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Résumé de l'article

Les auteurs examinent les changements dans les types historiques de migrations au sein des petites communautés frontières du nord de la Saskatchewan durant les périodes 1927-1960, 1961-1970 et 1971-1976. Des problèmes apparaissent lorsqu'on tente de formuler des modèles d'interaction spatiale dans les régions frontières, ou en voie de développement, en particulier le faible volume de migration et le fait que certains termes agglomérés sont impropres lorsqu'utilisés comme mesures de degré d'attraction et de répulsion des communautés. Comme procédure alternative, on utilise une méthode log-linéaire, laquelle identifie, par une analyse à dimensions multiples d'une matrice de données classifiées, les composantes dans les processus d'interaction spatiale. Les résultats initiaux montrent que le sexe de l'immigrant n'a pas d'effet sur la tendance à immigrer, et que les types spatiaux d'immigration n'ont pas changé d'une période à l'autre.

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MODELING CHANGES IN THE IN-MIGRATION PATTERNS OF NORTHERN SASKATCHEWAN COMMUNITIES: A LOG-LINEAR APPROACH

by

G. Thomas MURAUSKAS [1], Milford B. GREEN [2] and Robert M. BONE [3]

ABSTRACT

This paper examines changes in the historical pattern of in-migration to small frontier communities in northern Saskatchewan in three time periods: 1927-1960, 1961-1970 and 1971-1976. The problems associated with spatial interaction modeling in a developing or frontier region are noted, particularly the low volume of in-migration and the inappropriateness of mass terms as surrogate measures of nodal attractiveness and propulsiveness. As an alternative, a log-linear approach is adopted, whereby multidimensional contingency-table analysis of categorical data reveals structural components in the spatial-interaction process. Initial results indicate that the gender of the migrant has no effect on the propensity to migrate and that spatial patterns of in-migration have not changed over time.

KEY WORDS: Spatial interaction, in-migration patterns, northern Saskatchewan

RÉSUMÉ

Modélisation des changements dans les patterns migratoires internes des communautés de la Saskatchewan septentrionale: une approche log-linéaire

Les auteurs examinent les changements dans les types historiques de migrations au sein des petites communautés frontières du nord de la Saskatchewan durant les périodes 1927-1960, 1961-1970 et 1971-1976. Des problèmes apparaissent lorsqu'on tente de formuler des modèles d'interaction spatiale dans les régions frontières, ou en voie de développement, en particulier le faible volume de migration et le fait que certains termes agglomérés sont impropres lorsqu'utilisés comme mesures de degré d'attraction et de répulsion des communautés. Comme procédure alternative, on utilise une méthode log-linéaire, laquelle identifie, par une analyse à dimensions multiples d'une matrice de données classifiées, les composantes dans les processus d'interaction spatiale. Les résultats initiaux montrent que le sexe de l'immigrant n'a pas d'effet sur la tendance à immigrer, et que les types spatiaux d'immigration n'ont pas changé d'une période à l'autre.

MOTS-CLÉS: Interaction spatiale, formes migratoires, Saskatchewan septentrionale.

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The purpose of this paper is to examine changes in the historical pattern of in-migration to small frontier communities in northern Saskatchewan over three time periods. This paper also demonstrates the utility of the log-linear model as a supplement to gravity models in spatial-interaction modeling. Spatial interaction refers to the movement of people, goods, information between two of more places. The paper is divided into five sections. The first section provides a brief overview of some of the determinants of migration, in the context of a developing region. The second section describes the study area and its population, and provides an historical background to migration behavior in northern Saskatchewan. The third section examines the theoretical underpinnings of the social gravity hypothesis and how they pertain to the migration process in northern Saskatchewan. The fourth section describes the log-linear technique and the data sets employed in the study. The results and their implications are discussed in the final section.

THE MIGRATION PROCESS IN A FRONTIER REGION

The role of interregional migration in the regional development process in post-industrial market economies, while having had extensive treatment in the theoretical and empirical literature, is not completely understood (Gober-Meyers, 1978). Our understanding of the migration process and its repercussions for developing regions is even less complete. One difficulty is the transferability of demographic process models across different geographic and cultural settings (Brown and Lawson, 1985). Moreover, many of these theoretical propositions have yet to be empirically verified in peripheral regions. The goal of this paper is to test a social gravity model in a peripheral area of Canada, the northern frontier of Saskatchewan.

