

A MICRO-ANALYTIC MODEL OF MIGRATION BEHAVIOUR*

J. R. Tulloch and J. A. MacMillan**

Policy-makers are concerned with factors determining changes in the distribution of population among regions and between farm, rural non-farm, and urban groups. The concern can be classified according to five issues. First, gains in economic productivity will result if the length of time that job openings are vacant in growing centers can be reduced. Second, movement by the unemployed and underemployed from low income regions to productive jobs in growing regions will reduce differentials in income among regions. Third, there is an increasing awareness that undesirable consequences are associated with the unrestricted movement of people to major metropolitan centers (increasing costs of public services, congestion, pollution, crime, etc.). Fourth, regional planning requires population projections and the projection of migration is subject to greater error than the fertility and mortality components. Fifth, assessment and improvement of current mobility programs require knowledge relating to the process of migration. In all the instances outlined above, analyses of the behavioural processes underlying migration would be extremely useful. The purpose of the present paper is to present results of a study of migration behaviour in a rural area of Manitoba.

Objectives of the Analysis

The analysis of migration in past studies can be characterized into several classes, including: conceptual [17]; application of gravity models [14, p. 35]; tests of neoclassical economic marginal productivity theory [9]; descriptive [8, p. 5]; and studies of the behaviour characteristics of migrants.

The probability of migration has been estimated by Jenness [5] for the behaviour of participants in the Canada Manpower mobility program as a function of personal and employment characteristics of individuals. The likelihood of migration from an area for age, sex and race specific cohorts has been combined by Trott [18] with shift-share analysis coefficients to derive area estimates.

---

*Financial support for the study from the Canada Department of Manpower and Immigration is gratefully acknowledged.

**Department of Agricultural Economics, University of Manitoba.

The objective of the present study is to estimate: (1) the probability of migration for an individual as a function of social and economic characteristics, and (2) the volume of migration from the Interlake Region as a function of the characteristics of the region's population.

The analysis was conducted for four groups, chosen on the basis of migration behaviour: (1) all migration, (2) internal migration, (3) out-migration, and (4) multiple migration. All migration includes all persons who migrate. An internal migrant is defined as a member of the labour force who moves but has an address in the Interlake Region after the move. An out-migrant is one who moves to an address outside the Region. A multiple migrant is one who moves more than once in the period covered by the data (one year). Separate analyses of multiple migration are conducted for all internal and out-migration to isolate the factors associated with multiple migration.

Model Specification

The basic model is a multiple regression equation with a dichotomous dependent variable and a set of 0, 1 dummy explanatory variables. Models of this type have been used in the study of labour force participation [16], air travel [7], and recreation [3]. The general specification of the model is:

(1) $$P_m = a + \sum_{i=1}^{n} F_i \ (X_i)$$

Where: P_m = the probability of migration

a = the constant term in the equation

F_i = the function giving the value that relates the i^{th} factor to P_m

X_i = the i^{th} explanatory factor, and

i = 1,...,n, the number of explanatory factors in the model.

To transform the above formulation into a linear regression problem, each factor, or characteristic X_i, is broken down into the classifications within which the effect of factor X_i is hypothesized to be homogenous. Each of these classifications j, for j = 1,...,k (the number of classifications) is treated as an independent variable. Following the constraint required for estimation of such an equation by least squares, one classification of each factor is used as a base condition and dropped from the equation. The remaining variables are assigned values of one or zero, depending on the presence or absence respectively of the characteristic described by that variable. The resultant equation is estimated by least squares regression analysis to obtain values for the coefficients b_{ij}:

$$(2) \qquad P_m = a + \sum_{i=1}^{n} \sum_{j=1}^{k-1} b_{ij} X_{ij} + u$$

Where: P_m = 0 or 1 depending on whether or not migration occurred

k = the number of classifications of factor i

j = 1,...,k-1

X_{ij} = the variable representing the j^{th} class of the i^{th} factor

b_{ij} = the regression coefficient of variable X_{ij}

u = the error term, and

a and i are as defined above.

The value of P_m for an individual is made up of the equation constant plus the sum of the b_{ij} for which $X_{ij} \neq 0$. If all X_{ij} equal zero, then the probability of a person with characteristics described by the base classification of each factor is given by the equation constant. Each b_{ij} gives the changes in probability of migration associated with membership in the j^{th} class of the i^{th} factor, relative to membership in the omitted base class.

The assumption that the residuals have constant variance, homoscedasticity, does not hold when a dichotomous dependent variable is used [2, pp. 25-29]. Estimation by ordinary least squares under these conditions yields unbiased but inefficient estimates of the regression coefficients, and biased and inconsistent estimators of the variance of the estimates. However, unbiased and efficient estimates can be obtained using weighted least squares, a form of generalized least squares. By this procedure, observed values of independent variables are weighted by an estimate of their variance.

