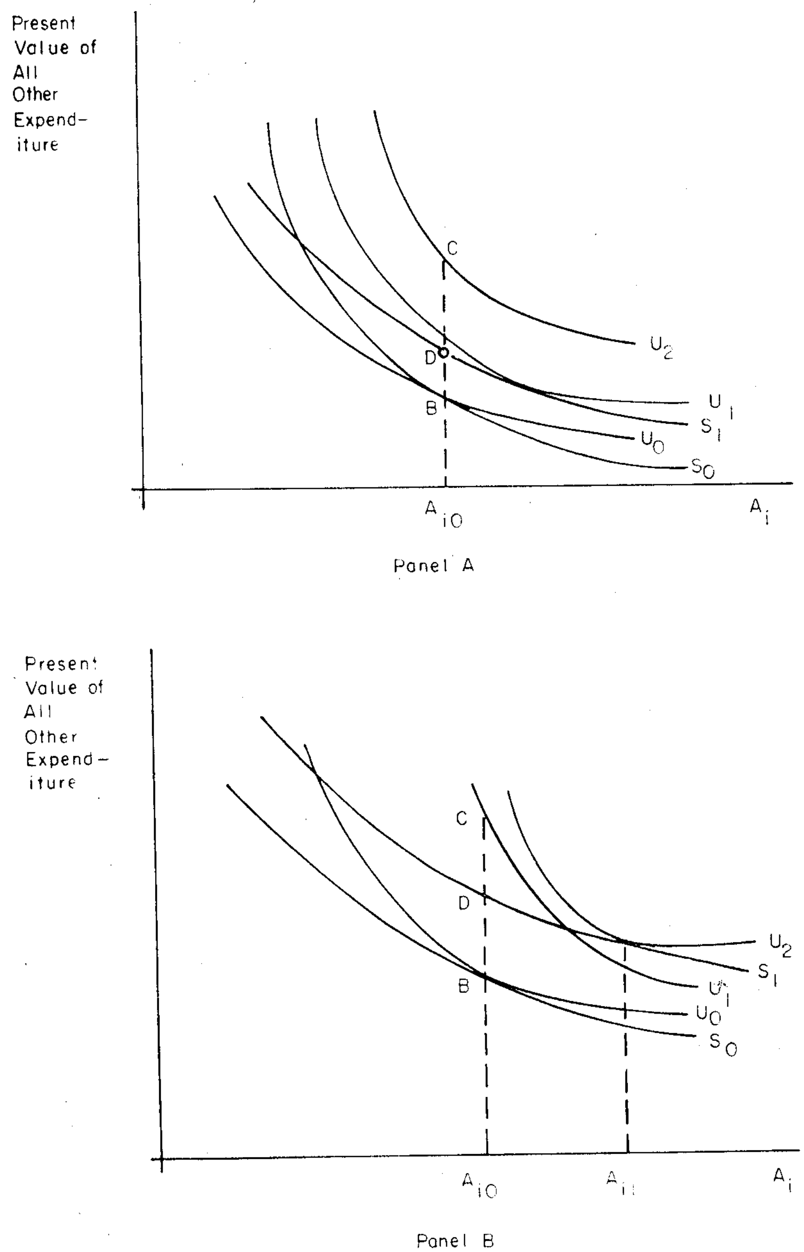

FIG. 1. Graphical exposition of the migration model when movement costs are independent of the change in the amount of the nontraded good.

is initially in equilibrium at point B which is associated with consuming A_{i0} of the non-traded good (and resides at the location implied by $A_i = A_{i0}$). Now assume that due to an increase in the demand for this family's human capital (at all potential residence sites) the entire budget constraint shifts upwards by an amount equal to BC.[9]

[9] In both figures the changes in potential income as well as the full costs of migration are shown as extremely large in an attempt to keep the figures uncluttered.

