

THE UNIVERSITY OF MANITOBA

THE ROLE OF TRANSPORTATION IN REGIONAL DEVELOPMENT:
IMPACTS ON INDUSTRIAL LOCATION

by

JACK W. CRAVEN

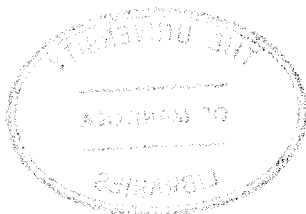
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the University of Manitoba in partial fulfillment of the requirements
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ABSTRACT

In Canada, concern and debate continues about the policy objective of using transportation policies and programs as instruments to encourage regional development. Analytical tools to measure the effectiveness of transportation policies in achieving this end are lacking. Much of the debate focuses on freight rates and subsidies for historical and economic reasons.

The thesis focuses upon the role of transportation in influencing location decisions of manufacturing firms. The central issue is whether or not transportation policies can be designed to influence these location decisions so that industrialization of selected regions may be encouraged.

The investigation is based on industrial location theory which hypothesizes that transportation costs and services are significant factors influencing the location decisions of manufacturing firms.

Theories of regional development and theories of industrial location are reviewed. Growth centre theory suggests that the spatial location of economic activity may be a critical determinant of growth. Transportation costs and services play a central role in industrial location theories (the micro-economic basis of growth centre theory). An eclectic framework derived from these various industrial location theories would suggest a firm's potential profit will vary across space. The choice of location and a firm's investment decisions are interrelated. Since anticipated profits at a particular location may not be realized, the entrepreneurs may face the alternative of re-locating the firm or remaining in the same location. The initial choice of location and the ability to continue operating in the same location may be interrelated.

Entrepreneurs unaware of profit variation through space may be forced out of business.

The geographic distribution of manufacturing firms in Southern Manitoba and their movement between 1961-66, 1966-71, and 1971-76 is described using Markov probability matrices. Communities are grouped into nineteen sub-regions or states with a twentieth state for all other locations as well as firms coming into and going out of existence. The Markov model identifies and quantifies several location decisions that are made:

1. initial location choice
2. movement between communities
3. remaining in the same location or leaving the study area or going out of existence.

The Markov model measures the relative importance of these kinds of moves. Tests are available to measure the significance of the firms' location on these kinds of decisions.

The results of the Markov model show that most of the industrial change within Southern Manitoba was due to firms entering or exiting the region and the industry with movements between communities being infrequent. Large gross changes in the number of firms masked net changes. Location influenced the likelihood of firm survival and the choice of a new site. The basic spatial distribution of industrial firms in the study area changed over time.

Firms in the food processing and beverage sector were selected to test the hypothesis that the likelihood of a firm surviving is related to the locational characteristics of the community where it is located. Three models of qualitative choice appear useful to analyse the decisions made by manufacturing firms to remain in their selected loca-

tions or not. These attempt to relate the decision of individual units to carry out an action or not with factors hypothesized to influence the decision. Since the decision is binary, it can be measured as a 0 or 1. The results are expressed as a probability that a course of action will be taken. The LOGIT model used grouped data for the time periods 1961-66, 1966-71, and 1971-76. Individual firm data between 1971-76 were analysed using the PROBIT and linear probability models.

The explanatory variables included measures of major locational attributes: distance from Winnipeg, average cost of labour and population change. Distance is useful as a proxy for transportation charges because the freight rate structure is too complicated. Average wages and salaries serve as measures of the average cost of labour. Population change is a measure of the change in market potential. Separate measures of transportation service are also included.

The hypothesis was not verified. In particular, distance from Winnipeg, as a proxy for transportation costs, and the measures of transportation services were not significant. Transportation policy may not be a useful tool to encourage regional industrial development. While industrial location theory suggests that transportation costs and services may influence individual firm decisions, their aggregate impact on a regional economy may be unknown.

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Thanks are due to Dr. Greg Mason for his assistance during the research and his useful comments on the dissertation. Dr. John Heads, Acting Executive Director, Research Branch, Canadian Transport Commission, deserves thanks for his review and comments on my thesis.

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I am grateful to my mother and sister for their encouragement and support in this endeavour.

Chapter 1

INTRODUCTION

Problem Statement

To what extent can governments use their regulatory power over the transportation industry to encourage industrial development in rural regions by influencing decisions regarding the location of manufacturing firms?

This problem has three components:

1. While industrial location theory suggests that transportation costs and services may influence individual firms decisions, will they have a substantial impact on a regional economy?
2. Can a policy analyst anticipate the consequences of a particular decision with respect to freight rates or service levels?
3. Can these consequences be measured in terms of economic indicators of regional development such as changes in employment and income?

Study Objectives

This thesis investigates the role of transportation in regional development through possible impacts on the location decisions of entrepreneurs.

The specific objectives of the research were:

1. to identify the changes in geographic distribution of manufacturing firms in Southern Manitoba over time focusing on specific communities and groups of communities;
2. to quantify the kinds of firm location decisions that might be undertaken;

- a) the initial choice of a location,
 - b) the decision to continue operating in the selected location,
 - c) re-location from one community to another community within the study area, and
 - d) leaving the study area or ceasing operations;
3. to specify a decision model to test the hypothesis that firm survival (continued operation) may be related to its location in the study region because potential firm profits may vary by location; and
 4. to relate this decision to transportation costs and services which industrial location theory postulates to be important causes of profit variation through space.

Background To Problem

Economic development means a change in the economic structure of a society that increases the welfare of individuals within that society, however welfare is measured. This concept includes economic growth which describes changes in a society reflecting an increase in the size or number of some specific economic measures. This change does not occur uniformly throughout the economy and differences from one region to another exist. Regional development as a field of study seeks to explain why these differences exist. Natural resources are not uniformly distributed, but this is not a sufficient explanation because if the costs of moving resources and commodities through space were negligible, then the fact of non-uniform distribution of resources would not hinder uniform growth throughout an economy. Thus, the costs of moving resources and commodities through space, transportation costs, do play some role

in the degree of variation in the rate of regional development.

One major economic change in the Prairie economy over the past forty years has been the mechanization of agriculture, and the consequential shift to fewer and larger firms with reduced demand for farm labour. The declining farm population undermined the base for the rural service centres and induced declining employment in non-government service occupations. These changes induced a major shift of population from rural areas to urban centres.

This shift in population has caused concern among government officials and social planners. The preference of rural residents to remain in home locations may be frustrated by a lack of employment opportunities. Maintaining social services in rural areas for a decreasing but dispersed population tends to be more costly than servicing a less dispersed population. Urban growth may lead to diseconomies in terms of higher social costs through traffic congestion, and pollution.

In Canada, government have extensive jurisdiction over the transportation industry. The federal government regulates rail, water, and air services, and to a certain extent, extra-provincial trucking through the Canadian Transport Commission. Provincial governments regulate trucking to varying degrees. Rate regulation and subsidies are important policy instruments. Crown corporations such as Air Canada and Canadian National Railways provide direct services to the public. Governments at both levels maintain and construct transport facilities.¹

¹Tyrchniewicz, E. W., and J. A. MacMillan, "Transportation in Agriculture: Farm Expense, Public Service, Subsidy, or Regional Development Instrument?", The Agrologist, January-February, 1974.

In the 1960's, the promotion of regional development in order to eliminate economic and social disparities among regions became a political concern for the Federal and Provincial governments in Canada.² These governments have regarded transportation policy as an acceptable tool of regional development. The suggested revision to the National Transportation Act illustrates Federal government policy. Section 3.(1) is revised to read:

It is hereby declared that the objective of the transportation policy for Canada is to achieve a transportation system that

1. is efficient
2. is an effective instrument of support for the achievement of national and regional social and economic objectives and
3. provides accessibility and equity of treatment for users, and it is further declared that achievement of the objective of the transportation policy for Canada requires the integration of services employing the most appropriate modes for each service and that it is the responsibility of governments to attend to the provision of the transportation system.³

Provincial governments in Western Canada supported this policy when Prime Minister Trudeau and other federal ministers met their provincial counterparts from the four Western provinces to discuss regional grievances with federal policies that were regarded as hindering the economic development of Western Canada, at the Western Economic Opportunities Conference

² Tom Kent, "The Structure of Canadian Regional Programs", Incentives, Location and Regional Development, ed. P. Phillips, (Proceedings of a Conference Sponsored by the Manitoba Economic Development Board), Winnipeg, 1975.

³ Canada, Bill C-33, 30th Parliament, 2nd Session (1976-77) First Reading, January 27, 1977, Section 1.

in Calgary on July 24-26, 1973. Transportation policy and rates were cited as critical issues. The provincial governments demanded concrete programs and policies and the federal government acknowledged the need for them.

Much of the discussion on transportation policy and regional development has focussed on freight rates. The focus has both an institutional and an economic basis.

The statutory grain rates and the Maritime Freight Rates Act are two examples of institutions. The statutory grain rates, set in 1925, are maximum rates which the railways may charge to move grain and grain products from the Prairies to export positions and for domestic use in Eastern Canada. These rates were intended to encourage the development and expansion of the Western agricultural industry through grain production. The Maritime Freight Rates Act, introduced to apply to railway rates in 1927 and extended to the trucking industry in 1969 as the Atlantic Region Freight Assistance Act provides subsidies for products exported from the Maritimes to Central Canada. The original principle behind this act was encouraging access to Central Canada for Maritime products which was one of the Terms of Confederation. The circumstances of low economic growth in the Maritimes has resulted in the wide interpretation of this program as being intended to assist Maritime economic development.⁴

The economic basis for the emphasis on freight rates is the separation of cost determination and rate-making in the transportation industry. Estimating the cost of shipping a single commodity in the trans-

⁴Legislation and Public Policy, Volume V, Atlantic Provinces Transportation Study, (Ottawa, Queen's Printer, 1967).

portation industry is almost impossible because common costs are incurred when the same service is provided to carry different products and joint costs occur when more than one service is technically inseparable. One of the few cases where such costs were estimated is grain;⁵ however the problems and complications in doing this were very great.

Consequently, the rates for specific commodities are based on principles only partly related to the cost of service. Rates are generally also set relative to:

1. the value of the product carried or
2. the price for which the product may sell in the market at its destination, or
3. the amount a shipper is willing and able to pay.

Some degree of arbitrariness is introduced into rate-making and this exposes the transportation industry to the suspicion of economic 'exploitation' and discrimination unjustified by market conditions. Suspicion of railways is more frequent because intermodal and intramodal competition may be limited. Government intervention to protect shippers is considered to be justified. This can lead to the argument that since arbitrariness enters into rate-making and rates cannot be set equal to the marginal cost of moving commodities, it is not unreasonable for the government to regulate freight rates so as to suit broader government objectives.

Government departments and agencies concerned with transportation are expected to formulate policies that will support the objective of

⁵The Commission On the Costs of Transporting Grain by Rail, Volume I (1976), Volume II (Supply and Services Canada, Ottawa, 1977).

promoting regional development.⁶ They need to know how these policies will affect the regional development process. At the same time, that objective is secondary to their operational goals which may be expressed in terms of efficiency of operations, better service to the public, etc. The policies adopted should consider all the objectives of these organizations, but these goals are inconsistent with one another. How these conflicting objectives should be resolved is the subject of constant debate. Effective decisions regarding rate regulation and subsidy programs require an understanding of the role of transportation in regional economic development.

Regional development economists have suggested a variety of ways in which transportation can influence regional development. First, transportation facilities are the basis of an infrastructure that makes economic activity both economically and physically possible. The region has better access to external markets to sell its products. Second, the many millions of dollars invested in transportation facilities may generate additional expenditures. Third, transportation costs are analogous to international trade tariffs. Drawing on this, regional economists have argued that altering freight rates can have similar impacts to changing tariffs on the regional distribution of production and inter-regional trade. Fourth, location theory postulates that transportation costs can be critical in determining the location of the firm. On this

⁶K. W. Studnicki-Gizbert, "Transportation Policy: Objectives and Policy Instruments" in Studnicki-Gizbert, ed., Issues in Canadian Transportation Policy (Toronto: Macmillan of Canada, 1974) pp. 361-407.

, "The Administration of Transport Policy: The Regulatory Problem", Canadian Public Administration Vol. 18, No. 4, 1975, pp. 642-658.

basis, many economists and public policy-makers feel that transportation policy could encourage rural industrialization which has been a central theme in development-oriented policy.

Industrial location theories attempt to explain the decision-making process by which firms select locations at which to produce. These theories are the basis for analyzing the impact of freight rates and transportation services on industrial location, and evaluating the consequences of transportation policies to promote industrial development.