The theoretical basis for this discussion of migration begins with the neo-classical model of regional economic adjustment, which postulates that labor moves from regions of low labor demand to areas of high demand or high wages (Courchene, 1970; Polèse, 1981). This movement of labor to rapidly growing regions achieves a point of equilibrium when the increase in the labor supply in the high wage region is sufficient to cause wages to decline to the wage level found in other regions. In terms of regional development, this theory argues that employment-motivated migration maximizes national and regional economic efficiency by achieving the optimum spatial allocation of the labor supply. Hence, an increase in per capita incomes occurs in regions and in the nation as a whole because people have moved to areas of the country where their marginal productivity is highest.

The neo-classical view of migration as a labor force adjustment mechanism was challenged by regional development theorists: Myrdal (1957), Hirschmann (1958), Friedmann (1967), Friedmann and Weaver (1979) and neomarxists such as Frank (1967). Myrdal, for instance, proposed a cumulative causation hypothesis, which stated that migration from poorer regions is a selective process, draining an already poor area of its skilled labor and inducing unfavorable changes in the age and sex structure of the remaining population. According to Myrdal, this precipitates a long, downward spiral in the economy of the poorer region, which in turn leads to further out-migration and the eventual demise of the region's economy.

Modifications to the neo-classical model of regional economic adjustment have recognized that the selective nature of migration, in terms of age, gender, educational attainment, occupational skills and other factors, can be a disequalibrating force. These factors have considerable ramifications on the donor region and the receiving region. Simply stated, out-migration benefits growing regions while it adversely

affects a declining region because the most productive element of society has moved. To account for the selective nature of the migration process, a relaxation of neo-classical assumptions is suggested, such as the absence of barriers to mobility, a homogeneous population, perfect information and income maximization (Gober-Meyers, 1978).

Whether economically-motivated migration in a frontier area with a dual economy is a sound assumption forms a major question in this paper. In the study area of northern Saskatchewan, there is a small-scale, locally controlled economy based on renewable resource harvesting (hunting, trapping and fishing), and a nationally/internationally controlled economy based on the large-scale exploitation of non-renewable resources, with an emphasis on high technology (Rae, 1976; Berger, 1977; Dacks, 1981; Usher, 1982). The significance of the dual economy is that members of the traditional economy may not respond to high wages because of 1) an insensitivity to wage levels due to a preference for traditional activities, and 2) an inability to compete in labor markets because of lower education levels than non-native workers (Bone and Green, 1984). Therefore, the assumption of rational economic behavior inherent in the regional economic adjustment model of migration may be less effective in this northern frontier than in a core setting.

Over the last forty years or so, the Saskatchewan frontier has been subjected to the process of integration into the economic, political and social spheres of mainstream Canada. Most of this integration has been associated with the increased role of government in creating a modern infrastructure and in delivering basic services at the community level. Migration by natives from the land into small settlements in northern Saskatchewan was motivated by the desire to obtain services found in these settlements. Some of the public services provided cash income, such as welfare payments, and in this sense the movement to settlements can be interpreted as "economically motivated".