A consistent estimate of the variance using parameters derived from the ordinary least squares computation can be derived where the variance of the regression coefficient is calculated by:

$$(3) \qquad Var(\hat{b}) = \frac{\Sigma x_i^2 Z_i}{(\Sigma x_i^2)^2}$$

Where: $x_i = X_i - \bar{X}$

X_i = the i^{th} observation on X

$\bar{X}$ = the mean value of X_i for all i, and

$Z_i = E(u_i^2)$, $i = 1,...,n$, where $E(u_i^2)$ is the expected value of u_i^2.

All summations are over i for i = 1,...,n the number of observations.

Hypothesized Determinants of Migration Behaviour

Characteristics and signs of coefficients are hypothesized as determinants of migration behaviour on the basis of theoretical considerations, results of other studies and judgment. Due to the absence of a theory of migration including social and economic variables, the hypotheses are primarily inductive.

Variables used in the study are defined in Table 1. Rural residence (X_1) is hypothesized to have a higher contribution to the probability of migration relative to urban members of the labour force. As employment opportunities in resource-based industries decline relative to employment in secondary and service sectors, members of the labour force can be expected to move to areas where better employment opportunities exist [8, p. 118].

Age up to 50 years (X_2 and X_3) is hypothesized to increase the probability of migration more than for persons over 50, reflecting the greater range of alternatives and mobility potential which exist for the younger group. Also, the coefficient for X_2 is hypothesized to be greater than X_3, as persons in the 17-25 age group are often completing formal education and have fewer responsibilities in the source area, such as home ownership [8, p. 335]. Females (X_4) are hypothesized to be less mobile than males; however, the size of the coefficient is expected to be small. Married persons (X_5) are expected to be less mobile than single persons--the latter group having fewer impediments to migration such as family obligations and children's education [5, p. 205, and 8, pp. 151-175]. Persons in the municipality less than 10 years (X_6) are hypothesized to be more mobile than longer-term residents, reflecting the fewer social and family ties such people have to the area [8, pp. 125-150]. Indians and Metis (X_7) are hypothesized to be less mobile than non-Indians or Metis, tending to remain in the areas of the reserves.

Education between Grades 8 and 13 (X_8) is hypothesized to increase the probability of migration relative to less education. Persons with education to this level are expected to have greater opportunities for employment and successful relocation [8, p. 43]. However, persons with university education (X_9) who are in the Interlake are expected to be less mobile than persons without university education. Such persons working in the area will tend to be employed in specialized occupations and have less incentive to migrate than persons in less satisfactory employment positions.

Persons in primary industries (X_{10}) are hypothesized to be more mobile than persons in the service sector, reflecting declining job opportunities in these sectors [5, p. 205]. Also, migration of persons in secondary industries (X_{11}) is expected to have a positive probability relative to service sector employment. Unemployment (X_{12}) is hypothesized to increase migration probability relative to employment. Persons who are unemployed will tend to migrate in order to find satisfactory employment opportunities [8, p. 336, and 5, p. 205]. Persons in income groups lower than $5,000 ($X_{14}$ and X_{15}) are expected to be more mobile than others, except for those

TABLE 1: Variables Used in the Behavioural Models

Factor		Variable Description
Residence	X_1	= 1 if person has rural residence (on a farm or in a town of less than 350 population in 1968)
Age	X_2	= 1 if person aged 17-25 years
		= 0 otherwise
	X_3	= 1 if person aged 26-50 years
		= 0 otherwise
Sex	X_4	= 1 if person female
		= 0 otherwise
Marital Status	X_5	= 1 if person married
		= 0 otherwise
Time in Municipality	X_6	= 1 if person lived in the municipality less than 10 years
		= 0 otherwise
Ethnic Origin	X_7	= 1 if person Indian or Metis
		= 0 otherwise
Education	X_8	= 1 if person has an educational level between Grades 8 and 13
		= 0 otherwise
	X_9	= 1 if person has university education
		= 0 otherwise
Industry	X_{10}	= 1 if person works in a primary industry (agriculture, forestry, fishing, trapping or mining)
		= 0 otherwise