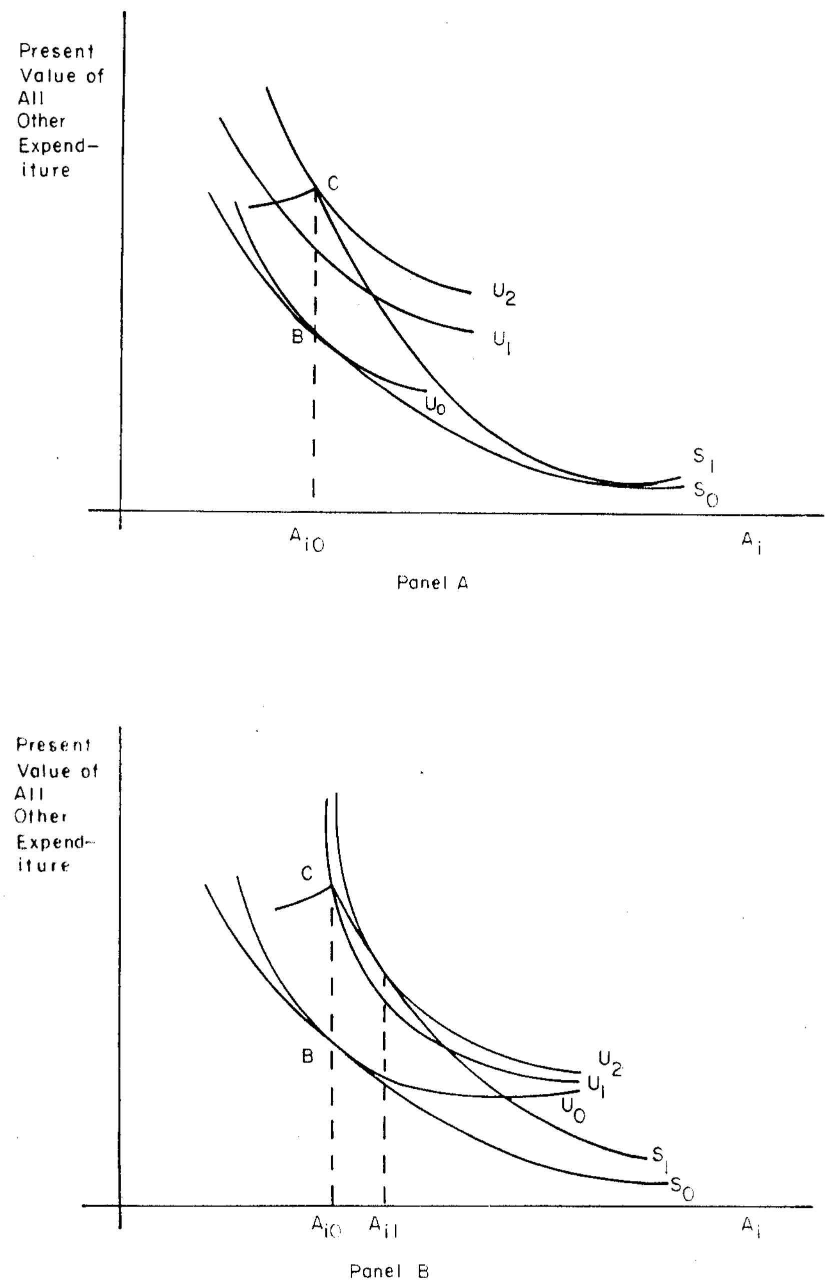

FIG. 2. Cost of migration depending on size of change in the nontraded good.

However, the household can realize only part of this higher income if they move as part of their resources must be used to produce the move. Thus the relevant budget constraint is the new potential income at each site minus the migration costs associated with moving to that site. The migration costs are assumed to be invariant with respect to where the family moves and equal to DC. Therefore, the new effective budget constraint is given by the curve S_1 and the single point B (as no migration costs are incurred if they remain at the same location). In Panel A we can see the case where, due to the shape of the indifference map, the family achieves its highest utility level, U_2, by remaining at the same location given a migration cost of DC and a potential income change of BC. Panel B shows the opposite case, i.e., by moving to a location which supplies $A_i^s = A_{i1}$ of the non-traded good the family achieves utility level U_2 (versus U_1 if it does not migrate).