Government transportation policies intended to encourage regional industrial development have not been properly evaluated.⁷ The economic evaluation of public policies and programs should compare their economic benefits with their social costs. If economic development can be accelerated or encouraged by transportation programs, such benefits could be measured in terms of the economic measures of development such as increment in personal incomes and employment levels.

Method of Investigation

The study area, Southern Manitoba, is the part of the Province of Manitoba south of the 53^o latitude. This region is characterized by a single metropolitan centre, Winnipeg, surrounded by a predominantly agricultural hinterland containing much smaller urban centres with manufacturing activity in many of them.

The time period for which the study was conducted extended from 1961 to 1976. A time period of ten to fifteen years may be sufficient

⁷ Economic Council of Canada, Living Together - A Study of Regional Disparities, (Ottawa, Canada: Minister of Supply and Services, 1977) p.190.

to recognize development patterns.

The first part of the investigation was a descriptive analysis of the spatial distribution of manufacturing firms in the study area during 1961-76. This spatial distribution changed as existing firms re-located or ceased operations (no suitable locations) and new firms selected locations within the study area. These actions reflected different location decisions which might be influenced by transportation policy instruments. Assessing the significance of these types of firm movements required their identification and quantification. A method of describing the geographic distribution of firms and their movement over time was needed so that the observed actions of individual firms could be consolidated to express their aggregate behaviour over time yet retaining the ability to identify specific sub-regional patterns. The organization of information on firms into the framework of a Markov probability matrix provided such a useful and concise method. Expressing the results as probabilities could have made forecasting changes in the regional industrial distribution possible.

This study uses as a data unit, an entity very similar to the establishment as defined by Statistics Canada, but labelled with the more familiar term, the firm.

The results of the descriptive analysis using the Markov probability matrix indicated that analysis of the ability of firms to survive in their present locations as opposed to re-locating or going out of existence might be fruitful. The explanatory analysis is restricted to the food processing and beverage sector (three digit Standard Industrial Classification code) because reducing the heterogeneity of firms seemed advisable and this sector is the largest in Southern Manitoba containing

29 percent of the firms located outside Winnipeg. The individual actions of firms are impossible to predict exactly due to uncertainties facing their decision-makers. Models of qualitative choice are suited to analyze decision-making in this context.

These models analyze the factors affecting a decision to undertake a course of action or not. Three models of this type were utilized. A LOGIT model using aggregate data and the ordinary least squares method of estimation was employed for the three time periods used in the Markov probability matrices. The number of sub-regions was reduced to fifteen for technical reasons. The number of firms involved in each period were: 399 in 1961-1966, 230 in 1966-1971 and 232 in 1971-1976. A linear probability model and a PROBIT model were applied to the analysis of individual firm data. The PROBIT model was estimated using a maximum likelihood technique. The individual firm data were based on the actions of the 232 firms between 1971-1976.

The main data sources for the characteristics of the locations of firms are the publications of the Regional Analysis Program conducted by the Manitoba Department of Industry and Commerce.⁸ The base year of the data is 1971.

⁸Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba - Update Part 1A (Volumes I and II) (Winnipeg, Manitoba, 1975).

, Regional Analysis Program Southern Manitoba Working Paper No. 1 Economic Characteristics (Winnipeg, 1975).

, Regional Analysis Program Southern Manitoba Working Paper No. 2 Analysis of Community Functions & Relationships (Winnipeg, 1974).

, Regional Analysis Program Southern Manitoba Working Paper No. 3 Analysis of Community Services & Facilities, (Winnipeg, 1974).

, Regional Analysis Program Southern Manitoba Working Paper No. 4 Analysis of Population Change 1951-1971 Southern Manitoba (Winnipeg, 1976).

Outline of Presentation

In Chapter 2, the economic theories of regional development and industrial location are reviewed. The relationships between the theories are discussed. Gaps in knowledge are indicated. Concepts useful for empirical analysis are drawn from the theories and presented.

Related literature on empirical analysis of industrial location problems are outlined in Chapter 3. The models used will be related to the ideas derived from the theory.

The method of investigation is detailed in Chapter 4. Specific sub-regions used in the Markov probability analysis and the LOGIT model are defined and illustrated. The models of qualitative analysis are described in terms of their theoretical implications, weaknesses, and strengths.

The discussion and interpretation of the results are found in Chapter 5.

Chapter 6 contains a summary of the study. Conclusions and implications for public policy are presented. Suggestions for further research are made.

Chapter 2

REVIEW OF THEORY

This study investigates the extent to which transportation costs and services influence regional industrial development through their impact on location decisions. The investigation employs two analytical models. Analytical models employed in applied research should be based on existing theoretical knowledge. The problem touches upon two complex processes - the economic development of a society, and its spatial organization. The state of theoretical knowledge is incomplete probably because the complexity of the processes defies simplification. The analytical models must be based on principles drawn from the existing partial theories. The purpose of this chapter is to briefly review the basic economic theories and indicate these principles.

Explaining the location of manufacturing activity is one part of spatial analysis of society conducted by social scientists. This part is the primary concern of this study, but the other parts are complementary in that transportation costs are theorized to play an important role. The other subjects studied include agriculture and urban land-use, the formation and hierarchical structure of communities, and residential location.

Regional development implies a spatial context to the process of economic development. The process of economic development, complex because time is introduced, is further complicated by the fact that the process is not identical across space.

This chapter will review theories of regional development from the perspective of five themes. Emphasis will be placed upon growth

centre theory which attempts to explain spatial variation in the rate of development explicitly. The discussion of industrial location theory will examine three approaches: production cost, market domination and profit maximization. Each is incomplete, yet the theoretical knowledge regarding industrial location has not been synthesized. Nevertheless, a theoretical framework supporting the analysis is developed from the three approaches presented.

Theories of Regional Development

The Five Themes

This section is a general review of regional development theories in the restricted sense of regional economic growth theories. While both comprehensive and general reviews have been written by many authors, a recent article by Clarke Edwards in the American Journal of Agricultural Economics is a straightforward summary of the various schools of thought in this field.⁹ Edwards has identified five central themes:

1. Increasing resource availability
2. Advancing technology
3. Expanding markets
4. Conquering space
5. Building institutions

Each theory is not restricted to only one theme, but none incorporates all five.

⁹ Clarke Edwards, "The Political Economy of Rural Development: Theoretical Perspectives", American Journal of Agricultural Economics, Volume 58, No. 5, December 1976 Proceedings Issue, pp.914-921.

Theories based on increasing availability have also been called supply-oriented theories. These theories postulate that differences in regional growth can be attributed to differences in the endowment of resources including natural resources, labour, and capital. Capital is important in the theories of Ricardo, Harrod, Domar and Solow.¹⁰ Hirschman¹¹ argued that public capital in the form of highways, schools, etc., is also important. Two conflicting views about population dynamics exist. One sees increasing population as the means to increased productive capacity and the other views increasing population as a burden on social welfare and as additional mouths to feed.

Advancing technology suggests that growth occurs by means of increased productivity of resources through technical improvement. Regional growth depends on the advanced training of the labour force and the rate of adaption of modern plant equipment.

Theories with expanding markets as a theme have been described as demand-oriented theories. According to these theories, regional development depends upon expanding demand through increasing local consumption, but more frequently through exports from the region to foreign markets or other regions. The notion of comparative advantage whereby regions or countries can jointly gain by engaging in trade is an early

¹⁰ David Ricardo, The Principles of Political Economy and Taxation, (1st ed. 1817) Reprint 3rd. ed. (New York: E. P. Dutton & Co., 1912). Roy F. Harrod, "An Essay in Dynamic Theory", Economic Journal, Volume 49 (1939): pp.14-33. Evsey D. Domar, "Capital Expansion, Rate of Growth and Employment", Econometrica, Volume 14 (1946); pp.137-147. R. M. Solow, Growth Theory: An Exposition (Clarendon Press, Oxford, 1970).

¹¹ Albert O. Hirschman, The Strategy of Economic Development (New Haven, Conn., Yale, University Press, 1958).

version of this idea. Export base theory and economic base theory are in this group. In each, regional growth occurs as a result of increases in exports, the sales of which induce growth of local or residentiary sales with accompanying increases in income and employment. The two differ in that export base theory postulates the existence of specific exporting sectors while the economic base theory postulates export sales across a wider variety of sectors. A demand-oriented notion related to industrial location is one that suggests firms should be encouraged to locate within a region to increase the derived demand for local resources. The theme has led some to argue that growth in one region can only take place at the expense of another region.

Edwards' theme of conquering space is directly related to the location theories discussed later in this chapter. Conquering space means the minimization of the resources required for moving goods and people through space to points of production or consumption. The resources saved in that process are available to produce more goods and services. This is the fundamental economic explanation behind spatial organization of society.

The advocates for building institutions for economic development argue that an implied assumption in other theories, that needed institutions evolve as development occurs, is incorrect. Institutions may have to be created to facilitate and provide opportunities for economic development. Credit unions, cooperatives, and the Regional Development Corporations in the rural regions of Manitoba may be examples of these institutions.

Every regional development theory is partial because it is not able to explain the process of regional development for any region during

any period completely. The integration of these partial theories is necessary. This investigation may contribute to this task.

Growth Centre Theory

The basic premise of growth centre theory¹² is that growth does not occur uniformly over geographic space. The concept originated from a non-spatial theory of economic growth suggested by the French economist, Francois Perroux. He used the concept 'growth pole' to describe a firm or industry which dominated the economy and which had an above average rate of growth. Its high rate of growth is transmitted to other industries in the economy. Such an industry was named a key or motor industry. For Perroux, the vehicle of growth and dominance is innovation. Innovation of new products induce imitation and may encourage the development of new complementary products. Innovation of techniques could result in savings in production costs passed on to other industries through price reductions. Successful innovation can create an atmosphere where innovation is encouraged through example, and new ideas are more readily accepted and supported. Perroux suggested that spatial concentrations of firms could be regarded as a concrete example of his growth pole.

Boudeville and other regional planners have used the growth pole concept in its geographic context extensively where it became known as the growth centre or point. These planners made extensive use of input-output models. Interindustry transactions were the source of dominance. The input-output multipliers became indicators of dominance, with the input-output tables identifying interindustry clustering relationships. The

¹² See David L. McKee, Robert D. Dean, William H. Leahy, ed. "Part III Development Pole Theory", Regional Economics: Theory and Practice (New York: The Free Press, 1970), pp.91-121.

instrument of growth was increased demand and investment, an approach consistent with the macroeconomic notions of the Keynesian multiplier and investment accelerator, although lacking a spatial dimension.

To compensate for this deficiency, growth centre theorists have emphasized the phenomenon of concentration of firms also known as "agglomeration". This does necessarily represent economic growth in a spatial context as more firms locate in the centre and employment and incomes increase. The phenomenon of agglomeration is frequently explained by the statement that the concentration of firms produces external economies which benefit all firms. Whether these external economies produce higher profits and induce further investment is a separate, but clearly related issue.

Growth centre theory, applied to an industrial development strategy, implies private and public investment should be concentrated in specific communities rather than dispersed throughout the regional economy. No clear set of decision rules exist on how to select the specific communities. Communities may be selected arbitrarily by regional planners or based on some selected criteria, one of which is usually the rate of past economic growth.

This approach is challenged by those who question the extent to which the gains from economic growth can be transmitted from the centres to peripheral areas.

Clearly, the concepts of growth centre theory are not well-defined and problems exist. First, external economies is a vague term and frequently is attributed to be a consequence of agglomeration as well as a cause. The logical relationship between the two becomes circular.

Second and more critical, the explanation of external economies is superficial because firms do not behave in a collective manner in a market economy, but make individual decisions. Furthermore, the individual firm is interested in its private profit and would be attracted to a centre if it could internalize any collective external economies created. In the absence of collusion, individual firms making location decisions do not know in advance that external economies may become available. This is especially true for firms entering an area with superficial knowledge of the area. Other location factors such as freight rates, market, wage costs are likely to be more influential than obscure external economies.

At the same time, an explanation of why some firms disperse away from the urban centres is required.

Agglomeration economies are but one location factor from the perspective of industrial location theory. A review of this theory which introduces both the concepts of space and of time into the theory of the firm is necessary to get a better understanding of the impact of space on economic development.

Theory of Industrial Location

Introduction

The basic economic problem faced by a society is that its members have unlimited wants, but only limited resources are available to achieve them. Economics studies how societies make the best possible use of their resources to achieve their wants. Industrial location theory, as a branch of economic thought, presupposes societies organize themselves spatially to optimize the use of resources in achieving the

production of goods and services wanted.