TABLE 1 - Continued

Factor		Variable Description
Industry	X_{11}	= 1 if person works in a secondary industry (manufacturing, construction, and trade in the exposure period)
		= 0 otherwise
Unemployment	X_{12}	= 1 if person was unemployed more than 8 weeks in the exposure period
		= 0 otherwise
Income	X_{13}	= 1 if earnings less than $1,500
		= 0 otherwise
	X_{14}	= 1 if earnings in the range of $1,501-$3,000
		= 0 otherwise
	X_{15}	= 1 if earnings in the range of $3,001-$5,000
		= 0 otherwise
Manpower Service	X_{16}	= 1 if person has taken any manpower service
		= 0 otherwise
	X_{17}	= 1 if person has taken BTSD Level III and/or IV[a]
		= 0 otherwise
	X_{18}	= 1 if person has taken vocational or special training[b]
		= 0 otherwise
	X_{19}	= 1 if person has taken farm management course[c]
		= 0 otherwise
	X_{20}	= 1 if person has taken manpower corps and/or VRT[d]
		= 0 otherwise

TABLE 1 - Continued

Factor		Variance
	X_{21}	= 1 if person has taken training in industry[e]
		= 0 otherwise
	X_{22}	= 1 if person has taken BTSD Level I and/or II[f]
		= 0 otherwise
	X_{23}	= 1 if person has taken employment referral
		= 0 otherwise
Dependent Variables	Y_1	= 1 if person migrated
		= 0 otherwise
	Y_2	= 1 if person migrated but remained in the Interlake
		= 0 otherwise
	Y_3	= 1 if person migrated out of the Interlake
		= 0 otherwise
	Y_4	= 1 if person migrated more than once
		= 0 otherwise

[a]Basic Training for Skill Development III and IV is adult education approximately the equivalent of Grades 5 to 8.

[b]Technical courses in community colleges or apprenticeship.

[c]A five week course on farm operation techniques and accounting.

[d]Manpower Corps includes job experienced training under supervision or public works projects, and Vocational Rehabilitation Training (VRT) is a program of counselling and rehabilitation.

[e]Training in Industry is classroom instruction in a business establishment.

[f]Basic Training for Skill Development I and II is adult education approximately the equivalent of Grades 9 to 11.

persons in the less than $1,500 group ($X_{13}$). Persons in income groups below $5,000 are expected to be attracted to areas where the opportunity for increasing their income exists. Although persons in the under $1,500 group also have this incentive, the costs of moving may be a factor inhibiting such a move.

All manpower services ($X_{16}...X_{23}$) except for farm management (X_{19}) and training in industry (X_{21}) are expected to increase the probability of migration by increasing the range of employment available to participants in the programs. The farm management program participants will tend to return to their farms, and the training in industry program participants will tend to remain with the firm they are employed with. A description of manpower services is given in the footnotes of Table 1.

Results

Probability of migration results are presented for all migration, followed by a brief summary of results for internal migration, out-migration and multiple migration.

The regression results for all migration (column 1, Table 2) are in general agreement with the prior hypotheses listed above. Although rural residence (X_1) has a negative probability relative to urban residence the size of the coefficient is not statistically significant. Age up to 50 (X_2 and X_3) has a positive probability relative to age over 50, and the coefficient from the 17-25 age group (X_2) is significantly different from the base group and greater than that for the 25-50 age group. The sign hypothesized for the sex coefficient (X_4) is not obtained and the coefficient is not statistically significant. However, the hypothesis for marital status (X_5) is partially supported. Married persons have a negative probability relative to single persons, but the coefficient is not statistically significant. Persons in the municipality less than 10 years (X_6) have greater probability of moving than those of longer residency, and the coefficient is statistically significant. The hypothesis for Indian and Metis (X_7) is not supported. The sign of the coefficient is positive and statistically significant. Checking with local administrators supports the finding that Indians and Metis are very mobile.

The signs for the education variables (X_8 and X_9) are consistent with the hypothesis, but the coefficient is not statistically significant. The results support the hypothesis relating to industrial status. Persons in primary and secondary sector jobs are more mobile than those in the service sector jobs.

The hypothesis that unemployment (X_{12}) is associated with a higher probability of migrating relative to persons with jobs is consistent with the results. The sign is positive and statistically significant. It was hypothesized that persons with incomes of $5,000 or below would be more likely to migrate than persons with higher incomes, except for those in the under $1,500 group. The results are consistent with the hypothesis that persons in the under $1,500 income class and in the $3,001-$5,000 class have a low probability of migrating. The coefficient for the $1,501-$3,000 group is

TABLE 2: Regression Equation Coefficients For All, Internal and Out-Migration[a]