In Fig. 2 we present an analysis similar to Fig. 1 except that now the full cost of migration is assumed to vary directly with the amount by which A_i differs from the initial quantity A_{i0}. In this case the new effective budget constraint is continuous and is represented simply by S_1. Once again Panel A shows the case where the family achieves its maximum utility by staying at the same location whereas Panel B shows the case where the family will migrate to an area supplying $A_i^s = A_{i1}$ of the non-traded good.[10]

III. THE COMPARATIVE STATICS OF MIGRATION

Equation (10) describes the family's derived demand for migration in the ith year as a function of changes in the quantities of the non-traded good demanded and supplied as well as the full price of migrating.

[10] Throughout the exposition of the model it has been assumed that there is a single non-traded good. If we introduce more than one non-traded good nothing is changed so long as we assume the supply functions are independent and that there is complete divisibility. In this case we have people locating at the location which supplies the desired bundle of location-specific goods.

Suppose, however, that a particular non-traded good cannot be continuously varied. In this case consumer reactions are similar to those of families in standard goods markets when indivisibilities are present. That is, more or less than the unrestricted optimal quantity may be consumed in equilibrium. In our application, the sub-optimal bundle of traded and non-traded goods which yields the higher level of utility determines where the household locates.

The joint supply case is slightly more complicated. By joint supply we mean that although any particular non-traded good may be perfectly divisible over locations, the bundle of traits may not be repackageable (i.e., one could not find a location which has say a mean temperature of 75°F and 50 inches of annual snowfall).

In general, one would expect less movement would occur than under the assumption that all conceivable combinations of non-traded goods are available at one or more locations. This is because the new set of non-traded good demands (caused by a change in one or more of the exogenous variables) may not be exercised (for any given migration costs) since the set of locations supplying the desired bundle may, in fact, be empty. Hence less migration will occur as one's opportunity set has been reduced.

It is of note, however, that qualitatively very little is altered. Just as discontinuities imply that individual demanders may not alter the quantity of particular goods consumed in the face of small changes in the exogenous variables, so here not every family in a given group will migrate due to small exogenous changes. But the probability that any random family will migrate will still increase in the presence of exogenous changes such as family composition change, income change, and so on. Hence qualitative effects will be the same.

Intuitively, the quantity demanded of any non-traded good changes over time as the result of three effects. The first source of change in the quantity demanded of a non-traded good relates to the household's life cycle.[11] A life cycle effect on the demand for a non-traded good is defined in this paper as a change in demand due to a perfectly forecast (expected) change in an independent variable. By way of illustration, the real wage rate typically rises over one's lifetime until about age 50. As the real wage rate is rising the value of one's time also rises. Since this increases the cost of leisure it will tend to cause the demand for the non-traded good to follow the same type of profile as the wage rate. This may sufficiently change the quantity of the non-traded good demanded to cause the family to migrate. Note that this effect occurs even when the expected and actual values of all exogenous variables are equal. This life cycle effect demonstrates how a family might plan several moves during its lifetime even if all events take their expected course. In fact, the life cycle effect makes it intuitively clear that the family is quite likely to move as the result of important (and fully expected) events which occur throughout a family's lifetime. This helps explain why researchers have observed the probability of a household's migrating is positively related with events such as job promotions, a child's graduation from high school and college, the birth of children, retirement, and so on. All of these events could cause sufficiently large changes in the demand for the non-traded good to cause the family to decide to relocate.

A second reason the demand for the non-traded good may change over time is that the value of an independent variable may change in an unexpected manner for reasons essentially internal to the family. For example, the household may unexpectedly: inherit an estate, have a child die, get a divorce, etc.[12] Any deviation of the actual from the expected value of an independent variable may cause a sufficiently large change in the quantity of the non-traded good demanded to cause the household to migrate to a new location. This change is the result of the direct effect of the change in the variable as well as the indirect effect of possible changing future expected values.

The third source of change in the demand for the non-traded good results from unexpected changes in the values of exogenous variables

[11] See Ghez and Becker (1975) for an analysis of life cycle consumption. Since our main concern in this paper is migration and not the derived demand for non-traded goods per se, and because it is the absolute value of the change in the derived demand for non-traded goods which affects migration we will eschew a discussion of the comparative statics of the derived demand for non-traded goods.