Three perspectives have appeared in industrial location theory. First, some writers emphasized production costs as the firm's concern in selecting a location. Cost minimization was the usual goal and transportation costs were considered to be important since they might vary by location. The demand for the firm's output and its revenue were assumed given. Second, writers treated production costs as given and suggested firms selected locations in order to maximize revenue or their share of the market. Synthesis of these approaches into the third approach - profit maximization - is incomplete.

Regardless of the type of analysis, a description of the spatial economy was required to introduce the concept of space and distance into the analysis. Markets, raw material sites and production sites were sometimes all treated as points in the space. Alternatively, market areas and supply areas for raw materials were assumed to be homogeneous plains punctuated with consumers or suppliers. Sometimes, the market was restricted to a straight line. Population density and income were frequently assumed to be uniform across space.

Production Cost Approach

The classical theoretical work in this school was conducted by Alfred Weber, Tord Palander, and Edgar Hoover,¹³ (although Hoover's

¹³ Alfred Weber, Theory of The Location of Industries, trans., C. J. Friedrich (1929, University of Chicago Press, Chicago, 1957). Edgar M. Hoover, Location Theory and the Shoe and Leather Industries (Cambridge, Mass., Harvard University Press, 1937).
, The Location of Economic Activity, (New York, 1948, McGraw-Hill Paperback, 1963). For Tord Palander's contribution, see David M. Smith, Industrial Location (New York: John Wiley & Son, 1971) pp.119-124.

analysis also covered the market approach). The production cost approach assumes that the market for a firm's product is defined and known. From among the various elements comprising production costs, the three selected as important in influencing a firm's location were transportation costs, labour costs, and agglomeration economies or diseconomies. This approach postulated that a firm would select the location where the transportation costs of procuring its raw materials and of distributing its product were minimized. Deviations from the minimum transportation cost location would occur whenever savings in either labour costs or other production costs (due to agglomeration or deglomeration economies) exceeded the additional transportation costs.

The impact of transportation costs on industrial location were analyzed in detail.

The splitting of transportation costs into procurement and distribution costs suggested rules to determine if the firm would locate near its market or near its supply area for raw materials. Generally, the firm would locate closer to its market if the distribution costs were the larger share of the total transportation bill, and closer to the sources of its raw materials if the procurement costs were the larger share of the total transportation bill.

Weber's analysis reduced the factors affecting the transportation costs to weight and distance hauled. Hoover observed that other physical characteristics of the cargoes relating to the ease of handling such as fragility, bulkiness, etc., were also critical. Spoilage of food materials limited how far these could be carried from a material site. Value of a product can influence the rate charged by public carriers so finished products tend to be charged higher rates. Final

products will have higher distribution costs if they require more care and effort in handling because they are fragile, explosive, or packaged in smaller quantities.

Production techniques interact with transportation costs. Weber assumed one production process for each product. The process could be weight-losing where the weight of the final product is less than the sum of the weights of the raw material inputs, or weight-gaining where the weight of the final product is equal to or greater than the transported raw materials. In the latter, the final product weight might exceed the sum of transported raw materials when it includes non-transported materials found at the production site. The production process could effect the split in transportation costs between procurement and distribution costs and influence firm location. Moses and Alonso¹⁴ introduced modifications to the production cost approach to incorporate location theory into the theory of production. The modification involves the entrepreneur's perceiving the delivered prices of the inputs to the production site as critical in his planning, not the transportation costs per se. The delivered price of the input equals the price of the material input at its source plus the unit transportation cost. At different locations, the ratio of delivered prices between two input materials will vary. The delivered price ratio can be expressed as

$$(P_i'/P_j')=(P_i + R_i S_i)/(P_j + R_j S_j)$$

where

¹⁴ Leon N. Moses, "Location and the Theory of Production", Quarterly Journal of Economics, Vol. LxII, (May, 1958) pp.259-272. W. Alonso, "A Reformulation of Classical Location Theory and Its Relation to Rent Theory", Regional Science Association Papers, Vol. 19, 1967.

P'_i, P'_j are the delivered prices of the inputs i, j
 P_i, P_j are the prices of the inputs i, j at their sites
 R_i, R_j are the transportation rates per mile for inputs
 i, j
 S_i, S_j are the distances to the production site from the
material site i, j

This price ratio is the slope of the iso-outlay curves in production theory. The standard set of production isoquants is constructed in Figure 1. AB is an iso-outlay line for a delivered price ratio for one location. CD represents the same outlay level for a different location. The slopes of the iso-outlay lines vary because the ratio of delivered prices vary. Since both iso-outlay lines are tangent to an isoquant (although different ones), the firm would be minimizing total costs at both locations by equating the ratio of marginal products of the factors to the ratio of delivered prices. However, the firm would be using a different technology and producing at a different level of output at each location. Procurement transportation costs would be minimized only by chance; distribution transportation costs are not considered. Moses introduced the possibility of factor substitution into location analysis.

Alonso presented a mathematical analysis of these modifications. In his analysis, he included procurement and distribution cost functions with space co-ordinates for the firm and transportation rates as variables. Changes in the space co-ordinates imply changes in distance from the market and material sites. His results indicate that the influence of the material and market sites due to transportation costs alone still exist, but the influence of the material site is modified by the substitution of factors induced by changes in the relative delivered prices of the

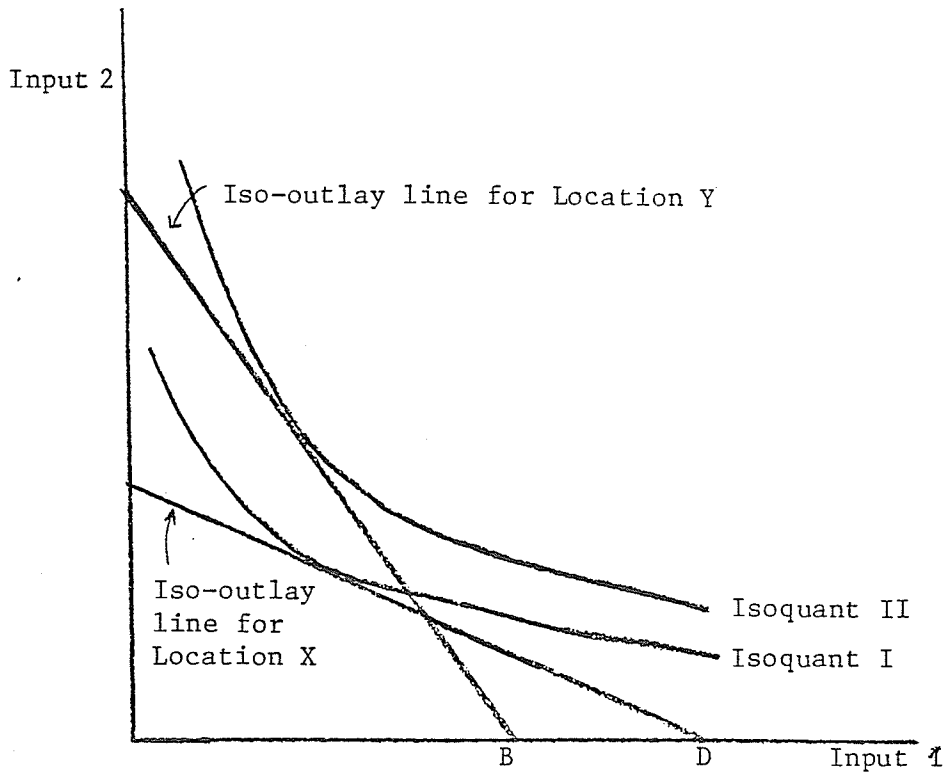


Figure 1. Impact of Different Delivered Price Ratios on Production Levels and Technology Selected

input materials.

Moses and Alonso have demonstrated how location theory is part of production theory. The links between location theory and production theory indicate that the selection of an optimum location is interdependent with the choice of technology and the level of output of the firm.

Isard suggested an alternate means of introducing transportation costs into production theory by treating transportation as a separate input. His analysis produces solutions identical to those found using Weber's analysis but in an indirect manner.¹⁵

Market Approach

The production cost approach has been criticized for not considering market factors. The introduction of space into economic analysis has a significant impact on demand analysis. Production costs influence the price at the factory site. Transportation costs incurred in moving the product to the buyer increase the selling price necessary to cover costs. This delivered price increases as one moves further from the production site. One means of analyzing this is shown in Figure 2.

In Figure 2, two firms A and B producing the same product are located at points A and B. The f.o.b. mill price or factory gate price is indicated by the vertical line rising above them. The delivered price at every other point is illustrated by the transport gradients.¹⁶ Consumers see the product produced by both firms as identical and purchase from the firm which sells at the lower price. C is the market

¹⁵David M. Smith, Industrial Location, pp. 148-151

¹⁶Hoover used this term in his 1937 book.

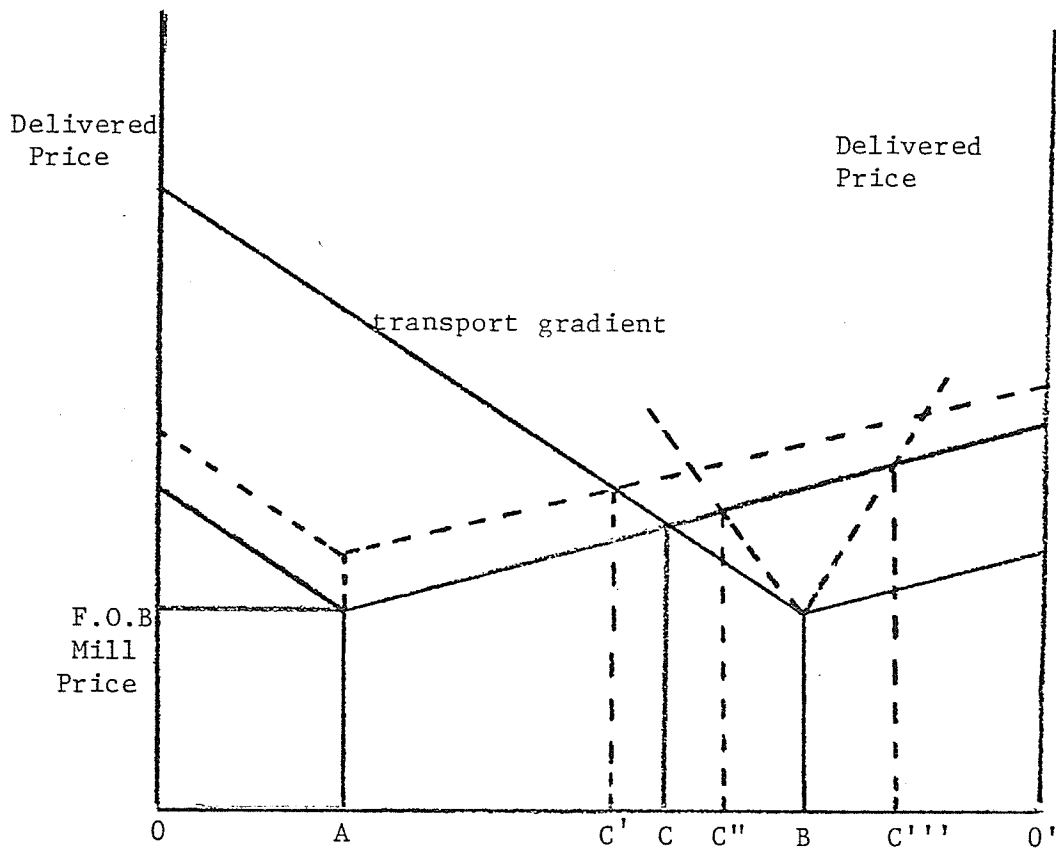


Figure 2. Transportation Costs Determine Market Boundaries

boundary defined by the intersection of the transport gradients. Consumers located between OC purchase from firm A; consumers located between CO' purchase from firm B. Transportation costs define the spatial market for a product. Differences in either production costs at the factory site or variations in transportation rates will alter the market boundary. Two alternate situations are illustrated. First, if the firm A had higher production costs than firm B (as illustrated by the broken vertical line extension at A), the new market boundary would be at C', reducing A's market. Second, if firm B had to pay higher transportation rates, indicated by the broken transport gradient lines, Firm B's market is reduced to those consumers between C''C''' . Interestingly, consumers between C'''O' in this situation can purchase from A at a lower price despite being closer to B.

Using this approach, some economists considered the impact of demand and competition for sales on the location decisions of firms in a spatial economy. Their work has developed into the theory of locational interdependence.