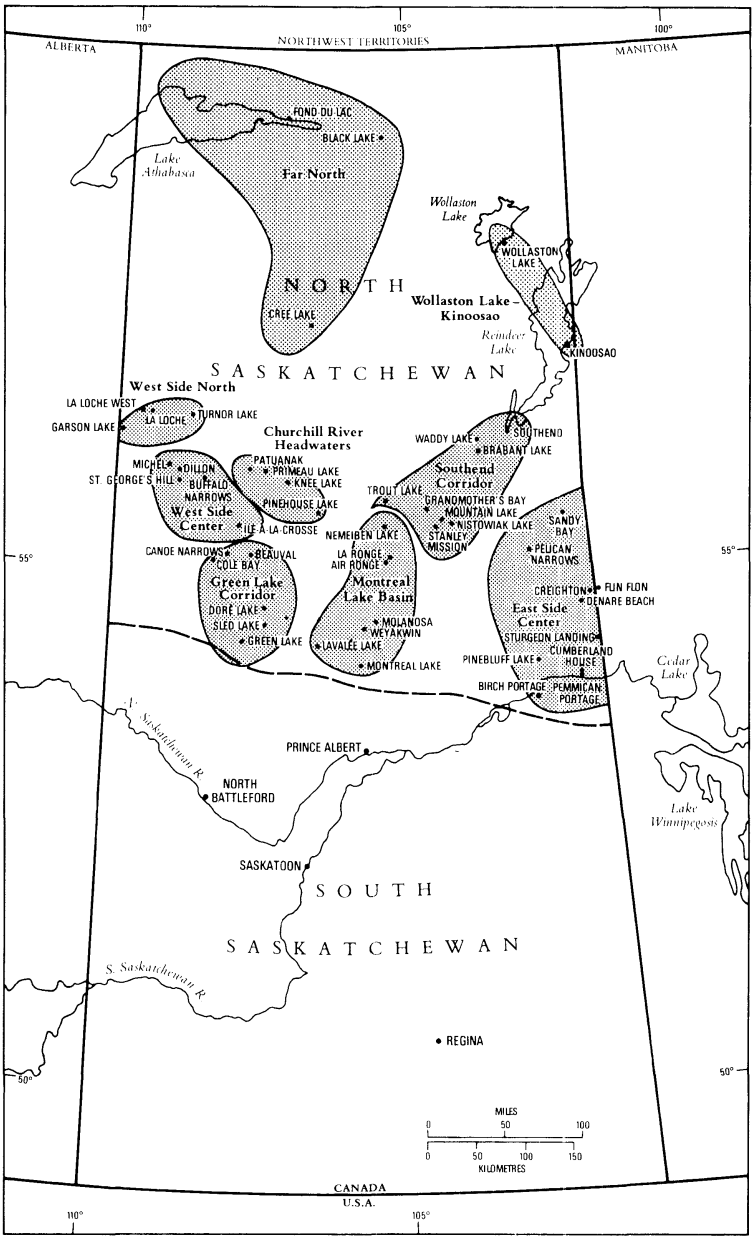
In the 1970's, few members of native societies were properly trained for the most basic permanent jobs in the introduced wage economy and none had extensive professional/managerial education (see Bone and Green, 1984). Consequently, employers recruited their workers from southern Canada where a skilled and experienced labor force exists. This northern movement of a select labor force, attracted primarily by higher wages, has altered the demographic characteristics of northern populations. For instance, the sex ratio (males to females) in the Northwest Territories has been extraordinarily high (Hamelin, 1979, p. 28; Bone, 1983), and only recently has this ratio begun to decline. Elsewhere, some empirical studies indicate that the propensity to migrate may not be particularly selective with respect to gender; however, this proposition is questioned by other studies that relate the changing nature of gender selectively to mature or more developed societies and the increasing participation of females in the labor force (Shaw, 1975, p. 22-24).

THE STUDY AREA: A BRIEF MIGRATION HISTORY

The North has experienced an unprecedented rate of modernization since World War II. Therefore, there is good reason to suspect a rapid geographical expansion of the northern in-migration field within the last 40 years. The study area defined as northern Saskatchewan (figure 1) consists of the northern two-thirds of the province of Saskatchewan. In 1981, the total population for the province was 968313; only

Figure 1

MIGRATION ORIGINS AND DESTINATIONS THE STUDY AREA



25 304 people lived in northern Saskatchewan or Census Division 18 (Canada, 1981). There were 59 200 natives (37 470 Treaty Indians, 4 135 Non-Status Indians, 17 455 Metis and 140 Inuit) living in Saskatchewan, and 16 605 (28,0% of all natives in Saskatchewan) were living in Census Division 18 (*ibid.*). In northern Saskatchewan, the native population (65,6% of the population in Census Division 18) was equally divided between Treaty Indians and the Metis, including Non-Status Indians (author's estimate).

This study specifically examines in-migration to Metis communities. The Metis trace their maternal lineage to the Indians and their paternal lineage to Euro-Canadian fur traders. Since the Indian Act, which was enacted by the Canadian Parliament, does not consider the Metis as heirs to aboriginal title, the Metis people were never entitled to any treaty provisions or benefits. Hence, the settlement patterns of the Metis were constrained by some factors not experienced by Treaty Indians, namely no access to reservations (or any other treaty provisions).

The Metis society of northern Saskatchewan has undergone profound changes over the past 60 years. These changes are reflected by the three time periods that this study examines. The first period (1927–1969) corresponds to the Metis practicing a subsistence hunting and trapping economy. For the most part, Metis families lived on the land, moving from place to place on a seasonal basis. In the 1950's the Metis began moving from the land to permanent settlements. This migration represented a major social shift in the Metis society. During the second period (1961–1970) the movement to settlements was intensified. This period was typified by the introduction and extension of various social welfare assistance programs to the north on the part of the federal government. The third period (1971–1976) marked the initiation of the provincial New Democratic Party (N.D.P.) government's attempt to extend a wider range of public goods and services to remote northern centers. The chief objective of the government was to provide the same level and variety of public services in the north as already existed in the south. During this six-year period the infrastructure of the north was greatly expanded. This expansion included extending the provincial highway system into the north, thus significantly improving accessibility.