[12] Of course, these events could occur in a completely expected manner. In that case they would exert only a life cycle effect.

which are external to the family, i.e., they are the result of changes in market valuations. Again the unexpected change exerts both a direct effect and an indirect effect via its effect on future expectations. An unexpected reduction in prejudice, for example, will tend to increase the real wage rates of minorities. This will cause the quantity of the non-traded good demanded by minority families to change. A sufficiently large change would cause the family to migrate to a new location (e.g., Black migration to the North since the Civil War; movements to avoid religious persecution).

In a similar fashion the changes in the quantity of the non-traded good supplied may be either expected or unanticipated.[13] As with demand, changes in supply may cause a family to move when all changes are perfectly anticipated. For example, a family may choose a location now for its school quality but correctly anticipates that 15 years from now the school quality in that area will be significantly lower. But the family may decide to live in the area until their children have completed their schooling and then move to another area. In general, however, since migration is a costly activity it seems that the family would attempt to choose its location such that the expected changes in its demand for the non-traded good is appropriately synchronized with the expected changes in its supply. For example, the family moves into a new development with low school quality when its children are pre-school age expecting that school quality will rise over time so as to meet the family's rising demand for school quality.

The more important supply induced cause of migration will be the unexpected changes in supply of the non-traded good. Given the current state of racial prejudice, this would seem to explain the flight of white from deteriorating neighborhoods as blacks move into these areas. More specifically, if we treat interaction with blacks as a non-traded good, as blacks move into these neighborhoods sooner than the white residents expected, the supply and demand for this non-traded good are no longer equal. The equilibrium will be restored only after the out migration of some whites from the neighborhood. Hence the greater are the unexpected changes in the supplies of the non-traded goods, the greater is the probability of migration.

We now turn our attention to an empirical examination of this model of household migration.

[13] There are two general types of changes in the supply of the non-traded good. First, other areas may change the quantity of the non-traded good they supply. Alternatively the family's own area may change its quantity supplied while other areas maintain their quantities. In both cases the relative attractiveness of the current site is altered.

IV. EMPIRICAL RESULTS

The data employed in this section are a one-quarter independent sample of observations from *A Five-Year Panel Study of Income Dynamics*. See Morgan (1975) for a discussion of this data source.

The variables affecting the probability of migration in the model presented earlier may be classified into three groups: (1) variables which reflect the presence of market discrimination; (2) those non-traded good demand shifters discussed in the previous section; and (3) those variables which affect migration costs.[14] The specific variables falling into each of these groups are shown in Table 1 along with their descriptions, means, standard deviations, and expected qualitative migration impacts.[15] Each of these variables is defined for two migration periods: 1970–1971 and 1971–1972. Comparing the results for these two periods provides an insight regarding the robustness of the coefficients.

Table 2 presents results employing non-linear maximum likelihood regression analysis which indicate the overall consistency of the hypotheses suggested by the model with observed behavior. In this table three probit regression (see Finney (1971)) are presented for each year with independent variables grouped as in Table 1.

Sex and race of head were included in the regressions of Table 2 with the expectation that they would capture the effects of discrimination on locational opportunities. Specifically if blacks and female headed families are discriminated against in the non-traded good market these families will have smaller opportunity sets than otherwise identical families. Hence, for given costs and demand shifts these families will be less likely to move. The size, significance and consistency between years of the sex of head coefficient was rather surprising in view of the large number of controls, while the race variable was inexplicably dissimilar in its impacts comparing (1) and (2) to (3) and (4) in Table 2.

Turning to the demand variables age is to be interpreted as a "benefit shifter." By this we mean that if, for example, a change in income leads to a new optimal quantity of the non-traded good, movement to the location providing it is more likely to occur the more periods remaining in which to enjoy the utility gain attributable to the movement. Thus the discounted benefits of moving in the face of an exogenous change will be lower for one having fewer periods remaining.

[14] Supply shifters (e.g., school deterioration) are not considered here due to lack of appropriate data although such shifters may also lead to locational disequilibrium as discussed earlier.

[15] Multicollinearity was not a major problem in the analysis. Simple correlations are available upon request for all variables used in the analysis.