Variable	All Migration	Internal Migration	Out-Migration
X_1 Residence	-0.031	-0.025	-0.017
X_2 Age 17-25	0.141**	0.047	0.143**
X_3 Age 26-50	0.002	0.003	-0.015
X_4 Female	0.033	0.035	0.017
X_5 Marital Status	-0.041	-0.022	-0.017
X_6 Time in Municipality	0.073*	-0.017	0.113**
X_7 Indian or Metis	0.106**	0.009	0.101**
X_8 Education Grades 8-13	0.053	0.060+	0.019
X_9 University	0.353	0.385	-0.021
X_{10} Primary Industry	0.175**	0.147**	0.126**
X_{11} Secondary Industry	0.064+	-0.031	0.108*
X_{12} Unemployment	0.107**	0.012	0.148+
X_{13} Income less than $1,500	-0.148**	-0.088*	-0.128+
X_{14} Income $1,501-$3,000	0.017	-0.021	0.044
X_{15} Income $3,001-$5,000	-0.081+	-0.073+	-0.050
X_{16} BTSD Level III and IV	0.221**	0.183**	0.106*
X_{17} Vocational or Special Training	0.300**	0.232**	0.132*
X_{18} Farm Management Training	0.140**	0.077+	0.092**
X_{19} Manpower Corps or VRT	0.185**	0.146*	0.062
X_{20} Training in Industry	0.152*	0.055	0.115+

TABLE 2 - Continued

Variable	All Migration	Internal Migration	Out-Migration
X_{21} BTSD Level I and II	0.244**	0.138**	0.135**
X_{22} Employment Referral	0.216**	0.155**	0.105*
Intercept	-0.062	0.011	-0.104

[a]Standard error estimates are given in Table 4.

**Significant at the 1 per cent level for a one tailed "t" test.

*Significant at the 5 per cent level for a one tailed "t" test.

+Significant at the 10 per cent level for a one tailed "t" test.

positive but not statistically significant.

The results are consistent with the hypothesis that participation in a manpower service (X_{17} - X_{23}) increases the probability of migration. The relative size of the coefficients, all of which are statistically significant, indicates that vocational or special training (community college and apprenticeship) have the greatest effect on the probability of migration, followed by the BTSD (adult education), manpower corps, and employment referral. The smallest coefficients were obtained for farm management and training in industry.

Breaking the data into internal and out-migrant groups gives an indication of the composition of the results for all migration. In general, the same characteristics are significant for all and internal migration. However, significant characteristics for internal and out-migrants are quite different, indicating that out-migration is a selective process in terms of those persons who migrate. Results for all internal and out-migration are also given in Table 2. In general, variables significant in the migration equations are the same as the significant variables in the analysis of multiple migration.

To derive estimates of the volume of labour force migrating, the coefficients obtained from the equations for out-migration and internal migration are weighted by the proportion of the labour force possessing the relevant characteristics, and the resultant values are summed. Net migration is determined by subtracting the estimate of out-migration from estimated in-migration.

The ratio of labour force to population was obtained from a study by MacMillan and Lu [10]. The estimated ratio for 1968 is 0.3345. Multiplying the inverse of this ratio by the labour force estimates gives an indication of the magnitude of population movements. Weights for other characteristics were derived from an earlier survey of the area [4].

The estimated volume of internal migration is greater than gross out-migration or in-migration estimates, shown by the estimates given in Table 3. Gross out-migration levels are less than gross in-migration levels, yielding a net in-migration of 93 persons. Over the period 1961 to 1968 the net population change for the Interlake was a decrease of 2694 persons, an average decrease of 0.77 per cent per year. The direction of change in net migration rates varied over different parts of the interlake, with a decrease in eight and an increase in five of the thirteen municipalities.

The evidence of net out-migration over the 1961 to 1968 period suggests that the expected net population change for 1968 would be negative. However, this long-term average does not allow for information on year-to-year variations in the direction of net migration. There is a possibility that the estimate for out-migration will be biased downwards, (due to non-response bias resulting from difficulties in contacting clients who moved) which could account for the net increase in Interlake population estimated.

TABLE 3: Estimated Volume of Gross and Net Migration

	Gross Internal Migration	Gross Out-Migration	Gross In-Migration	Net Migration[a]
Percentage of Interlake Labour Force	7.3	2.9	3.1	+ 0.2
Volume of Labour Force[b]	1160	461	492	+ 31
Volume of Population	3468	1378	1471	+ 93

[a]A positive value indicates a movement into the area.

[b]Volume figures are based on a total labour force of 15,884 persons.

Volume estimates given in Table 3 reflect the 1968 characteristics of the Interlake labour force. However, useful information on the response of migration behaviour to changes in aggregate labour force characteristics can be obtained by varying the proportion of the labour force in each group. Implied is the assumption that equation coefficients are constant over the range of the changes.

If the level of general education and university education is increased, the internal and out-migration equations would indicate changes in the percentage of the population migrating. Increasing the proportion of persons educated to within the range of Grades 8 to 13 will increase internal migration.