THE SOCIAL GRAVITY-HYPOTHESIS AND IN-MIGRATION TO NORTHERN SASKATCHEWAN

In many studies of spatial-interaction behavior, it has been shown that the distance between two points and the size of their respective populations (mass) provide a high degree of statistical explanation, with respect ot the volume of flow between two points (Lowe and Moryadas, 1975; Haynes and Fotheringham, 1984). The mass movement of people from one place to another has been shown to vary directly with the perceived unattractiveness of the origin and the perceived attractiveness of destinations, and to vary inversely with the distance separating the origin from the potential destination. This relationship, best described as "social gravity", was first modeled by Zipf (1949). Since then, the gravity model and variants of it have become widely used to model various forms of spatial interaction, including migration.

The traditional (unconstrained) gravity model is given by:

$$M_{ij} = K P_i^{b1} P_j^{b2} d_{ij}^{b3} \quad (1)$$

where, M_{ij} is the movement from origin i to destination j,
K is a constant of proportionality,
P_i is the nodal propulsiveness of origin i,
P_j is the nodal attractiveness of destination j,
d_{ij} is the distance between origin i and destination j,
and b_1, b_2 and b_3 are regression parameters.

A general linear model is obtained by taking the logarithms of both sides of the equation. Regression parameters are then estimated using the ordinary least squares method.

In this equation, several measures can be used as surrogates for nodal propulsiveness and attractiveness. Most often, these measures are representations of mass, such as population size, the number of functions or the number of telephones. However, measures of mass may not necessarily be appropriate measures of nodal attractiveness and propulsiveness. For instance, many migrants originating from communities in southern Saskatchewan and elsewhere originate from communities that have a greater population size than the destination communities to the north, while migrants originating from within northern Saskatchewan have had a greater propensity to originate from places of smaller size. Hence, nodal attractiveness and propulsiveness cannot be effectively specified using measures of mass. There are no inherent difficulties in obtaining measures of distance. Absolute (linear) distance is often used, although relative measures of distance, measured by time, cost or effort, may be used.

For northern Saskatchewan communities, population size is the *only* available surrogate measure for mass. Because this is a temporal study, reliable population estimates for all origins and destinations in all time periods are needed. This adds complexity to the problem, since census data from northern Canada, particularly prior to 1981, have been far from reliable (Murauskas, 1983, ch. 4). Even today, many northern communities remain legally unincorporated municipal entities. Moreover, many of the communities in northern Saskatchewan are very small (communities with a population size above 400 tend to be exceptions), and the volume of migration among these communities, and between the north and south, has tended to remain relatively small with respect to contemporary urban Canada.

Relatively few studies of spatial-interaction behavior have been undertaken in frontier regions, especially where migration volumes have been low. This gap in the literature can largely be accounted for by the inherent difficulties in obtaining regression parameters for the gravity model or variants of it. A log-linear analysis of contingency tables is seen as an appropriate alternative for the calibration for a gravity model-like model, as it does not employ measures of nodal propulsiveness or attractiveness, and analysis is not hindered by using small data sets. This log-linear methodology is elaborated upon in the next section of this paper.

MULTIDIMENSIONAL CONTINGENCY-TABLE ANALYSIS OF CATEGORICAL IN-MIGRATION DATA

The log-linear approach to contingency-table (cross-tabulation) analysis has the advantage of being an exploratory as well as a confirmatory tool of analysis. This characteristic gives the log-linear model innumerable possibilities as an analytic method in the social sciences (Knoke and Burke, 1980). Fingleton (1981) demonstrates

the utility of the log-linear approach in modeling categorical data of a geographical nature. Until recent advances in methodology were made, the analysis of contingency tables was limited to the examination of two categorical variables at a time; multidimensional tables were decomposed in order to facilitate pairwise comparison. Multidimensional analysis of contingency tables allows the researcher to identify higher-order interactions among variables, and to isolate these from pairwise relationships (Willekens, 1983).

The basis of this approach is to approximate the cell frequencies of a contingency table by controlling for the relationships among all the categorical variables in the contingency table. In the general log-linear model, the expected cell frequencies of a contingency table, denoted by F_{ij}'s, are functions of parameters representing characteristics of the categorical variables and their relationships with each other. In assessing how well a model "explains" or fits the data, the concern is with the extent to which the frequencies expected under the model, (the F_{ij}'s), approximate the frequencies actually observed (the f_{ij}'s) in the contingency table (Knoke and Burke, 1980, p. 11).