TABLE 1

Variable Definitions, Means, Standard Deviations and Expected Direction of Impact on the Probability of Migration (PROBMIG). (The first number for each variable refers to 1970–71, the second refers to 1971–72, except as noted).

Variable name	Mean	Std. Dev.	Description and expected effect on PROBMIG
PROBMIG	0.2486 0.2693	0.4323 0.4437	Dummy dependent variable (=1 if a move occurred during the year; 0 otherwise).
RACEHEAD	0.3886 0.3886	0.4876 0.4876	Dummy variable (=1 if non-white; 0 otherwise (−).
SEXHEAD	0.2757 0.2879	0.4470 0.4529	Dummy variable (=1 if female-headed; 0 otherwise) (−).
AGEHEAD	43.37 43.09	14.81 15.54	Actual age in years (−).
FAMCOMPd	0.3071* 0.2957 0.2971	0.4615* 0.4565 0.4990	Dummy variable (=1 if a change in family composition occurred; 0 otherwise) (+). *'d numbers are for the period 1969–70.
FAMINCd	2.417* 2.528 2.486	3.178* 3.316 3.675	Absolute value of the change in price-deflated income between years, *in thousands*. (+).
HOURSILLd	99.58 103.2	268.9 251.4	Absolute value of the change in annual hours of illness between years (+).
HRSUNEMPd	101.7 110.2	285.9 289.4	Absolute value of the change in annual hours of unemployment between years (+).
HEADEDUCd	0.1071 0.1514	0.5426 0.6899	Change in head's education (=1 if in a different education bracket between years) (+).
HEADWAGEd	1.076 1.182	3.940 4.238	Absolute value of change in price-deflated wage between years (+).
NOSCHOLKID	0.4557 0.5036	0.4982 0.5002	Dummy variable (=1 if head does *not* have children in school; 0 otherwise) (+).
JOBTENURE	2.704 2.616	2.122 2.145	Bracketed, with higher numbers indicating longer job tenure (−).
GOCHURCH	1.601 1.613	1.218 1.223	Bracketed, with higher numbers indicating more frequent church attendance (−).
NUMSTATES	2.196 2.248	1.465 1.595	Actual number of states head has lived in (+).
EDUCHEAD	3.509 3.561	1.971 1.971	Bracketed years of education, with higher numbers indicating more education (+).
WAGEHEAD	3.039 3.072	4.543 3.125	Actual dollar amount of hourly wages (?).
MARITALSTAT	0.6621 0.6500	0.4731 0.4771	Dummy variable (=1 if married; 0 otherwise) (−).

TABLE II

Probability of Migration (PROBMIG) probit regressions.
Standard errors beneath respective coefficients.