The industrial composition of the Interlake labour force can be expected to change over time, as primary industries decline relative to secondary and tertiary employment. The effect of a change of this nature on migration is to decrease the expected volume of migration, both for internal and out-migration. For example, if there is a decrease of twenty per cent in the proportion of the labour force in primary industries, all of who move into secondary industries, the change in the percentage of internal migration would be a decrease of 1.1 per cent, representing 175 persons in the labour force.

Migration response to an increase in unemployment is to increase both internal and out-migration. A twenty per cent increase in the proportion of the labour force unemployed can be expected to increase internal migration by 0.1 per cent (16 persons) and out-migration by 0.4 per cent (64 persons).

The equations indicate that both internal and out-migration are affected by manpower retraining services. Considering the aggregated situation, an increase of twenty per cent in the proportion of the labour force receiving manpower services can be expected to increase internal and out-migration by 0.2 per cent (32 persons).

Statistical Properties of Estimates

The model used in this study requires interpretation of results based on consideration of heteroscedasticity, as outlined above, additivity and low R^2. Heteroscedasticity adjustments are introduced by use of consistent estimators of variance for the coefficients. The need for adjustments can be assessed by comparison of efficient and unbiased estimators obtained by generalized least squares with results obtained by ordinary least squares.

Using generalized least squares the average absolute change in coefficients was 0.011, with a range from 0.029 to 0.0 (Table 4). The average percentage change was fifty-three per cent, ranging from six hundred per cent to zero per cent. Some of the changes refer to non-significant variables and are therefore of little importance.

Examination of the standard error estimates shown in Table 4 indicates that for this sample, ordinary least squares estimates tend to be biased upwards in comparison to the unbiased estimates obtained by generalized least

TABLE 4: Comparison of Results Estimated by Consistent and Inconsistent Estimators for All Migration, Aggregated Manpower Services

	Variable	Coefficient		Standard Error		
		O.L.S.[a]	G.L.S.[b]	O.L.S.	G.L.S.	C.S.E.[c]
X_1	Residence	-0.039	-0.048^{+}	0.046	0.033	0.043
X_2	Age 17-25	0.153^{**}	0.162^{**}	0.081	0.063	0.045
X_3	Age 26-50	0.001	0.007	0.072	0.042	0.041
X_4	Female	0.032	0.038	0.066	0.063	0.060
X_5	Marital Status	-0.042	-0.050	0.051	0.039	0.047
X_6	Time in Municipality	0.069^{**}	0.057^{*}	0.045	0.033	0.042
X_7	Indian or Metis	0.097^{*}	0.083^{*}	0.055	0.044	0.044
X_8	Education Grades 8-13	0.062^{+}	0.033	0.049	0.034	0.042
X_9	University	0.390	0.361	0.296	0.325	0.350
X_{10}	Primary Industry	0.179^{**}	0.185^{**}	0.062	0.062	0.062
X_{11}	Secondary Industry	0.071^{+}	0.071^{+}	0.052	0.046	0.050
X_{12}	Unemployment	0.112^{**}	0.111^{*}	0.051	0.051	0.045
X_{13}	Income less than $1,500	-0.116^{**}	-0.104^{*}	0.066	0.057	0.043
X_{14}	Income $1,501-$3,000	0.039	0.012	0.066	0.043	0.057

TABLE 4 - Continued

Variable	Coefficient		Standard Error		
	O.L.S.[a]	G.L.S.[b]	O.L.S.	G.L.S.	C.S.E.[c]
X_{15} Income \$3,001-\$5,000	-0.061	-0.066^{+}	0.061	0.048	0.051
X_{16} Manpower Services	0.207**	0.197**	0.062	0.058	0.044
Intercept	-0.073	-0.079	0.121	0.242	
R^2	0.18**	0.15**			

[a]Ordinary Least Squares.

[b]Generalized Least Squares.

[c]Consistent Standard Error.

**Significant at the 1 per cent level for a one tailed "t" test for regression coefficients and an "F" test for R^2.

*Significant at the 5 per cent level for a one tailed "t" test.

+Significant at the 10 per cent level for a one tailed "t" test.

squares and the consistent estimate for ordinary least squares.[1] Dominance of an upward bias reflects the results obtained by Buse [2, p. 53], and Bowen and Finegan [1, p. 648], but is contrary to results of Zellner and Lee [19, p. 392]. The effect of an upward bias in standard error estimates is to bias t values downwards, increasing the possibility of a Type II error, acceptance of the null hypothesis when it is false.