The theory of locational interdependence states that demand factors and the location of other firms are important in determining the location of a firm. The theory explains the location of firms in terms of their seeking to control as large a share of the market as possible. In the theory, all firms face the same production costs, and the consumers are scattered uniformly across either a linear market or a plain. Distribution costs are a function of distance and result in different delivered prices to buyers throughout the market. The factors affecting the location of the firms in the market are the elasticity of demand, the transportation rate, and the marginal cost of production.

General rules of firm behaviour have been derived:

1. The more elastic the demand for a product, the more firms would be interested in keeping delivered prices as low as possible and firms would tend to scatter across the market area. The more inelastic the demand for a product, the less concerned firms would be about keeping delivered prices low and there would be a tendency to concentrate in the center of the market in order to ensure equal access to all extreme points of the market.
2. Lower transportation rates encourage centralization of the firms because each can sell to the entire market from its center.¹⁷ High transportation rates would encourage dispersion as firms not in the center of the market would gain advantage in obtaining exclusive control of some part of the hinterland market.
3. Decreasing marginal costs of production may encourage dispersion as transportation costs become a large proportion of the delivered price and firms disperse to serve the periphery of the market. Location strategies will vary with pricing policies.

Greenhut observed that smaller firms with an interest only in a small segment of the market will choose an area far away from rivals and may have a greater freedom of site selection when compared to larger firms that intend to sell to the entire market and must contend with the

¹⁷M. L. Greenhut, Microeconomics and The Space Economy, Scott Foreman and Co., (Chicago, 1963), p.170.

behaviour of rivals. This implies smaller firms may tend to locate in less industrialized regions.¹⁸

The assumption that firms relocate instantaneously and without cost is very weak eliminating the problem of location choice entirely. The firm can find the ideal location by hopping around the economic landscape and trying every location. Since the theory also permits firms to occupy the same point in space, it eliminates competition for space.

The theory does not contain a 'threshold' level of demand concept, similar to the central place theory for the service sector. All firms adjust their sales volume so that new entrants can co-exist with smaller market shares. A 'threshold' concept permits one to discuss demand conditions for entry into a market and to discuss how location and the number of firms in a market are related.

Profit Maximization Approach

Profit maximization is a generally accepted goal of the firm in traditional economic theory. The synthesis of the production cost and market approaches to industrial location theory has not been satisfactory.

The need for a synthesis was recognized by one of the early writers in industrial location theory, August Losch. Simultaneously, he noted that the element of uncertainty¹⁹ entered into the choice of location:

¹⁸ Ibid., p.180.

¹⁹ A traditional view in economics has been to distinguish between risk (probabilistic) and uncertainty (no probabilities). Currently, some researchers have argued that the distinction is not meaningful and do not use it. See Michael J. Webber, Impact of Uncertainty on Location, (Halstead Press, Sydney, 1972) pp.94-95. The distinction will not be made in this study either.

There are two reasons for this: the practical difficulty of determining exactly under given conditions how good a site really is, and the fundamental impossibility of foreseeing how these conditions will change. Dynamically there is not a best location because we cannot know the future.²⁰

Losch developed a useful concept to introduce space into economic analysis, the demand cone, which is illustrated in Figure 3. Losch assumed the existence of a plain with a uniform population density, and identical incomes and demand curves for all consumers. A firm located at site S can select a particular mill price, f.o.b. for its product. At that price, a specific quantity (Q_p) will be sold to consumers in the immediate vicinity of the firm. Consumers, further from the production site, would have to pay a higher delivered price. Given normal demand curves, consumers (at any given distance from the production site) will purchase small quantities as the delivered price is increased. Each point on the demand cone represents the quantity purchased at that point. The boundary of the market area occurs where the delivered prices reach a level at which nothing will be purchased. Total sales for the firm is the volume of the demand cone:

$$D = b \cdot \pi \int_0^c f(p + t) dt$$

where D = total demand as a function of the f.o.b. net mill price

b = 2 x population density of a square in which it costs one money unit to ship 1 unit of good along a side of the square

d = f (p + t) - individual demand as a function of price at

²⁰A. Losch, The Economics of Location, W. H. Woglom, W. F. Stoper, trans. (New Haven: Yale University Press, 1954), p.16.

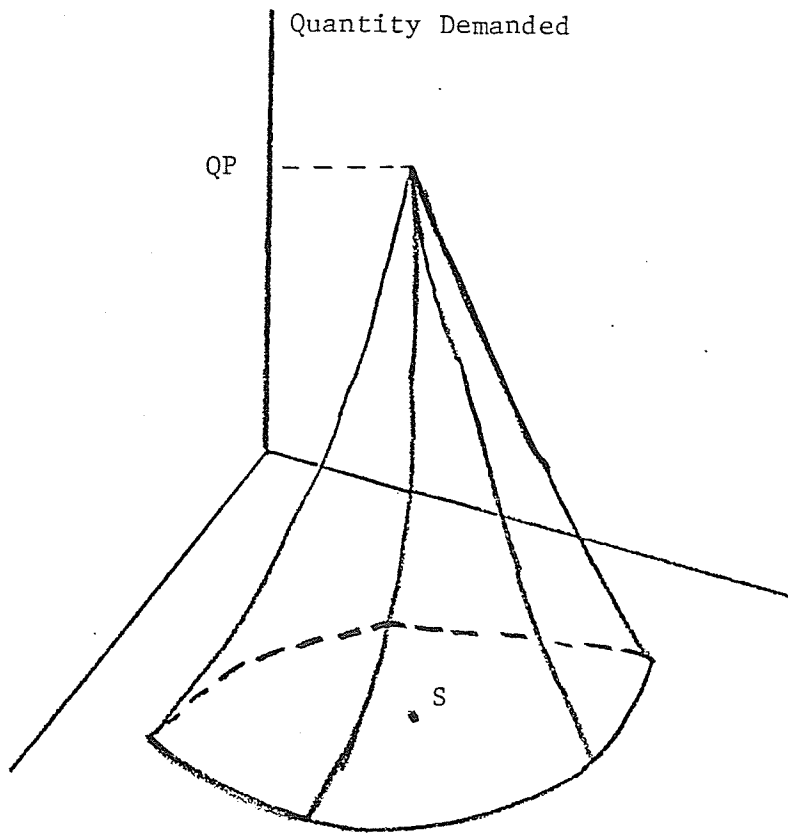
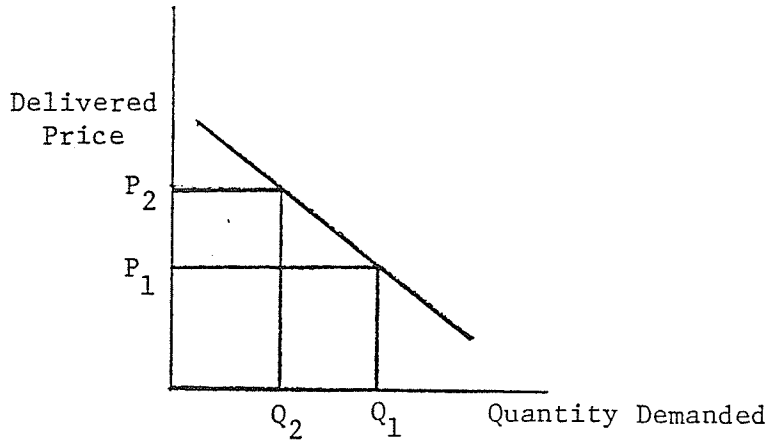


Figure 3. Loschian Demand Cone

the place of consumption

p = f.o.b. net mill price

t = freight costs per unit from factory to consumer

c = maximum possible transportation costs (function of distance)

Losch used this concept to explain how a hierarchy of communities based on secondary industry could develop in a region. His analysis concluded that competition would lead to areal markets in the form of hexagons with the optimum industrial location in the centre. Each industry could have a web of market areas of a different size depending on the transportation costs of that product. His explanation how firms of different industries would locate in the same location (community) was forced - he imagined the webs placed on top of each other so that at least one of every type was located at one place and then he imagined the webs being rotated about this one centre so that a pattern of coincidence occurred. Greenhut observed that Losch could not demonstrate that the industrial pattern he illustrated could develop in a market economy with competition and free entry.²¹

More recent criticism of Losch's concept of a hexagon hierarchy has argued that the hexagon form of market is not unique, but that it is one of several geometric patterns that might form. Furthermore, Greenhut's views that such a system would not develop naturally through free entry in a competitive society is supported.²²

²¹ M. L. Greenhut, Plant Location In Theory and In Practice: The Economics of Space (Chapel Hill: University of North Carolina Press, 1956), pp. 269-272.

²² B. Curtis Eaton and Richard G. Lipsey, "The Non-Uniqueness of Equilibrium in the Loschian Location Model", American Economic Review, March 1976, pp.77-93.

Parenthetically, Losch's attempt to show how a hierarchy of communities might arise based on the dispersion of manufacturing activity parallels Christaller's central place theory.²³ Central place theory deals with the dispersion of service activities. Another related concept is the metropolitan centre-hinterland construct.²⁴ In the metropolitan centre-hinterland concept, the region is characterized by a metropolis dominating a hinterland comprising the remainder of the communities in the hierarchy and the rural parts of the region. The metropolis is perceived as exerting functional dominance where the critical control decisions, involving finance, logistics, communications and administration are made. One implication is that the economic growth of the region is influenced by what happens in the metropolis.

Agglomeration Economies

Agglomeration, the continuously increasing concentration of industrial firms in large urban centres, is a phenomenon that industrial location theorists have attempted to explain. Hoover argued that there was no single factor, but different factors could be conducive for agglomeration in different industries. He suggested that urbanization economies were consequent on the enlargement of the total economic size of a community, i.e., its population, personal income levels, and production levels.

²³ Christaller, W., Central Places in Southern Germany, Carlisle W. Baskin, trans., (Englewood Cliffs, New Jersey: Prentice Hall 1966).

²⁴ Roderick D. McKenzie, "Part IV Dominance and The Region", On Human Ecology, Amos H. Hawley, ed., (Chicago, University of Chicago Press, 1968), pp.205-305.
Don J. Bogue, The Structure of the Metropolitan Community, (University of Michigan, 1949).

Losch and Weber identified factors contributing to agglomeration. The achievement of reduced costs through economies of scale summarizes them. Internal economies of scale achieved by a single large scale plant discourages a firm from operating several scattered smaller plants. Firms in the same industry concentrated in a single urban centre induce economies of scale in several ways.

1. The concentration makes economically feasible the establishment of auxiliary firms that provide at lower costs products and services which firms had to provide for themselves individually.
2. Suppliers of materials and services may achieve economies of scale in filling orders when selling to firms concentrated in one location. They could pass savings in costs back to purchasing firms through lower prices.
3. Pools of trained labour may be created for the benefit of all.
4. All firms may achieve internal economies of scale by each specializing in different product lines.

Firms in different industries concentrated in a single urban centre can benefit each other by making possible:

1. reduced utility and infrastructure costs such as electricity, water, sewage systems, and road construction and maintenance by widening the tax base to pay for such services,
2. the ability of consumers to purchase a mix of goods on one shopping trip and thus encourage business for all firms in the centre, and
3. the creation of markets for each other's products by drawing their collective work forces to the same centre.

New firms tend to be started by employees of established ones. The new entrepreneurs will likely locate near the old firm because they are familiar with the market area and may have the necessary personal contacts.

Weber suggested rising land values would encourage industrial dispersion by increasing land costs to the firm directly and by higher labour costs due to higher housing costs.

Losch recognized that an urban centre where agglomeration occurs may be founded for non-economic reasons. An urban centre may be selected as a political, administrative or a military centre and attract supporting industry for that reason. It may be, fortunately, located at the intersection of main transportation arteries, such as roads or rivers.

Theoretical Framework

Industrial location theory has been the basis upon which Richardson and Dorf have developed the concepts of the space revenue surface, and space cost surface.²⁵ With some modifications, these can serve as the principal ideas for a theoretical framework.

The space revenue surface is derived from the Loschian demand cone. The total sales of the firm as represented by the integral of the demand cone (D) can represent a point in space with the same co-ordinates as the firm. This output level may be valued at the mill price, f.o.b. (P_0) for every unit of output. The revenue at that point becomes

$$R = P_0 D$$

²⁵ Harry W. Richardson, Chapter 4 "The Optimal Location of The Firm", Regional Economics, (London, Weidenfield and Nicolson, 1969) pp.59-90. Ronald J. Dorf, "An Analysis of Manufacturing Location Factors for Communities 2500 to 50,000 Population in The West Central Region", Ph.D. dissertation, Kansas State University, 1976 pp.12-47.