Independent variables	1970–71 (1)	1970–71 (2)	1970–71 (3)	1971–72 (4)	1971–72 (5)	1971–72 (6)
Constant	1.3682	1.3713	0.79055	1.9262	1.9252	0.96896
	(0.3158)	(0.3146)	(0.2428)	(0.3129)	(0.3128)	(0.2312)
RACEHEAD	0.07374	0.07380		−0.26436	−0.26379	
	(0.1133)	(0.1133)		(0.1087)	(0.1086)	
SEXHEAD	−0.72997	−0.73137		−0.82204	−0.82210	
	(0.1975)	(0.1971)		(0.1962)	(0.1962)	
AGEHEAD	−0.03711	−0.03713	−0.03779	−0.04312	−0.04314	−0.04271
	(0.0038)	(0.0038)	(0.0037)	(0.0037)	(0.0037)	(0.0037)
FAMCOMPd	0.58850	0.58856	0.59630	0.33793	0.33816	0.31403
	(0.1070)	(0.1070)	(0.1054)	(0.1027)	(0.1027)	(0.1002)
FAMCOMPdlag	−0.04086	−0.04124	−0.04918	0.04615	0.04612	0.03748
	(0.1072)	(0.1072)	(0.1058)	(0.1019)	(0.1019)	(0.1000)
FAMINCd	0.03808	0.03881	0.04053	0.03373	0.03348	0.03641
	(0.0182)	(0.0168)	(0.0168)	(0.0184)	(0.0182)	(0.0177)
FAMINCdlag	−0.02435	−0.02428	−0.02554	0.00740	0.00745	0.01025
	(0.0160)	(0.0160)	(0.0160)	(0.0158)	(0.0158)	(0.0154)
HOURSILLd	0.00044	0.00044	0.00051	0.00020	0.00020	0.00015
	(0.00020)	(0.00020)	(0.00020)	(0.00018)	(0.00018)	(0.00017)
HRSUNEMPd	0.00015	0.00015	0.00015	0.00022	0.00022	0.00015
	(0.00015)	(0.00015)	(0.00015)	(0.00016)	(0.00016)	(0.00016)
HEADEDUCd	0.18228	0.18312	0.16319	0.33529	0.33478	0.30877
	(0.1008)	(0.1005)	(0.0997)	(0.1155)	(0.1153)	(0.1160)
HEADWAGEd	0.00433			−0.00142		
	(0.0406)			(0.0153)		
NOSCHOLKID	0.30404	0.30381	0.37275	0.14221	0.14258	0.28472
	(0.1053)	(0.1053)	(0.1004)	(0.0988)	(0.0987)	(0.0930)
JOBTENURE	−0.14270	−0.14323	−0.14350	−0.10243	−0.10219	−0.09592
	(0.0294)	(0.0290)	(0.0283)	(0.0272)	(0.0271)	(0.0263)
GOCHURCH	−0.08373	−0.08386	−0.08065	0.02778	0.02790	0.00555
	(0.0403)	(0.0403)	(0.0393)	(0.0383)	(0.0383)	(0.0374)
NUMSTATES	0.10248	0.10255	0.10193	0.09603	0.09615	0.11586
	(0.0430)	(0.0430)	(0.0421)	(0.0390)	(0.0389)	(0.0381)
EDUCHEAD	0.02303	0.02309	0.00727	−0.05837	−0.05836	−0.05264
	(0.0315)	(0.0315)	(0.0303)	(0.0303)	(0.0303)	(0.0288)
WAGEHEAD	−0.05708	−0.05646	−0.05700	−0.05784	−0.05809	−0.04060
	(0.0284)	(0.0278)	(0.0270)	(0.0257)	(0.0256)	(0.0233)
MARITALSTAT	−0.69801	−0.69857		−0.68212	−0.68232	
	(0.1839)	(0.1839)		(0.1841)	(0.1841)	

Hence we expect, and observe in Table 2, a strong negative effect of increasing age on the probability of migration.

As was expected unlagged family composition change leads to a higher probability of migration. This is because the changes in family size which result from divorce, marriage, children being born, or their leaving home would lead to revised demands for housing services, which in general are exercised by moving.[16] The coefficient on 1-year lagged family composition change is small and not significant. Table 2 also reveals that an increase in the formal educational achievement of the family's head increases the probability of the family's moving.[17] Formal education is viewed as an element of the vector B_i.

The unlagged absolute value of the change in family income exerts the expected positive effect on migration. Since this variable is particularly prone to alternative interpretations a digression is in order. The emphasis of this paper has been on the fact that as real incomes change the demand for the non-traded good changes which causes the family to move in order to exercise its new optimal demand. An alternative interpretation reverses the direction of causation, i.e., the family moves in order to obtain a higher income. In the presence of costly information there will be an equilibrium amount of search per period hence an equilibrium amount of arbitrage opportunities per period available by searching for higher incomes or other location-specific improvements. This latter interpretation has received greater attention in the literature. The interpretation suggested in this paper supplements the usual search interpretation in the following manner. If preference functions are similar over all individuals then in a world of zero information costs the income differentials which exist between locations serve as compensation for differential quantities of the non-traded good (or bad). In such a world income differentials would provide no incentive for migration since in equilibrium like individuals would achieve the same utility everywhere. In such a case the interpretation of the income change coefficient suggested here seems appropriate. One advantage of our interpretation is that it suggests that families will move as the result of either a rise or fall in income while the search interpretation would have migration occurring only in the presence of rises in income. Our work indicates that families move as the result of both rises and falls in income. Clearly both processes are going on since information costs are in the real world non-zero.