In the equation for all migration, of the 16 coefficients tested, "t" tests based on the ordinary least squares standard error estimate show that the significance of three coefficients was reduced from one per cent to the five per cent level, one coefficient from five per cent to ten per cent, and one coefficient significant at the ten per cent level was removed from that group. The coefficient of variable X_9, university education, which was significant at the ten per cent level, lost that significance. These changes in significance levels indicate that ordinary least squares standard error estimates are not reliable for coefficient tests. Adjustments to obtain consistent standard errors should be estimated for each variable in each equation.

The problem of additivity arises because extreme values of the characteristics can result in probability estimates less than zero and greater than one. For example, the maximum possible positive value for the probability of all migration estimated by ordinary least squares is 1.205, and the maximum negative value is -0.270. However, the estimated probabilities for the 400 observations used to estimate this equation were all less than 1.0, although 39 (9.75 per cent) observations had negative estimates. The maximum of these was -0.199. This suggests that the combination of characteristics which give estimates beyond the zero-one range is not common. The problem of negative probability estimates occurs most frequently for equations where the number of observations in which the person migrated decreases as a proportion of the total observations. All of the values lie within the standard error of estimate for each equation, which averages 0.319, with a range from 0.506 to 0.214.[2] Of the seventeen per cent of the estimates obtained from the generalized least squares equation which were outside the 0 to 1 probability

---

[1]This discussion refers to the estimates obtained for the equation for all migration; however, in general, the same relationship holds for all equations for the consistent standard error estimates. Generalized least squares was only applied to this equation because of the relatively high cost of this procedure.

[2]The standard error of estimate is a measure of the dispersion of Y values about the estimated regression function. In a model of this type, the true standard error of estimate is not the same as that given by standard regression programs which are based on dispersion about the observed zero and one, not the probability range between those values. The values given above will thus tend to be biased upwards. Further discussion of this point in relation to the R^2 is given below.

range 8.75 per cent were greater than 1.0 and 8.25 per cent were less than 0. The range of estimates was from 1.882 to -0.763. These estimates are not appropriate under the assumption of additivity. Therefore, ordinary least squares with adjustments for consistent standard errors is the estimation procedure used.

Low values for the R^2 are often found in cross-section survey analyses [12, p. 15] and values in studies using dichotomous dependent variables are typically low [6].

There are several arguments which suggest that a test of an equation based on how closely the R^2 approaches a value of 1.0 is not valid in such situations. The choice of a standard of 1.0 to measure the validity of an equation based on the R^2 contains the implied assumption that one hundred per cent of variance in the dependent variable is systematic. As it is not possible to determine a priori that portion of the R^2 which is systematic, the choice of any standard below 1.0 is equally defensible. If the variance in a given dependent variable cannot be explained to an acceptable level by a systematically structured equation which has firm logical support, then it may be necessary to conclude that mathematical forecasting of that phenomenon by use of regression analysis is not possible. This situation applies generally to regression models.

More specifically, Orcutt and Rivlin, in reply to a criticism by Solow [15, p. 322], suggest that in the situation where a 0, 1 dichotomous dependent variable is used to represent a probability observation, the variance explained by the regression is based on deviations of the zeros and ones from the estimated probabilities. However, because it is a probability which can take on the value of any real number between zero and one being estimated, a more useful statistic than the R^2 is the standard error of the estimated probabilities. Melichar [12] indicates that the estimated coefficients are not able to give very accurate estimates for any of the individual observations; however, good estimates of the means for groups of individuals are obtained.

Jenness explains a low value for the R^2 obtained in a study of the success of labour relocation, by indicating that some explanatory variables are missing from the equation used [5, p. 205]. Neter and Maynes argue that a more appropriate measure of the relationship between the independent variables may be a correlation ratio, a measure of the degree of the total relation between the variables which does not restrain the functional form of the relation as does the R^2, a measure of linear relation [13]. The arguments presented in this section indicate that interpretation of the R^2 and the significance of that measure is not clear for equation forms specified with a 0, 1 dependent variable.

Limitations

The definition of migration used in this study is constrained by the data collected for an evaluation of manpower services [11]. The previous study was designed to obtain information on an individual for a 12-month period prior to participating in a manpower service and a 12-month period after receiving the service. Data for a "norm" group was collected for two consecutive calendar years. The information used in analyzing migration includes the data collected immediately after the service for the manpower service clients and for the second calendar year for the "norm" group. In both cases the individual's address at the end of the year is taken as his final residence, and if it is different from that during the service, migration has occurred. However, a person may move out of the area and return to a different address in the area and be classified as an internal migrant.