When a firm considers all possible locations, then the revenue earned at each point in space can be represented by a revenue surface with every point on the surface representing the total potential revenue that can be earned at that point. Under the original assumptions, all Loschian demand cones are identical and the revenue surface is a plane whose height represents the total potential revenue. Relaxing the assumptions such as that of uniform population density alters the shape of the surface. The Loschian demand cones are no longer identical. Loschian demand cones for production sites in pockets of dense population, such as cities or towns, will obviously be larger than those elsewhere. The resulting revenue surface will appear like a mountain range with peaks in the more densely populated areas and troughs in the less densely populated areas. The assumptions about individual demand curves and incomes may be relaxed with similar results to the revenue surface. Transportation rates charged in distributing the final product affect the shape of the space revenue surface.

The construction of a space cost surface is also possible. At every point on the total revenue surface, the quantity of output that can be sold at the given P_0 is defined. A profit-maximizing firm could determine the minimum cost of producing that specific quantity, and could select the appropriate plant size, production technique and combination of resources given input prices. The minimum cost of producing the given quantity that could be sold at that point in space becomes the corresponding point on the cost surface. Transportation costs to procure raw materials are included in the minimum cost estimate.

The shape of the space cost surface is more difficult to define than the space revenue surface. While individual costs may vary

according to specific patterns, the space cost curve is the summation of costs for more than one kind of input and material. In addition, substitution among inputs and materials may be possible. Transportation costs will increase the delivered price of a raw material at production sites further away from its source. Even with dispersed raw material sites as in agriculture, transportation costs can vary with the location of the processing plant. Wage rates may be higher in metropolises than in smaller communities although supply shortages for specific types of labour in the smaller centres may result in higher wage rates for these occupations and create additional costs. The competition for land results in higher land costs in urban centres which decrease away from the centre. The combined cost surface would no doubt be uneven and firms will consider those sites where the costs are lower although the site selected will be the one where the firm anticipates to maximize profits. The space revenue and cost surfaces are constructed in the same space and may be imagined as shown in Figure 4. Where the space revenue surface is higher than the space cost surface are suitable locations for the firm. The difference between total revenues and total costs at those points is the potential profit at that point.

A profit maximizing firm will want to select a location in space where its potential profits could be maximized, e.g. points A, B or C. The analysis suggests that profit levels will vary by location. This implies that location decisions are coincidental to investment decisions. This view has been advanced previously by Danielsson and Krumme.²⁶

²⁶ Albert Danielsson, "The Locational Decision From the Point of View of The Individual Company", Swedish Journal of Economics, Volume 66, June 1964, pp.47-87.
Gunter Krumme, "Toward a Geography of Enterprise", Economic Geography, Volume 45 (1) January pp.30-40.

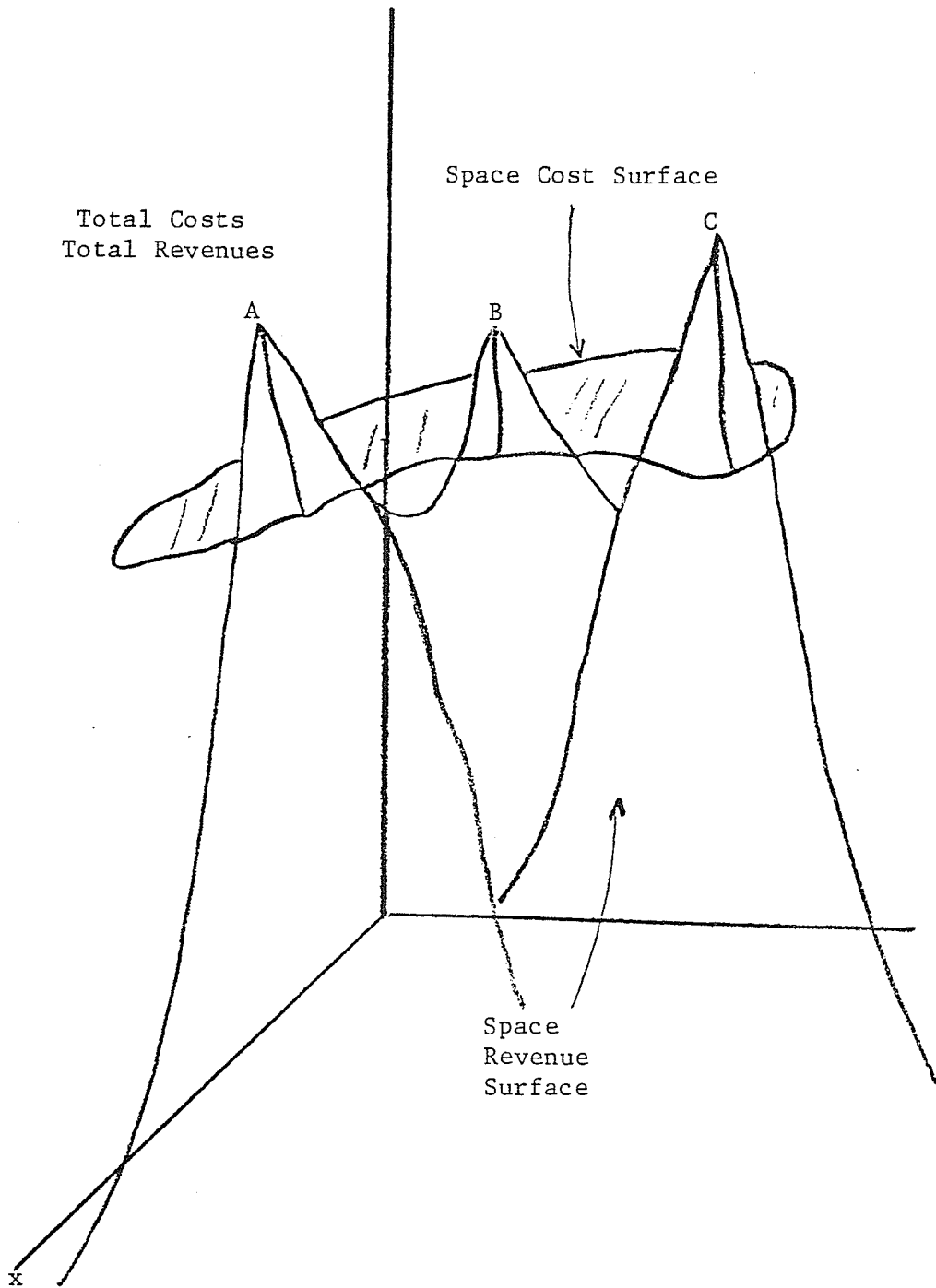


Figure 4. Space Revenue and Cost Surfaces



The firm whether purchasing or renting land, buildings and equipment is committing itself to a location for some time period. An adjustment in location is not accomplished quickly. It may also be costly to re-locate. Thomas has suggested that every investment decision - expansion automation, and modernization involves a locational aspect.²⁷ As an investment decision, different locations may be regarded as providing alternate streams of profit over time. An investment decision that does not involve re-location confirms the initial location choice as being correct in the past and continuing to be correct in a future time period.

However, the firm cannot select the optimum location exactly with certainty. Five reasons why this is true exist.

First, the impact of the prices charged on final sales revenue depends on the elasticity of demand which may be unknown. It should be noted that the space cost surface and the space revenue surface are defined for a specific price and quantity demanded. Price is constant for each space revenue surface. The quantity demanded varies across space. Since total revenue depends on the elasticity of demand, a change in price will not necessarily produce a uniform shift in the surface.

Second, the space cost surface is defined such that each point represents the minimum cost of producing that quantity. As discussed above, Alonso and Moses indicated that the location associated with the minimum cost of production may change with the level of production and technology. Various prices and quantities may produce different sets of surfaces. The most profitable location at one price-quantity

²⁷Morgan D. Thomas, "Regional Economic Growth: Some Conceptual Aspects", Land Economics, Volume 45, February 1969, p.48.

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combination may not be the most profitable one at another price-quantity combination.

Third, the decisions of rivals can sharply alter the market area covered by the firm's revenue surface and reduce anticipated revenues. The space revenue surface of the firm will be affected by the presence of competitors. Competitors can reduce the market area of a firm and the quantity sold. A firm selecting a new location will have its space revenue surface shaped by the presence and location of existing firms. Once it selects a location, it can alter the space revenue surface of its competitors. Competition for inputs can increase their prices and alter the cost surface of all firms. These interactions create uncertainties.

Fourth, a large number of points may have to be examined. The volume of information that a firm should consider could be very large. For completeness, this would require information on costs of all inputs for a great many possible locations and market information on the areas that could be served from all possible sites. The quality of the information may not be suitable in that it could be incomplete, dated, or vague.

Fifth, when a decision-maker makes an investment decision involving location, he is interested in future profits. Even if the information on the location choices is complete and exact, it is restricted to describing the past and the present and can only serve as a guide to the future. The decision-maker must anticipate future profits when future economic conditions are uncertain.

The issue of the actions of rivals raises the question of the nature of the market for the firm's product. Although the model suggests a perfectly competitive market since the price is determined for the firm,

this is not likely to be the case. Greenhut²⁸ has argued that the introduction of space into the theory of the firm tends to eliminate the perfectly competitive market where a large number of anonymous buyers and sellers trade. The spatial location of every firm gives it a unique identity. Each firm's product can appear unique to consumers at different distances from the various plant sites because the final delivered price might be different for each firm. The market structure becomes monopolistic, if not oligopolistic. This observation may be obscured by the absence of price competition in oligopolistic markets due to cartels and other forms of explicit or implicit collusion (price leadership). In the absence of price competition and most firms being the price takers, the analysis is not different for a firm in a non-competitive industry. Otherwise, the analysis in the earlier section illustrated in Figure 2 suggests two types of actions for rivals. Firms locate near one another to minimize price differentials over the market. Firms at distant locations from one another engage in price wars to enlarge their own market. Either way, the outcome for sales revenue becomes uncertain.

Decision makers in a firm searching for a location have the objectives of finding a location where present and future profits are maximized, and where the possibility that those profits will be reduced in the future is minimized. These profits justify the investment decision associated with the location decision. A good location may be defined as one where the level of profits remains acceptable to the decision-maker for the life of the investment and does not discourage re-invest-

²⁸M. L. Greenhut, Microeconomics and The Space Economy (Scott Foreman and Co., Chicago, 1963).

ment in that location. The firm survives there. A bad location may be defined as one where the level of profits become less than acceptable. Should this happen, the firm will have to make a decision to relocate. If profits become negative, the firm will have to cease operations if it cannot re-locate.

The survival of the firm is important for regional development. High levels of profit could encourage reinvestment and expansion of the firm. The surviving firm is able to make a sustained impact on the region contributing to employment, incomes, and the tax base of the local community.

Firms consider existing communities as possible locations. As places where firms may exist already, they indicate locations where a suitable site may be found. This can reduce the uncertainty about selecting the right location. Communities are the nodes of the existing transportation network and this may be significant in determining whether the location is good or not. Communities form the pockets of dense population where peaks in the space revenue surface will occur. The communities which are the good locations become the growth centres hypothesized by the growth centre theory. As firms, through the search process, identify potentially good locations for themselves individually and locate in those communities, they may collectively generate external economies after the fact which can be internalized in each individual firm's cost function. Conceptually, these economies may be perceived as depressions in the space cost surface of the individual firm induced by other firms.

To extend this analysis beyond the firm to the entire manufacturing industry it is necessary that the major location factors be common for

all firms regardless of product produced. Although particular firms do have specific requirements, location factors do have common elements applicable to many sectors. In transportation, the existence of the basic infrastructure, roads, rail lines, and airports, benefits all firms. The volume of traffic from a location affects the level of service provided and the rates charged by public carriers. Workers in the same occupation may be employed in different sectors so that a developed labour market in one community or group of communities may serve more than one sector. Public services are common to all firms. The various factors that induce external economies may be common to firms of more than one industry.

Summary

An investigation of the role of transportation in regional development should be based on models that specifically introduce space into the economic analysis. Growth centre theory, one of several theories of regional development, has such a spatial focus. Growth centre theorists have emphasized the process of agglomeration of firms in specific urban centres. The explanation why this process occurs is not satisfactory. It relies on the concept of external economies which is often vaguely defined. Sometimes the argument becomes circular with external economies (to the firm) being both a cause and a positive effect of the process of agglomeration. One problem is explaining how firms acting individually in a market economy realize that each can internalize benefits arising from their collective behaviour in the absence of collusion. A second problem is explaining why many firms chose to remain dispersed. To argue that these firms are avoiding

diseconomies is hardly sufficient.