The initial log-linear model is a *saturated model*, where all possible effect parameters are present. There is no parsimony with the saturated model, since the expected cell frequencies generated by a saturated model will always equal the cell frequencies in the contingency table. Some of the effect parameters in a saturated model may not have values which are significantly different from 1,00. More parsimonious and simpler models can be arrived at by setting these effect parameters to 1,00. In a multiplicative model an effect parameter with a value of 1,00 has no effect. These *nonsaturated models* attempt to provide expected frequencies (F_{ij}'s) which are least discrepant from the actual frequencies (f_{ij}'s) found in the contingency tables. In other words, a nonsaturated model allows one to identify the structural relationships within a set of categorical variables. The logic of the nonsaturated model is to attempt to describe these data structures with as few effect parameters as possible.

The model fitting procedure described above is essentially equivalent to testing hypotheses regarding the independence of categorical variables. According to Willekens (1983), it is this equivalence that provides a basis for linking spatial-interaction analysis to contingency-table analysis. Willekens demonstrated the specification of a spatial-interaction model as a hierarchical log-linear model. This model was applied to a structural analysis of intra-urban migration patterns in Rotterdam in 1973. Three categorical variables were specified: ethnicity (of which there were four categories), zone of origin and zone of destination (where seven categories of each zone were defined). This specification was particularly useful in terms of disaggregating the effect of ethnicity to indicate how the migration behavior of certain ethnic groups differed. In other words, Willekens' specification of the model effectively isolated the *structural* components in the migration process particular to Rotterdam in 1973.

The methodology described above is adapted in order to isolate the structural components of in-migration to frontier communities in northern Saskatchewan, from 1927 to 1976. This study derives its data from the occupations directory subfile of the Northern Saskatchewan Housing Needs Survey (D.N.S., 1977). This household survey was conducted by the Institute for Northern Studies (University of Saskatchewan) in 1976. This subfile contains information on 5 846 respondents of various ages in 37 northern Saskatchewan communities, and records the housing conditions of the residents of these 37 Metis settlements. This survey excluded the major centers of La

Ronge, Creighton and Uranium City, as well as all Indian reserves. The survey includes each respondent's age, gender, community of residence, previous place of residence (if any), place of birth, length of residence in the community, as well as a number of socio-economic variables associated with present and previous employment experiences.

In this study, a migrant is defined as any individual having a birthplace other than the individual's community of residence. Non-migrants were excluded from the study and the study ignores stage migration. In an effort to eliminate involuntary migration and to exclude individuals who may have been born outside their home communities because a hospital did not exist in the home community, only those individuals who moved to their respective home communities at or above the age of 18 are included in the analysis. With the exclusion of all cases not meeting the above mentioned criteria, including cases where critical data are missing, the in-migration data set was reduced to 522 cases (see Murauskas, 1983).

These 522 cases of in-migration cover a period of fifty years, 1927 to 1976. Since the survey from which this migration data is derived was conducted in 1976, there is no record of in-migration and subsequent out-migration or death prior to the date of the survey. In small part, this explains why the majority of in-migration cases occur just prior to the date of the survey.

The specification of this temporal in-migration study as a log-linear model includes four variables, denoted by A, B, C and D. A and B, respectively, are categorical variables representing the area of origin and the area of destination. There are 9 categories (1 through 9) representing the destination area (variable B), and there are 11 categories representing the origin (variable A); categories 1 through 8, are identical to the categories of the destination area variable (all of which are in northern Saskatchewan), while categories 10 through 12 represent origin areas which are all found in the south (Category 9 is not specified as an area of origin because no migrants originated from this area throughout the study period). A community's categorical membership for both variables A and B was determined on the basis of cluster analysis, where absolute proximity to other communities was the major grouping criterion. Origin and destination areas 1 through 9 are mapped and appear in figure 1. The group membership of all origin and destination communities in this study is given in table 1.

Variable C represents the time period in which a migrant moved to a destination community in northern Saskatchewan. Categories 1, 2 and 3, respectively, represent time period 1 (1927–1960), time period 2 (1961–1970), and time period 3 (1971–1976). As noted earlier, these time periods are representative of the profound changes experienced by Metis society in northern Saskatchewan over the past 60 years. Variable D represents the gender of the migrant (categories 1 and 2, respectively, for males and females).