The results reflect the behaviour determined by characteristics of individuals and conditions in the Interlake Region. Other conditions (the "pull" effect) affect the coefficients, and analyses under different social and economic conditions would likely result in different estimates. Other studies analyzing migration as a function of geographical wage rate differentials indicate the importance of the economic conditions on migration behaviour. The present study results would not change over time if it is assumed that wage rate differentials between the Interlake and non-Interlake do not change over time and that social values remain constant.

Another shortcoming of the conceptual approach taken to migration behaviour is that it is not possible to derive an estimate of in-migration by the same procedure without the collection and processing of a large volume of data on the Manitoba and Canadian labour force.

Dummy variable regression analysis, the technique used in the behavioural models, implies several behavioural assumptions which do not always reflect the actual situation. Included in these are the assumptions of no significant interaction between independent variables, and homogenous behaviour in the characteristic ranges specified by the variables.

Transfer to volume estimates based on the behavioural equations also transfers the shortcomings of those equations. If the estimates are to be used for prediction, no indication of the variance explained is available on which to base the choice between alternative equations.

The data used to estimate the equations of the behavioural section are taken from a stratified sample of the Interlake labour force. Mobility data in the sample refer to a one year period, and therefore data on characteristics of the labour force refer to that period. Data on these characteristics refer to the last job held, which in the case of migrants could be the job after migration. An attempt to use the second to last job in the case of migrants was not successful, as several persons who migrated reported on one job only. Thus, to retain the conceptual basis that an individual's characteristics before migration determine the migration probability, it is necessary to assume that migrants remain in the same industrial group before and after migration, and secondly, that if a person is unemployed for more than eight weeks, he is unemployed for at least eight weeks before migration. A similar assumption is necessary for the income groups, this value being taken over the whole year. It is hypothesized that these assumptions do not severely limit the meaning of results obtained, although no test of this hypothesis is undertaken.

For the purpose of the behavioural analysis, the data are separated into three groups--non-migrants, internal migrants and out-migrants. Of the total number of contacts attempted in the survey, sixty-three persons were classed as "distant clients"--persons who had moved out of the survey area and were not able to be contacted. The effect of this group of non-respondents on the sample is to reduce the number of out-migrants included. In the behavioural equations, one effect is to bias the absolute value of estimated coefficients downwards for the probability of out-migration, although it is not possible to determine the extent of this bias. Because the gross out-migration estimate is used in conjunction with the estimate for in-migration to derive net migration for the area, there will also be a downward bias in the net out-migration estimate.

Implications and Conclusions

The results obtained in the study indicate several important implications of the migration process as it relates to the Interlake Area. Implications which relate to the behavioural and volume aspects of the study are discussed with respect to the characteristics examined in the behavioural analysis.

Rural residents do not tend to be more mobile or to move more often than urban residents. The net effect of migration on the rural-urban balance of population will depend on the destination of migrants and whether commuting rather than migration occurs as an adjustment to increasing urban employment opportunities. The coefficient for out-migration of persons aged 17 to 25 years is relatively large and highly significant, indicating that persons in that age group tend to move out of the Interlake more than older persons. Data on the migrants used for the estimation of in-migration show that none of the in-migrants were in the 17-25 age group. The net effect then will be a decrease in the proportion of the Interlake labour force in that age group. Over time this pattern will reduce the mobility (and therefore adjustment) potential of the labour force, suggesting a decreasing effectiveness of policies designed to increase mobility.

The results imply that the composition of the Interlake labour force in terms of sex distribution and marital status will not be significantly affected by migration. Persons resident in the area for less than 10 years are more likely to move out of the area than longer-term residents. Thus it could be hypothesized that there is a base group of the labour force who are long-term residents, and fluctuations in the labour force size and composition are caused largely by a more mobile group of persons moving in and out. That is, there is no tendency towards an overall replacement of the labour force. Although Indian and Metis persons are quite mobile in terms of out-migration, there is no tendency for them to move within the area any more than non-Indian and Metis persons.

Results obtained indicate that formal education in general does not significantly affect the migration behaviour of individuals in the labour force. (Students who go to university and take jobs outside the area are not included in the sample.) Because out-migration is not thus affected, concern about the declining quality of the labour force and a loss of investment of educated persons moving out may not be warranted. However, the actual education and skill level of the labour force are not necessarily accurately measured by formal education. A preferable indicator may be length of job experience or specific trades training. The significance of coefficients for various manpower retraining programs supports this hypothesis. The formal education level of the sample of in-migrants included only four persons with less than Grade 8 education; the remainder of in-migrants had education in the range of Grades 8 to 13.

The mobility of persons in primary industries is greater than for other persons. Therefore, as the emphasis of industrial composition of the labour force changes from primary to other industries, then the mobility of the labour force will decrease. It can also be expected that the size of the coefficient for primary industry will decrease simultaneously as the need for adjustment through mobility decreases for that group in the labour force.