Industrial location theory, as the micro-economic basis of growth centre theory, should be re-examined and developed so that regional growth theories can have a sounder foundation. Three approaches have been followed in the theoretical analysis of industrial location - production cost minimization, market share maximization, and profit maximization. Transportation costs have been identified as critical in all of these, yet the manner and extent of its influence is unclear and various hypotheses have been suggested. These include: firms seek to minimize transportation costs, transportation costs vary the delivered prices of raw and semi-finished materials to alternate production sites, and transportation costs vary the delivered prices of final products to the consumer.

An eclectic theoretical framework is presented suggesting firms face sets of space revenue and cost surfaces. The space revenue surface is based on the Loschian demand cone where transportation costs affect the delivered price to the consumer and the quantity demanded varies accordingly. Total quantity demanded at any specific point in time may vary with the location of the firm. The space revenue surface represents the total quantity demanded valued at the factory gate price. The space cost surface is the minimum cost of producing the quantity demanded if the firm was at that location. The difference between the two surfaces at any point is the firm's potential profit which varies across space. A firm guided by profit maximization would seek the location where its potential profit is largest. However, the space revenue and space cost surfaces can shift in a non-uniform manner, and it is uncertain that a point of maximum profit will remain profitable through

the life of the capital investment undertaken.

It should be recognized that the location decision and the investment decision of a firm are coincidental. The interrelationship between location and the profit level means that a firm's ability to survive over time may be dependent on its location.

Chapter 3

REVIEW OF RELATED LITERATURE

This study is investigating the role of transportation costs and services in influencing regional industrial development through their impact on firm behaviour with respect to location. This issue must be handled on two levels - that of the firm, and that of an aggregate regional economy. It may be established that a locational advantage such as low transportation costs will have a positive impact on a firm, yet its effect on the aggregate regional economy may be cancelled by a negative impact on another firm due to a locational disadvantage. This chapter reviews previous studies and examines the approaches and models used. It will introduce briefly the models used in the dissertation in the context of previous studies.

An investigation of the problem could follow two approaches. A direct approach would be to contact manufacturing firms in the study region and question those individuals involved in making decisions affecting a firm's location. The company officers could be asked why their present location was selected and under what circumstances would the firm re-locate. Specific questions could determine which factors hypothesized to influence such decisions are the most critical. Assessing the relative importance of transportation-related factors would be the objective. An indirect approach would be observing the spatial dispersion of manufacturing activity over time and analyzing any changes using appropriate economic models. The objective of the analysis would be to identify the relative importance of transportation in affecting these changes. Both approaches will be critically discussed with examples of the studies presented.

Survey Approach

Many surveys of firms with respect to location decisions have been conducted, (Appana, 1975; Maclaughlin and Robock, 1949; Rees, 1969; Townroe, 1971; Toyne, 1974; U.S. Department of Commerce, 1973; Yeates and Lloyd, 1963). In general, the interviewers approached the firms and asked respondents to identify those factors critical to the firm's location decisions from a list of possible factors, and rank them in order of importance. Rees was specifically interested in the significance of one factor, water, relative to the others. McMillan,²⁹ reporting on a number of similar surveys, observed that transportation factors were usually ranked third or fourth in importance after markets and raw materials.

McMillan criticised the results of the surveys which indicate that markets are the most important factor.

No plant can justify its existence without a place to sell its output. Therefore markets must rank high. But these are not determinants of a particular location. Instead, they are prerequisites to operation.³⁰

Greenhut has discussed the difficulty of distinguishing what could be correctly described as a market factor and a transportation factor.³¹ Proper working of the questionnaire to elicit a meaningful response is difficult, because the distinction has to be made clear to the respondents, yet successful questionnaires require short unambiguous questions.

²⁹T. E. McMillan, "Why Manufacturers Choose Plant Locations vs. Determinations of Plant Locations", Land Economics, 1965, pp.239-246.

³⁰ibid., p.240.

³¹M. L. Greenhut, "Size of Markets Versus Transport Costs in Industrial Location Surveys and Theory", Journal of Industrial Economics, VIII, 1960, pp.172-184.

Surveys have found that personal reasons often play a role in the choice of location. This has been interpreted as a lack of economic rationale in making these decisions. The dichotomy between economic and non-economic factors affecting location decisions may be misleading. Myrdal has argued that once it has been decided a particular issue lies within the realm of the economic problem, factors affecting the issue should be classified into 'more relevant' or 'less relevant' categories, not economic or non-economic.³² A location may be finally determined based on criteria affecting the personal happiness of the firm's management. Yet, if personal happiness affects their performance as managers, then the factors increasing personal happiness are relevant and the choice economically rational. A company might select a community with attractive golf courses, a symphony, or a good climate because it will be easier to assign and keep competent managers who ensure the efficient operation of the plant so that the maximum output is produced from the resources available. Those community features are relevant location factors and economically rational.

The survey approach is inappropriate for the analysis that is required in this study. The study will investigate the relationship between a firm's location and its ability to survive over time. This requires respondents to provide historical information or information about future intentions. Surveys are not entirely suitable for collecting historical information. Respondents may not have personal knowledge about the event in question and may not have access to written records (if they exist). The increased inconvenience and difficulty in re-

³²G. Myrdal, Economic Theory and Underdeveloped Regions, (London, Gerald Duckworth & Co. Ltd. 1957) p.10.

sponding reduce the likelihood of response. Decision-makers in firms that did not survive might not be located for questioning. Those who might be found may bias their responses to protect their own self-worth and exaggerate locational disadvantages. If respondents from existing firms were asked about the future likelihood of moving or going out of business, it would be difficult to eliminate the speculation and the response bias that would appear in the answers. Historical data are important if the study is to link transportation, industrial location, and regional development. Otherwise, the evidence will be at best circumstantial.

Indirect Approach

Macro-economic Models

The macro-economic approach to location analysis in regional economics uses input-output models, econometric models and gravity models.

The input-output models (Czamanski, 1972; Klaasen, 1967; Czamanski and Ellis, 1974) emphasize interindustry linkages within regions. The linked industries are identified using the trading or production co-efficients indicating sales to one sector from another. The input-output tables are examined for clusters of industries which are related to one another in this manner. Percentage of output sold to or purchased by a particular industry is used as a criterion for relating industries. It is hypothesized that these groups of industries would be located in regional proximity as suppliers and customers of one another. This model requires detailed breakdown of sectoral data to be properly implemented.

The econometric models of Harris (1972, 1973, 1974) utilize national input-output tables to derive regional exports and imports by county for various industries. A linear programming model using the transportation algorithm estimated the marginal transportation costs for each industry to export a unit of output from one country to another, and to import a unit of an input from a producing country. These marginal transportation costs are used as variables in an econometric model. Harris uses the model to relate changes in county employment in a particular industry to:

1. the marginal transportation cost for exporting that industry's output,
2. the marginal transportation costs of receiving inputs for that industry,
3. the annual wage rate in that county in that industry,
4. the value of land in the county, and
5. the population density of the county.

As measures of agglomeration, Harris included as independent variables the county output of the major industries buying from or supplying the industry being analyzed. The criterion for choosing the major buying and supplying industries is the percentage of output bought or sold. Personal consumption expenditures, personal income, government expenditures, or exports were included as variables for those industries where sales to final demand were a large proportion of output. If they were significant, Harris classified the industry as market-oriented. Previous output and capital investment were also introduced as independent variables in the location equation.

Applying the Harris approach to Manitoba presents a number of

problems. Since Harris used a national model of the United States, he could identify for the purposes of the model the counties of origin and destination for the exports and imports in most of the manufacturing industries. Using a regional input-output model, the source of the imports to or the destination of exports from the region may not be adequately identified. As an example, manufactured goods to the Interlake Region are likely distributed from Winnipeg, but the original site of production could be Winnipeg, Toronto, Montreal etc. The transportation cost component will vary considerably. The regional input-output table available for the Interlake³³ is also more aggregated than the one used by Harris. Consequently, the statistics may show 'cross-hauling' i.e., an industry in a municipality exporting and importing simultaneously, when in fact, one sub-sector may be importing while another sub-sector may be exporting. Another cause of apparent 'cross-hauling' is the aggregation by industry and not by commodities since an industry may export one product and import another to sell. Harris' model reduces this source of apparent cross-hauling by using Almon's product to product table technique which aggregates commodities, not industries. The available regional input-output tables for Manitoba regions are industry aggregations.

Economic potential or potential accessibility models are gravity models based on the influence of the market upon a firm's location (Clark, 1966; Clark, Wilson, and Bradley, 1969; and Chisholm and O'Sullivan,

³³J. A. Macmillan, C. M. Lu, and C. F. Framingham, Regional Development Planning and Evaluation: An Impact Analysis of Manitoba's Interlake Area Development Plan, (Ames, Iowa: Iowa State University Press, 1975).

1973). Firms are hypothesized to select a central location within a market to maximize their access to potential customers and suppliers and minimize their transportation costs. Gravity models are based on the principle that the force of attraction between two objects is the multiple of their masses divided by the distance separating them. The gravity models substitute the population of two areas for the mass factor. Clark, Wilson, and Bradley calculate indices for regions in Europe. The formula to calculate the index for any given region is:

$$P_i = I/M + \sum_{j=i}^m I_j / (M + T_{ij} + F)$$

where P_i = economic potential of region i

I = regional income

M = minimum cost of production

T_{ij} = transportation cost from i to j

F = tariffs

The regions are ranked in order of the value of the index value calculated. Manufacturing industry is postulated to be attracted to the regions with the higher indices.

Historical analysis is another type of investigation that may be included in the indirect approach (Fogel, 1964). Fogel investigated the contribution of railroads to American economic growth in the 19th century. The prevalent view was that the railroads were indispensable for the development of the United States and no substitute was possible. Fogel called this belief, the "axiom of indispensibility".³⁴

³⁴ Robert W. Fogel, Railroads and American Economic Growth: Essays in Economic History, (Baltimore, Maryland: John Hopkins Press, 1964) p.1.

Fogel examined the transportation technology of the prerailroad era and imagined the existing canal system being extended in the absence of the railroads. He estimated the differences in interregional transportation costs or social savings that occurred with the development of the railroads. He analyzed the question whether agricultural land far from alternate means of transportation would have come into production in the absence of railroads. Fogel also examined the impact of railroad technology on the demand for other products.

He concluded that the contribution of railroads to American economic growth might not have been as critical as imagined. The creation and expansion of the railroad industry were part of the American development process, but not necessarily indispensable.

The logic of Fogel's approach is good for analyzing the contribution of a single mode, although the historical nature of the analysis limits the usefulness of the results for policy analysts interested in designing short or medium term programs.

Micro-economic Models

Linear programming models using the transportation algorithm are commonly employed in location analysis for a single industry (Stollsteimer, 1963; Fuller, Randolph and Klingman, 1976; von Oppen and Scott, 1976). The basic model requires knowledge about: the market sites and market demand for a commodity, the existing and potential production sites, present and potential production capacity, and transportation costs between production and market sites. The objective is to determine the optimum location of the plants in the industry so that transportation costs are

minimized. Since transportation costs are not the only factor determining location, modifications are required to introduce more realism and to measure the importance of transportation relative to other locational factors. An optimization model may provide a poor guide to actual choices since firms do not necessarily select the optimum location.

The use of Markov Chain analysis of industrial migration in Canada has been initiated by Collins for Statistics Canada in a study of industrial migration in southern Ontario.³⁵ The study developed a forecasting model using Markov Chain analysis of industrial structure. Two aspects were examined. The primary emphasis was on the movement of firms through different size categories measured in terms of employment. Spatial movement from one location to another was the second aspect. The source of information was annual data over the period 1961-1966 from the Census of Manufactures collected by Statistics Canada. Almost all firms were uniquely identified on the data tape with a combined location code, Standard Industrial Classification code and establishment code. Collins discusses the use of stochastic processes in analyzing analysis. He concluded that the spatial movement of firms in southern Ontario was forming a ring around Toronto with both inner city firms and firms from outside Toronto moving to the Toronto suburbs.

³⁵ The study is reported in: L. Collins, Industrial Migration in Ontario, Statistics Canada, Cat. No. 31-509 (Ottawa: Information Canada, 1972), and L. Collins, "A Procedure for Forecasting Changes in Manufacturing Activity," Location Dynamics of Manufacturing Activity, ed. L. Collins, D. F. Walker, (London: John Wiley & Sons, 1975).