The saturated log-linear model (for the northern Saskatchewan in-migration data set) is given by:

$$F_{ijkl} = \eta_{\tau_i} A_{\tau_j} B_{\tau_k} C_{\tau_l} D_{\tau_{ij}} AB_{\tau_{ik}} AC_{\tau_{il}} AD_{\tau_{jk}} BC_{\tau_{kl}} CD_{\tau_{jl}} BD_{\tau_{ijk}} ABC_{\tau_{ijl}} ABD_{\tau_{ikl}} ACD_{\tau_{jkl}} BCD_{\tau_{ijkl}} ABCD \quad (2)$$

where, η is the geometric mean (the general effect parameter), which is analogous to the slope intercept in the general linear model.

Table 1

Origin and Destination Areas and their Communities

NORTHERN SASKATCHEWAN IN-MIGRATION (1927–1976)

ORIGIN AND DESTINATION GROUPS

1. Montreal Lake Basin
   - Air Ronge
   - La Ronge
   - Lavaliee Lake
   - Molanosa
   - Nemeiben Lake
   - Timber Bay
   - Trout Lake
   - Weyakwin
2. Southend Corridor
   - Brabant Lake
   - Grandmother's Bay
   - Mountain Lake
   - Nistowiak Lake
   - Southend
   - Stanley Mission
   - Waddy Lake
3. Churchill River Headwaters
   - Knee Lake
   - Patuanak
   - Pinehouse Lake
   - Primeau Lake
4. East Side Center
   - Birch Portage
   - Creighton
   - Cumberland House
   - Denare Beach
   - Deschambeault Lake
   - Pelican Narrows
   - Pemmican Portage
   - Pine Bluff
   - Sandy Bay
   - Sturgeon Landing
   - Sturgeon-Weir River
5. Green Lake Corridor
   - Beauval
   - Canoe Lake
   - Cole Lake
   - Dore Lake
   - Green Lake
   - Jans Bay
   - Sled Lake
6. West Side Center
   - Buffalo Narrows
   - Dillon
   - Ile-a-la-Crosse
   - Michel
   - St. George's Hill
7. West Side North
   - Garson Lake
   - La Loche
   - La Loche West
   - Turnor Lake
8. Far North
   - Black Lake
   - Cree Lake
   - Fond-du-Lac
   - Gunnar
   - Stony Rapids

DESTINATION GROUP ONLY

9. Wollaston — Reindeer
   - Kinoosao
   - Wollaston Lake

ORIGIN GROUPS ONLY

10. Southern Saskatchewan
    - Meadow Lake-Battlefords Corridor:
      - Clear Lake
      - Edam
      - Leoville
      - Livelong
      - Lloydminster
      - Loon Lake
      - Meadow Lake
      - Meota
      - North Battleford
      - Pierceland
      - Speers
    - Prince Albert District:
      - Big River
      - Canwood
      - Duck Lake
      - Ethelton
      - Kinistino
      - Leask
      - Nipawin
      - Paddockwood
      - Prince Albert
      - St. Louis
      - Shell Lake
      - Smeaton
      - Sturgeon Lake Reserve
      - Weldon
      - Wierdale
      - Yellow Creek

Table 1 (suite)

Origin and Destination Areas and their Communities

NORTHERN SASKATCHEWAN IN-MIGRATION (1927-1976)

Hudson Bay-Yorkton Corridor:
- Arran
- Canora
- Carragana
- Endeavour
- Hazel Dell
- Hudson Bay
- Hyas
- Kamsack
- Kelvington
- Lintlaw
- Pelly
- Porcupine Plain
- Rockford
- Rose Valley
- Sheho
- Sturgis
- Theodore
- Wadena
- Yorkton

Saskatoon District:
- Alvena
- Biggar
- Cudworth
- Davidson
- Hague
- Leroy
- Meacham
- Middle Lake
- Outlook
- Saskatoon
- Vonda
- Watrous
- Young

Southeast Corner:
- Estevan
- Heward
- Kennedy
- Storthoaks

Southwest Corridor:
- Dodsland
- Eastend
- Kindersley
- Leader
- Maple Creek
- Shaunavon

Regina-Moose Jaw Division:
- Assiniboia
- Bridgeford
- Gravelbourg
- Lucky Lake
- Moose Jaw
- Regina
- Rouleau

Fort Qu'Appelle-Melville District:
- Balcarres
- Cupar
- Esterhazy
- Fort Qu'Appelle
- Grayson
- Killaly
- Leross
- Melville

11. Manitoba

12. All Other Origins
    Canada:
    - Alberta
    - British Columbia
    - Maritime Provinces
    - Northwest Territories
    - Ontario
    - Quebec

    United States of America

This saturated model can be simplified by using fitted marginals notation:

$$F_{ijkl} = < ABCD > \quad (3)$$

All the lower order associations (effect parameters) are hierarchically nested within the fitted marginals.