Changes in the absolute value of annual hours of illness does appear to be significant in 1970–71 migration but not for the period 1971–72

[16] One would suspect that divorce would lead to much larger changes in the probability of moving than would a child leaving home. The latter family composition change occurs much more frequently in the data. The effects of the different types of family composition changes were not separated due to convergence problems in the probit analysis. Furthermore, we were unable to distinguish between the types of changes discussed in Section III (e.g., life cycle versus anticipated).

[17] The education change variable would have likely worked better had it been available as actual years of education rather than the bracketed coding.

(even with the appropriate one-tailed test[18]). The change in the absolute value of head's annual hours of unemployment was also of the correct sign but not significant. These variables were included to reflect both life-cycle and unanticipated changes in the family's health (hence its expected life span and permanent income) and in the market conditions for the head's skills respectively (hence permanent income).[19]

Holding absolute family income change constant the absolute value of wage changes appeared not to significantly affect the probability of migration.

The impacts of migration cost variables on the probability of migration were in the main as expected. That is, those variables which were *a priori* viewed as affecting the cost of movement: the presence of children in school, job tenure, previous moving experience, and wage levels, altered the probability of migration significantly and in the expected direction. The head's wage level is found to be negatively related to the probability of migration. This suggests that migration is quite own-time intensive. As was expected, families in which the head was married exhibit a lower probability of moving. We included this variable under the simple idea that the costs of up-rooting two people would be higher than for a single person.[20]

Anomalies between the regressions of the two years are apparent for some cost variables (e.g., religion, education in Table 2) but to elaborate would make an already long paper longer yet. Rather we turn to a discussion of the importance and explanatory power of the regressions and then an illustration of how they may be used.

Table 3 presents summary statistics for the regressions of Table 2. The coefficients collectively are found to be significantly different from zero. The values of λ indicate that we can reject the collective null hypothesis at the 99% level.[21] A further indicator of the validity of our equations is that they correctly predict whether or not a move will occur more than four-fifths of the time.[22]

[18] The appropriate test for the coefficients of probit regressions relates to the normal distribution.

[19] An additional interpretation of the latter variable is suggested by the search literature for positive changes in this variable (i.e., an increase in the number of hours unemployed). This literature has often noted that periods of intensive search (i.e., unemployment) will precede moves. This implies that families with abnormally high unemployment levels are searching for a more attractive job or residence site and hence will tend to exhibit a relatively higher probability of migration even in the presence of unchanged market conditions for the head's skills.

[20] Mincer (1976) has provided a convincing rationale for the observed effect in his analysis of "tied movers" and "tied stayers" among the married.

[21] $\lambda(= -2 \times \log \text{likelihood})$ is distributed χ^2 with the degrees of freedom indicated in Table 3.

[22] If the calculated probability of movement according to the regression was greater than 0.5 a move was predicted; if less than 0.5 no move was predicted.

TABLE III

Summary statistics for the regressions of Table 2

Statistics	1970–71 (1)	1970–71 (2)	1970–71 (3)	1971–72 (4)	1971–72 (5)	1971–72 (6)
Regression degrees of freedom	1091	1092	1095	1159	1160	1163
−2.0 × log likelihood ratio (degrees of freedom in parentheses)	368.8 (18 df)	368.8 (17 df)	352.7 (14 df)	395.5 (18 df)	395.5 (17 df)	370.9 (14 df)
Non-movers (actual)	816	816	816	853	853	853
Movers (actual)	295	295	295	326	326	326
Number of correct predictions	915	915	911	959	959	946
Percent correct predictions	82.4	82.4	82.0	81.3	81.3	80.2
Number of predicted movers	191	191	199	230	230	217
Percent predicted to move	17.2	17.2	17.9	19.5	19.5	18.4

An indication of the elasticity of the migration decision with respect to the independent variables is provided by examining the "percentile effective doses."[23] This approach suggested that age of head and number of states lived in were the two most elastic variables in the analysis with respect to the range and degree of responsiveness. They were the only variables taking on values close to their means and still being able to lead to a 50% probability of migration holding all other variables at their means. That is, for the first equation of Table 2, a head of age 26 or a head who had lived in 10 states would each have had a greater than 50% likelihood of moving, *ceteris paribus*.