The single year transition probability matrices provided inadequate projections of industrial structure by size of firm. Collins attempted to improve the projections by using several techniques to eliminate unstable elements in the matrices - ones with non-zero entries in some years and zero entries in other years. The first was combining adjacent states. Two other approaches, new to Markov analysis, were fitting a smoothing probability surface about the main diagonal, and fractional disaggregation intended to estimate representative mean annual transitional probabilities.

The particular usefulness of this technique is the capability to organize data in sets corresponding to specific locations. This is useful because the theoretical framework developed in Chapter 2 suggests firm profits may vary among locations. The Markov probability matrix can provide a concise means to organize information on firms for further explanatory analysis. The technique also quantifies the behaviour of firms with respect to movement among locations over time. Since the method incorporates the actual spatial distribution of firms within the regional economy under study, the results may be more applicable and useful for policy formulations.

The application of industrial location theory to the analysis of a regional economy requires a useful and concise method of describing the geographic distribution of firms and their movement over time. To be useful, that method should incorporate the actual spatial distribution of firms within the region under study. At the same time, it should recognize the stochastic nature of the location decisions and be suitable for further explanatory analysis. The organization of information on firms into the

framework of a Markov probability matrix provides such a useful and concise method.

The model selected for this study must serve two additional functions - an explanatory one and a predictive one. The explanatory function is required to relate industrial location decisions to measures of transportation costs and services. The predictive function is needed to measure the impacts of potential changes in transportation costs and services on the spatial distribution of manufacturing firms.

Ginsburg has noted that probability and econometric models are complementary.³⁶ Each has strengths which the other lacks. Time series regression analysis ignores systematic interrelationships among the phenomena being analyzed. Probabilistic models can handle interdependent choices and the behaviour of the system modelled is not independent of previous developments. Cross-sectional regression analysis is static. Probabilistic models are explicitly dynamic. In cross-sectional regression analysis of population movements, there is no guarantee that the individual values will equal the total number originating from individual points, nor that these values will be positive. The same problem may exist for industrial migration. Probabilistic models require more data and the probabilities do not provide additional information beyond a descriptive summary of the data itself. Regression analysis introduces knowledge about the mechanism underlying the process. It allows for decision about

³⁶ Ralph B. Ginsburg, "Critique of Probabilistic Models: Application of The Semi-Markov Model to Migration", and "Incorporating Causal Structure and Exogeneous Information with Probabilistic Models: With Special Reference to Choice, Gravity, Migration, and Markov Chains", Journal of Mathematical Sociology, London, Gordon & Breach Science Publishers, Volume 2, No. 1, January 1972, pp.63-103.

policy formulation and greater realism. The probabilistic model incorporates actual flows and treats all firms as a system.

While Markov Chain analysis has been used primarily for population migration studies, this method has been applied to analyze the structure of the agriculture sector. One study used farm numbers to construct indirectly a Markov transition matrix in order to project farm numbers by different income classes.³⁷ The change in the number of farm operators between 1961-1966 was estimated using regression analysis and hypothesized variables. The number of farms and farm operators were assumed to be equivalent. The estimated changes were used to calculate an estimated distribution of farm numbers by different income size classes in 1966. Using the actual distribution in 1961 and the estimated distribution in 1966, the transitional matrix is derived with each income class as a separate state. Two assumptions are made in order to derive the matrix. An increase in the farm numbers in 1966 in any income class comes from the immediately lower income and a decrease in farm numbers implies that number left the agriculture industry. To follow a similar procedure, assumptions or hypotheses about the transitional re-distribution of manufacturing activity would be required. Such hypotheses may be based on very tenuous grounds since location theory is not sufficiently developed to support such explicit hypotheses. A more serious concern is the fact that such a scheme could not take account of new firms entering the province or coming into existence.

³⁷ James A. MacMillan, F. L. Tung, and John R. Tulloch, "Migration Analysis and Farm Number Projection Models: A Synthesis", American Journal of Agricultural Economics, Vol. 56, No. 2, May 1974, pp.292-299.

One group of econometric models that could be used in combination with a Markov probability model are models of qualitative choice. These models are characterized by the dependent variable assigned only two values, 0 or 1. They can be used to analyze situations where individuals; persons, households or firms make a decision to undertake an action or not. A decision to carry out that particular course of action is quantified as the number 1, and a decision not to carry out the particular action is quantified as the number 0. The estimated values of the dependent variable between 0 and 1 can be interpreted as probabilities that the course of action will be undertaken.

Qualitative analysis of the location choices of firms selecting communities in Kentucky and Tennessee between January 1, 1970 and December 31, 1973³⁸ was conducted to measure the probability of a community attracting a firm and to provide a method of estimating the effects of community action in influencing the decision. The study employed a linear probability model with a dependent variable having a value of 1 if there was a plant location in the community where the plant employed twenty persons or more, and 0, if not. All manufacturing industries were included.

The dependent variables were:

1. site quality
2. site ownership, that is, whether by a government or non-profit organization, or not,

³⁸D. Eldon Smith, Brady J. Denton, David R. Kelch, "Locational Determinants of Manufacturing Industry in Rural Areas", Southern Journal of Agricultural Economics, Volume 10, No. 1, pp.23-32.

3. availability of bond financing,
4. labour availability,
5. fire protection rating,
6. community population,
7. access to Interstate Highway system,
8. miles to the nearest Standard Metropolitan Statistical Area (SMSA),
9. manufacturing employment,
10. presence or absence of a college, and
11. educational expenditures per pupil.

Despite acknowledging the problem of heteroscedasticity and its consequences, the authors accepted the calculated t-values, generated by the regression package, as guides to the significance of the coefficients associated with the variable. Four variables were definitely insignificant—manufacturing employment, community problems, labour availability, and miles to the nearest SMSA. Although the authors treated the remainder as significant and drew implications from them, only quality and bond financing would meet a suggested criterion of acceptability, i.e., double the acceptable t-value if the variances had been constant.

A discussant criticized this study in the same journal for this and other points.³⁹ This author concurs with Ms. Batie on the other criticisms: Smith, Denton, and Kelch did not present any conceptual base

³⁹ Sandra S. Batie, "Discussion: Determinants of Manufacturing Industry in Rural Areas", Southern Journal of Agricultural Economics, Volume 10, No. 1, pp.33-37.

upon which the variable selection could be justified; and they drew conclusions from their results which cannot be supported. For example, they concluded that the advantages of agglomeration were not greater from the fact that community population and county manufacturing employment were not significant. However, site quality, which they found to be significant was measured by the diameter of water and sewage lines, the land area of the site, and access to rail service. It would seem plausible that these might be related in some way with the economies of the agglomeration process.

Summary

To investigate the role of transportation in regional development requires a model that can explain firm behaviour with respect to location decisions and relate that behaviour to impacts on an aggregate economy. Previous approaches and existing models used in locational analysis do not explicitly deal with firm behaviour and the regional economy.

Surveys attempt to collect information on firm behaviour directly, but such an approach seems inappropriate for this analysis. The information required may be difficult to obtain. Difficulties exist in wording questions to isolate complex motivation and eliminate response bias, and in ensuring sufficient participation of firms under study.

Macro-economic models using aggregated data such as employment and output levels ignore individual firm decisions which industrial location theory implies is the medium through which transportation influences the spatial structure of an economy. Regional input-output models are one example.

Linear programming models using the transportation algorithm can focus on the individual firms. These models assume decision-makers operate under conditions of certainty and find the optimum location. Uncertainty in decision-making prevents this and models that account for uncertainty may be more valid.

A Markov probability model can describe the actual collective behaviour of manufacturing firms over time and document changes in the spatial distribution of the manufacturing industry. A model of qualitative choice may be able to explain this behaviour in terms of locational factors. If this can be accomplished, it may then be possible to measure the impacts of such changes in terms of aggregate economic measures such as employment or output. The link between location decisions, location factors, specifically transportation, and regional development may then be demonstrated.

Chapter 4

MODEL DESCRIPTION

The theoretical analysis in Chapter 2 suggests that the potential profit for a firm will vary across space and firms will choose to locate within a community or choose to leave a community depending on their perception of future profits. Transportation costs and services will affect the level of those profits. The purpose of the investigation is to determine will they influence the location decisions a firm makes, and could they significantly affect the spatial distribution of manufacturing firms?

The analysis should first organize the data on the spatial distribution of all manufacturing firms and their movement through time and space into the framework of a Markov probability matrix. The probabilities calculated could be used to test the theoretical propositions that neither a firm's choice of location, nor the ability to survive in a particular location is random. The probabilities can be used as measures of the significance of the several types of location decisions that can be made:

1. the initial choice of a location,
2. the decision to continue operating in the same location,
3. re-locate from one community to another within the study region and
4. leaving the study area or ceasing operations.

They can also be used to evaluate the proposition that the choice of location and firm survival are interrelated.

The study area is that part of the Province of Manitoba, south of the 53rd parallel. The time period selected is between 1961 and 1976. The

study employs models of qualitative choice to further analyze the observed behaviour of those firms within the subset of manufacturing firms that process food and manufacture beverages. The models will test the hypothesis that the survival of a firm may be related to its location.

This chapter:

1. explains the concept of the Markov probability matrix,
2. defines the sub-regions into which the study area is divided,
3. defines the concept of the firm used in this study,
4. provides a description of the data sources,
5. elaborates the conceptual basis for models of qualitative choice, and
6. specifies the models used.

Markov Probability Analysis

Markov Probability Matrices

A finite Markov process is one where the probability of an event occurring depends only on a previous outcome. Essentially, in Markov chain analysis, a basic element exists in a series of distinctive states or classes which may be size categories, geographic locations, etc. for a discrete time interval. Transitional probabilities can be attached to the possibility of the basic element moving from one state to another or remaining in its present state in the next discrete time interval. These probabilities can be expressed as follows:

$$P = \begin{array}{cccccc} & S_1 & S_2 & S_3 & \dots & S_n \\ S_1 & P_{11} & P_{12} & P_{13} & \dots & P_{1n} \\ S_2 & P_{21} & P_{22} & P_{23} & \dots & P_{2n} \\ S_n & P_{n1} & P_{n2} & P_{n3} & \dots & P_{nn} \end{array}$$

S_i ($i=1,n$) represents the various states in which the element can exist; P_{ij} is the probability that an element in state i during the current time period will be in state j in the next time period, with $0 \leq P_{ij} \leq 1$.

Each row in the matrix is subjected to the rule $\sum_{j=1}^n P_{ij} = 1$, i.e., each row is a probability vector.

A finite Markov chain is a finite Markov process where the transitional probabilities do not depend on the time period.

There are four basic properties of Markov Chain models. Each has implications for the application of the model to locational analysis. They are all interrelated through the initial definition of the state which is important. Two of the properties are assumed. The other two can be verified using statistical tests of the data.

The first assumed property is that the elements can be grouped into distinct states. The individual probabilities become meaningless if the states into which the elements are grouped, are not distinct. For example, if the rural municipalities were to be grouped into states, it would be necessary to have a priori information that these states were different with respect to the factors that influence location decisions, e.g., those related to transportation systems and costs. However, fine distinctions between individual states can result in a very large matrix containing small unstable elements.

The second assumed property is that the probabilities are uniform for all elements in the state. All elements in the state have the same probabilities of leaving or remaining. The initial definition of the state and the choice of the measure of industrial activity is relevant here. If the firms are the basic elements, it must be assumed all firms in that industry grouping will react to locational factors in the same manner. When choosing the measure of industrial activity, it is necessary to have reasonable grounds that this is the case for the industry in question.

The third property is the first order one which holds that the distribution of elements among states in time period t depends only on the distribution in time period $t-1$. This is a first-order Markov process. A statistical test exists to verify if the Markov matrix exhibits a "zero" order property (i.e., the distribution of elements among the states in one period is independent of any previous period), or not. Data from three time periods are required to verify this. A statistical test also exists to verify that a Markov matrix does not exhibit second-order, third-order, or higher properties, that is, the distribution of elements among the states in a particular time period depends also on the distribution in some time period earlier than the one immediately preceding the period in question. However, this test requires both data from as many time periods as there are states and the identification of the movement of every individual element from one period to the next. Consequently, the second test has been rarely applied. Collins has observed that information about how location decisions are made does not suggest that a second-order or higher Markov process would be exhibited

by firms.⁴⁰ In conclusion, it is possible to reject a "zero" order Markov process by statistical test, but second-order or higher Markov processes can be assumed not to exist. This third property is called simply the Markov property.