Willekens (1983) demonstrates that the 'Ab' effect parameter in the log-linear model is equivalent to a distribution function in traditional gravity model formulations.

The role of the distribution function is to impose interaction effects on the (origin to destination) flow matrix. Willekens argues that the distribution function employed in traditional gravity model formulations captures the general effect of distance, but not space. This is because the distribution function employed in traditional gravity model formulations is only a function of intervening factors, such as the reciprocal of the travel cost function or the distance deterrence function. Willekens maintains that the 'AB' effect parameter in the log-linear specification captures the general effect of space.

THE RESULTS AND THEIR IMPLICATIONS

A maximum likelihood estimation (MLE) procedure was used for the stepwise deletion of effect parameters from the saturated model. The MLE procedure stops when the expected cell frequencies generated by a simpler log-linear model become significantly discrepant from the actual frequencies in the contingency table. The most simple (parsimonious) model, which generates expected frequencies significantly close to actual frequencies, is arrived at by deleting 11 effect parameters (by setting these effect parameters to 1,00). This model is given by:

$$F_{ijk} = \eta_{\tau_i} A_{\tau_j} B_{\tau_{ij}} AB_{\tau_k} C \qquad (4)$$

or in fitted marginals notation:

$$F_{ijk} = < AB > < C > \qquad (5)$$

Statistical parameters of the $< AB > < C >$ Model
- Degrees of Freedom: 495
- Likelihood-Ratio Chi Square: 372.84
- Pearson Chi Square: 377.69

The simplicity of the terminal log-linear model is an indication of the simple structural components of the northern Saskatchewan in-migration process. The absence of all effect parameters with "D effects" indicates that the gender of the migrant had no effect on the propensity to migrate. This result counters what is suggested in the literature. Many empirical studies indicate that migration is primarily a selective process, attracting from the ranks of the young, the educated and the skilled. This literature also suggests that migration is *especially* selective of males in *traditional* societies. However, the resulting log-linear model indicates that male selectivity was absent in all three time periods. This suggests that in Metis society, migration that is selective of males has been absent from this society for at least the last 60 years.

The absence of the "ABC" effect parameter indicates that the distribution function (the interaction effects) did not change over the course of the study period. As indicated by the resulting nonsaturated model, ($F_{ijk} = < AB > < C >$), the distribution function (the 'AB' effect parameter) is independent of, but related to, time (the 'C' effect parameter). In other words, the in-migration pattern (or the spatial structure of the in-migration field) has not changed over time. However, the number or volume of migrants has increased over time. The flow matrix gives the mean or aggregate in-migration pattern for northern Saskatchewan communities for all three time periods (table 2). The vector matrix for the 'C' effect parameter indicates the degree to which the in-migration volume increased throughout the study period (table 2).

Table 2

Effect Parameters of the Nonsaturated Model
The Mean Migration Pattern in Northern Saskatchewan (1927–1976): the "AB" Effect Parameters Independent of Time Periods

To	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*Row Effects*
From										
1	29,260	6,911	2,005	,097	,888	,122	,182	,560	2,291	1,054
2	4,556	22,368	,776	,706	,344	,205	,306	,939	,887	,628
3	3,747	,665	4,891	,581	,283	3,535	,251	,772	,729	,764
4	,307	3,386	,750	19,591	,332	,198	,295	,907	3,713	,650
5	,292	,742	,712	,150	24,514	2,068	1,216	,862	,814	,684
6	,102	,260	1,080	,401	5,999	7,300	5,344	1,307	,285	1,956
7	,330	,839	,805	,169	,357	9,423	8,779	,975	,920	,605
8	,449	1,142	1,096	,230	,486	1,253	,432	23,437	1,253	,445
10	3,672	,126	,523	6,866	3,259	1,305	1,631	,146	,597	4,043
11	,201	,511	,491	29,997	,942	,129	2,126	,594	4,298	,994
12	1,998	,242	1,006	2,651	,446	1,899	2,836	1,218	,265	2,100
Column Effects	1,375	,541	,563	2,681	1,272	2,135	1,430	,466	,493	1,675