[23] The terminology here is due to the application of probit analysis to biological experimentation in which, e.g., the dosage of rat poison required to yield a predicted 50% response (kill) rate is estimated. In the present context we examined for any single variable, holding all other variables at their mean values, the magnitude required to make the probability of migration equal to 10 and 50% respectively. That is, if a very low value of a particular variable is required to result in a 10% migration probability and a very large value is required to make the probability of migration equal 50% then the variable is less likely to be quantitatively important for the migration decision. In many respects the percentile effective doses provide information akin to the usual partial elasticity measures. Further details, with other percentile effective doses, of the analysis leading to the conclusions of the text are available upon request.

TABLE IV

Illustration of the Regression Results for Two Hypothetical Households.

Independent variables	Variable values for household A	Variable values for household B
RACEHEAD	0	0
SEXHEAD	0	0
AGEHEAD	22	50
FAMCOMPd	1 (recent divorce)	0 (no changes)
FAMCOMPdlag	0	0
FAMINCd	$1 (in thousands)	$0.5 (in thousands)
FAMINCdlag	0	0
HOURSILLd	0 (no health change)	0 (no health change)
HRSUNEMPd	0 (same hours unemp)	0 (same hours unemp)
HEADEDUCd	0 (no change)	0 (no change)
HEADWAGEd	$0.75	$0.25
NOSCHOLKID	1 (no kids in school)	0 (some kids in school)
JOBTENURE	3 (1 to 3 yrs)	6 (19 plus years)
GOCHURCH	1 (not regularly)	3 (regularly)
NUMSTATES	4 (states lived in)	2 (states lived in)
EDUCHEAD	4 (H.S. graduate)	4 (H.S. graduate)
WAGEHEAD	$3	$5
MARITALSTAT	0 (single)	1 (married)
Predicted Probability of Movement:		
1970–71 results	0.90	0.01
1971–72 results	0.88	0.04

However, the general conclusion which emerges is that the quantal migration response is due to the combined effect of many variables since other variables are seldom held at their means for individual families. Illustrating we have calculated the probability of migration for the two very different individuals described in Table 4. The first column in this table gives the characteristics of a hypothetical high mobility household, A, whose head is young, recently divorced and without children, having a brief job tenure, and so on. The second column in Table 4 gives the characteristics of a hypothetical low-mobility household, B: older, with children in school, long job tenure, etc. In many respects A and B are assumed alike—for example, the heads are both high school educated white males with no change in annual hours of illness, educational level, or unemployment and with no lagged income or family composition changes. Still the probability of a move for household A is 0.88 using the 1971–72 coefficients, compared to

0.04 for B.[24] If the 1970–71 coefficients are used the probabilities are 0.90 and 0.01 respectively, indicating that the results are similar across years.

V. SUMMARY AND CONCLUSIONS

Classifying the goods consumed into those which are traded and those which are non-traded was found to lead to a useful model of migration. In this manner one may conceptualize how changing demands for the non-traded goods lead to an incentive to migrate. Hence the probability of movement should be positively related to any variables which cause the demand for the non-traded good to change.

The model briefly summarized above was tested and was found to be in strong conformity to observed behavior. In the main all variables expected to lead to changed non-traded demand were found to increase the probability of movement. Another set of variables representing costs of movement was found to inhibit migration. Discrimination variables had the expected effect of reducing the range of options available to those discriminated against hence leading to a lower probability of migration. Unfortunately we were unable to test the importance of supply shifts of the non-traded good (e.g., the deteriorating neighborhood). The regressions which led to these conclusions were very significant, explained much of the observed migration and appeared to be fairly stable across years. This model of migration suggests the importance of changing socio-economic and demographic factors on household mobility.

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[24] To perform this and similar calculations, form the product of the coefficient vector and a chosen X vector of values of the independent variables (plus the constant). This sum can then be translated to a probability of movement by reference to a cumulative normal table (e.g., if the sum of the coefficients times the variable values equals zero with positive shifters cancelling negative, the probability of movement will be 0.5).

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