The results show that levels of migration vary directly with the level of unemployment, reflecting the adjustment role of migration. Persons who tend to be unemployed are likely to be in a more mobile group than other persons, increasing the mobility potential of unemployed persons.

Migration behaviour varies between persons of different incomes. The results imply that those members of the labour force with less than $1,500 income are less mobile than any other income group. Because persons at this end of the income scale require the ability to find new opportunities, some policy for increasing the mobility potential of this group may be indicated.

All manpower services studied increase the probability of migration. One possible mechanism by which manpower services influence migration is by raising program participants' preference for relocation. If the increased mobility indicates a satisfactory adjustment of the labour force, then these programs may be sufficient. However, projections made for the Interlake indicate that by 1980, about 5,700-8,800 of the area labour force will need to be employed out of the area, in government or finance sectors, or they will be unemployed [10, p. 70]. Decisions are required concerning the expansion of mobility programs versus expanding programs designed to improve local employment opportunities.

REFERENCES

1. Bowen, W. G., and T. A. Finegan. The Economics of Labour Force Participation. Princeton: Princeton University Press, 1969.

2. Buse, A. A Technical Report on Binary Dependent Variables Applied in the Social Sciences. Edmonton: Alberta Human Resources Research Council, 1972.

3. Davidson, P., F. G. Adams, and J. Seneca. "The Social Value of Water Recreational Facilities Resulting from an Improvement in Water Quality: The Delaware Estuary," in A. V. Kneese and S. C. Smith (eds.) Water Research. Baltimore: Johns Hopkins Press, 1965.

4. Framingham, Charles F., James A. MacMillan, and David J. Sandell. The Interlake Fact. Winnipeg: Hignell Printing Ltd., 1970.

5. Jenness, R. A. "Manpower Mobility Programs," in G. G. Somers and W. D. Wood (eds.) Cost-Benefit Analysis of Manpower Policies. Kingston: Queen's University, 1969.

6. Juster, F. "Consumer Buying Intention and Purchase Probability: An Experiment in Survey Design," Journal of the American Statistical Association, 61 (1966), 690.

7. Lansing, J. B., and D. B. Blood. "A Cross-Section Analysis of Non-Business Air Travel," Journal of the American Statistical Association, 53 (1958), 928-947.

8. Lansing, J. B., and E. Mueller. The Geographic Mobility of Labour. Ann Arbor: Institute for Social Research, 1967.

9. Lianos, T. P. "Labour Mobility and Market Imperfections," Canadian Journal of Agricultural Economics, 18 (1970), 97.

10. MacMillan, J. A., and Chang-mei Lu. "Area Manpower Planning: Projection and Impact Models." Research Bulletin. 72-5 (December, 1972). Winnipeg: Department of Agricultural Economics, University of Manitoba.

11. MacMillan, J. A., L. A. Bernat, and J. J. Flagler. Benefits and Costs of Manpower Services in the Interlake Rural Development Area. Research Bulletin 72-1 (March, 1972). Winnipeg: Department of Agricultural Economics, University of Manitoba.

12. Melichar, E. "Least Squares Analysis of Economic Survey Data." Paper presented at the Annual Meeting of the American Statistical Association, September, 1965, Philadelphia, Pennsylvania.

13. Neter, J., and E. S. Maynes. "On the Appropriateness of the Correlation Coefficient with a 0, 1 Dependent Variable," Journal of the American Statistical Association, 65 (1970), 504.

14. Olsson, G. Distance and Human Interaction, A Review and Bibliography. Bibliograph Series No. 2. Philadelphia: Regional Science Research Institute, 1965.

15. Orcutt, G. H., and A. M. Rivlin. "An Economic and Demographic Model of the Household Sector: A Progress Report," in National Bureau of Economic Research (ed.) Demographic and Economic Change in Developed Countries. Princeton: Princeton University Press, 1960.

16. Orcutt, G. H., et al. Microanalysis of Socioeconomic Systems: A Simulation Study. New York: Harper and Brothers, 1961.

17. Ravenstein, E. G. "The Laws of Migration," Journal of the Royal Statistical Society, XLVIII, Part 2 (June, 1885), 167-227. Cited by Lee, E. S. "A Theory of Migration," Demography, 3 (1966), 47-57.

18. Trott, C. E. "Differential Responses in the Decision to Migrate," Paper presented at the Regional Science Association Meetings, November, 1971, Ann Arbor, Michigan.

19. Zellner, A., and T. H. Lee. "Joint Estimation of Relationships Involving Discrete Random Variables," Econometrica, 33 (1965), 382-394.