THE EFFECT OF TIME PERIOD ON THE VOLUME OF INTERACTION: THE "C" EFFECT PARAMETER

Time Period	*Parameter*
1927–1960	,626
1961–1970	,945
1971–1976	1,690

1) Montreal Lake Basin
2) Southend Corridor
3) Churchill River Headwaters
4) East Side Centre
5) Green Lake Corridor
6) West Side Centre
7) West Side North
8) Far North
9) Wollaston — Reindeer
10) Southern Saskatchewan
11) Manitoba
12) All Other Origins

The flow matrix reveals a simple geographical pattern of in-migration to frontier communities in northern Saskatchewan. There was a high propensity for migrants to move to destination communities that were within the area of origin ; this is particularly evident in the Montreal Lake Basin (1), the Green Lake Corridor (5), the Far North (Lake Athabaska Basin) (8), the Southend Corridor (2) and the East Side Center (4) (figure 1). Furthermore, it appears that inter-community marriages and other family and kinship ties have precipitated much of this intra-areal migration. The propensity for inter-areal migration within northern Saskatchewan was low, indicating that there was little movement over great distances. The propensity for inter-areal migration is most evident between neighboring areas : between the West Side North (7) and West Side Center (6), between the Montreal Lake Basin (1) and the Southend Corridor (2), and from the West Side Center (6) to the Green Lake Corridor (5). There was little or no propensity for migration (cell frequencies tending toward 1,00) between the Lake Athabaska Basin (8) and the West Side North (7), the East Side Center (4), the Churchill River Headwaters (3), and the Southend Corridor (2). In part, this can be explained by the distances separating these areas. However, cultural barriers between the Plains Cree and the Chipewyans of the Far North also appear to have impeded migration.

The spatial pattern of in-migration originating outside of northern Saskatchewan resembles series of streams to a select number of destination areas. Furthermore, migration to these destinations appears to have been economically motivated. The flow matrix indicates that southern Saskatchewan (10) out-migrants were most likely to move to the East Side Center (4), the Montreal Lake Corridor (1) and the Green Lake Corridor (5). All three areas share a common characteristic: a higher degree of economic coordination with the south. Moreover, the East Side Center (4) includes the Flin Flon-Creighton mining district. Migrants originating in Manitoba (11) were primarily attracted to mining areas, particularly the East Side Center (4), and to a much lesser extent, the Wollaston-Reindeer area (9). However, both of these areas border Manitoba and it is apparent that some of this inter-provincial migration was promoted by family, kinship or other social ties. The in-migration patterns of migrants originating outside of Saskatchewan and Manitoba (12) are not particularly discernible because the information loss with this level of spatial aggregation is too high.

The assertion that the spatial pattern of in-migration in northern Saskatchewan had not changed over a period of 50 years is indeed astounding. Considering the development and extension of infrastructure into northern Saskatchewan throughout the study period, this assertion was not anticipated. An expanding network of roads and highways, and improvements in intra-regional and inter-regional communications, in large part due to gradual introduction of telephones and television, led to an expectation of an impact on spatial-interaction patterns. This evidently was not the case in northern Saskatchewan from 1927 to 1976.

CONCLUSION

Traditional methods of modeling spatial interaction behavior, namely gravity model formulations, have enabled researchers to verify certain theoretical propositions empirically and to obtain a better understanding of the spatial correlates of migration. However, the usual gravity model formulations have certain limitations which may hinder analysis where data sets are small. Such is the case for northern Saskatchewan, a frontier region where established theoretical propositions are less likely to hold true. The paucity of the literature which addresses spatial-interaction behavior in frontier regions can partially be explained by the availability of appropriate methodologies.

The log-linear model, which enables multidimensional contingency-table analysis of categorical data, is a recent methodological advance that is well suited for spatial-interaction modeling, particularly where data sets are small. Furthermore, the log-linear method can reveal structural components in the spatial-interaction process including non-spatial components.

The log-linear analysis of categorical in-migration data for northern Saskatchewan communities reveals two major findings. First, spatial patterns of in-migration have not changed over a fifty year period, despite the introduction and extension of an infrastructure. Secondly, the gender of a migrant has had no effect on the propensity to migrate. The second conclusion counters the widely held proposition that migration tends to be selective of males in traditional societies.

However, it would be tentative to conclude that this analysis has totally revealed the structural components of in-migration to northern Saskatchewan. It is clear that other variables in the migration process merit scrutiny, and it is suggested that the log-linear approach is well suited for such a course of future inquiry. Moreover,

analyses of migration in other developing or frontier regions are needed to further our knowledge and understanding of migration in such areas.

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