The fourth property states that the relationships among the transitional probabilities are constant. Nothing is occurring over time that would cause the probabilities of moving from one state to another to change in value. Statistical procedures are available to test this property. Data from a minimum of three time periods are required for the test. This property is known as the "stationarity" property.

A transitional probability matrix consists of individual probabilities: each of which describes the likelihood of a certain action occurring. A probability in the main diagonal will represent the likelihood of remaining in the same location. It would be calculated as the number of elements remaining in the community in the year $t + 1$ over those existing in the community in the year t . Probabilities off the main diagonal will represent the likelihood of re-location from one place to another. They would be calculated as the number of elements in the alternate locations that are no longer in the community in the year $t + 1$ over those existing in the community in the year t .

Measuring Manufacturing Activity by Location

The measure of manufacturing activity is the number of firms in a locality. Using firm data, it is possible to measure actual firm movement. Firm movement between two locations may likely be in both directions

⁴⁰L. Collins, Industrial Migration in Ontario, Statistics Canada, Cat. No. 31-509 (Ottawa: Information Canada, 1972), p.32.

and analysis of the gross movements would be more useful than analysis of net movements. The location decisions which are being investigated are made on an individual firm basis. Each location decision involves an interplay of firm needs and community characteristics. Knowledge of which firm moves would enable the researcher to obtain information on the firm's needs. This information would be useful to determine the impacts of industrial location on regional development.

The effect of community characteristics on the transitional probabilities will be measured using regression analysis. One disadvantage in using the number of firms as a measure is that the influence of factors affecting the location decision of a firm may vary with firm size. The costs of re-location of large firms in terms of investment in new facilities, recruiting new employees, or assisting the movement of present ones will increase with the size of the firm. Since an area with an available labour force larger than the plant work force is preferable, the location options for a firm may vary with its size.

The term, firm, requires elaboration. The concept of the firm in economics is aspatial, focusing on what a firm does - an institution dominated by an entrepreneur or entrepreneurial "spirit" where inputs of resources and services are combined through a technological process to yield an output or outputs. The legal concept of a firm may be utilized in applied economics, but this is aspatial as well focusing on ownership. The terms, plant or factory, contain the idea of a specific location. Multi-plant firms where the individual plants perform identical functions can be handled as if they were single-plant firms. Multi-plant firms complicate locational analysis where the individual plants do not perform duplicate functions. The problem arises where individual plants in the

same firm perform related, but separate operations.

Statistics Canada publishes information on the geographic distribution of manufacturing firms in Canada, and their basic unit is the establishment which is "the smallest unit capable of reporting input and output data usually a plant or mill".⁴¹ Its manufacturing data are broken down into industrial sectors according to the Standard Industrial Classification codes. Separate head offices, sales offices, etc., are not reported in the sub-provincial data because Statistics Canada feels the concentration of these in large metropolitan centres such as Montreal or Toronto would distort the data reported. At the national and provincial level, the data from separate head offices are included in the sector where a company's activity is largest.

The basic data for this study were obtained from the Manitoba Trade Directory. Most companies operated at a single location, but occasionally, the Directory indicated that either separate branches or plants were in operation, or a head office existed at a separate address. Generally, such branches and head offices were treated as separate entities. This study did not follow the Statistics Canada procedure of excluding head offices where identifiable because:

1. their activities are indispensable to the total operation of the manufacturing sector,
2. these activities are carried out in many other firms at the same location as manufacturing activity, and
3. in the majority of cases, no evidence existed that manufacturing activity did not also occur at the addresses indicated as head

⁴¹ Statistics Canada, Manufacturing Industries of Canada: Sub-provincial Areas 1974, Catalogue 31-209 Annual, (Ottawa: 1978), inside back cover.

office addresses.

Statistics Canada publishes in the previously mentioned reports, tables of data obtained from a questionnaire for separate head offices utilized in the annual Census of Manufactures. While they do not indicate the number of head offices, these tables show that separate head offices in Winnipeg contributed to 2.0 percent of the total provincial employment in 1974.⁴² In the 1976 data used in this study, separate head offices would not have exceeded and may have been less than 2.1 percent of the entities considered. Any distortions in results for Metropolitan Winnipeg attributed to their inclusion would be minimal.

In conclusion, this study uses as a data unit, an entity very similar to the establishment as defined by Statistics Canada, but labelled with the more familiar term, the firm, to be consistent with the theoretical discussion.

Description of Data Source

The source of data was the Manitoba Trade Directory.⁴³ The study covers a 15 year period from 1961 to 1976. Three transitional matrices were constructed to cover the period 1961-1966, 1966-1971, and 1971-1976 in order that the data could coincide with the census information. The directories for the years 1962, 1966, 1970-1, and 1976 were used. No directory was issued for 1961 or 1971 specifically.

The directories include the following information:

1. name of firm,
2. location,

⁴²Ibid., Table 12, p.271.

⁴³Manitoba Department of Industry and Commerce, Manitoba Trade Directory (Winnipeg: Sanford Evans Publishing Ltd., 1962, 1966, 1970-1, 1976).

3. mailing or street address,
4. names and telephone numbers of owners, or managers and other officers,
5. whether the firm is a branch of a national or international chain, or not.

Ranges of employment are provided, but unfortunately, these proved to be too broad to be useful.⁴⁴ The 1976 Directory indicates which firms export from Manitoba.

The firms were matched by name using a computer. A check of unmatched firms for similar addresses was made and the initial results were altered by hand. In some cases, firms in intermediate years were omitted, from the directory, but this information was added after checking with the directory for the following year.

The information is collected by mailed questionnaire by Sanford Evans Publishing Ltd. for the Manitoba Department of Industry and Commerce. An attempt is made to send these to all firms. Where there is no response, firms deemed to be important are contacted by telephone. Mr. H. Knuschel, responsible for the directory, claims at least 90 percent coverage of Manitoba firms.⁴⁵ The directory provides a means of advertising, so an incentive to respond exists.

The States

In a Markov model, the definition of the "states" is restricted. The states must be as homogeneous as possible, but distinct from one

⁴⁴Ranges are: 0-10, 11-25, 26-50, 51-100, 101-200, 201-500, 501-1,000, 1,000+.

⁴⁵Telephone conversation with the author, March, 1978.

another. However, the size of the probability matrix, being the square of the number of states, can become very large if the fine differences between states become factors to distinguish one state from another. For this study, 19 states are defined. The division of the province of Manitoba into these 19 states is admittedly subjective, but based roughly on three factors:

1. population size,
2. distance from Metropolitan Winnipeg, and
3. the apparent clustering of some communities and relative isolation of others.

The 19 states (see Figure 5) are defined below:

1. Winnipeg -- Metropolitan Winnipeg
2. Brandon
3. Brandon "Circle" -- a group of large communities surrounding Brandon: Rivers, Carberry, Minnedosa, Souris, Virden, and Neepawa
4. Brandon Hinterland -- the smaller communities located within the following municipalities: Ellice, Birtle, Shoal Lake, Strathcona, Harrison, Clanwilliam, Rosedale, Archie, Miniota, Hamiota, Blanshard, Saskatchewan, Odanah, Langford, Wallace, Woodworth, Daly, Elton, North Cypress, Pipestone, Sifton, Glenwood, Oaklake, and South Cypress.
5. Portage La Prairie
6. Portage Hinterland -- the communities outside Portage La Prairie in the region known as North Central comprising the municipalities of Glenella, Lansdowne, Westbourne, Lakeview, Portage La Prairie, Cartier, MacDonald, Grey, North and South Norfolk and Victoria.
7. Selkirk

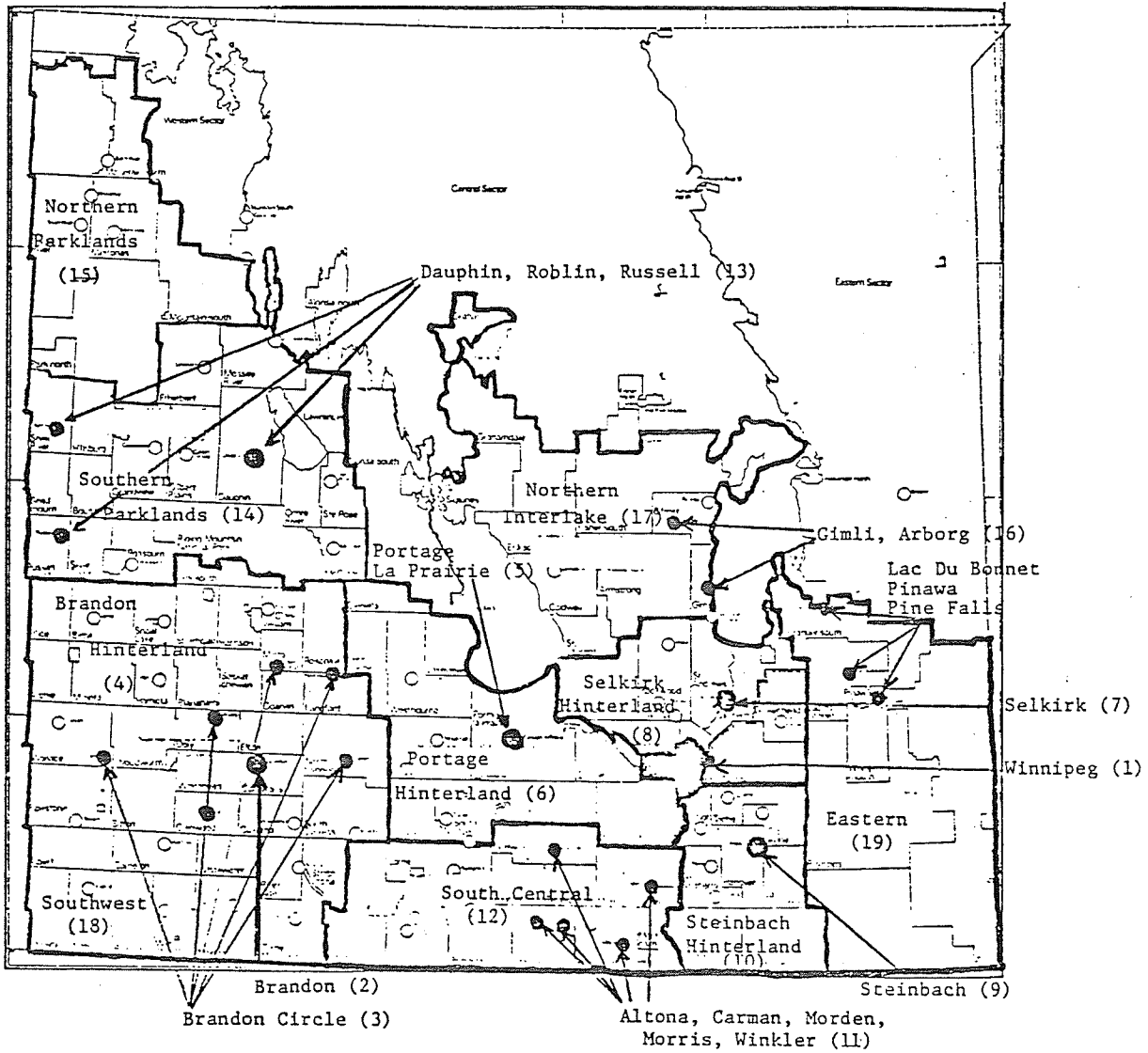


Figure 5. The Markov Model States Illustrated

8. Selkirk Hinterland -- the communities outside Selkirk in Census Divisions 5 and 9
9. Steinbach
10. Steinbach Hinterland -- the communities outside Steinbach in Census Division 1 and Stuartburn municipality
11. Altona, Carman, Morden, Morris, and Winkler
12. South Central -- the communities in the South Central Region (excluding those in state 11). The South Central Region corresponds with Census Divisions 2 and 3 excluding the municipalities of Riverside, Strathcona, and Turtle Mountain.
13. Dauphin, Roblin, Russell
14. Southern Parklands -- the communities in the municipalities of Grandview, Gilbert Plains, Dauphin, Ochre River, Ste. Rose, McCreary, Lawrence, Mossey River, Ethelbert, Shell River, Hillsburg, Shellmouth, Boulton, Russell, Silver Creek and Rossburn (excluding those in state 13).
15. Northern Parklands -- the communities in the municipalities of Swan River, Minitonas, and Mountain
16. Gimli, Arborg
17. Northern Interlake -- the communities in the Interlake Region in Census Division 12 excluding Gimli and Arborg
18. Southwest -- the communities in the municipalities of Albert, Cameron, Whitewater, Riverside, Strathcona, Edward, Arthur, Brenda, Winchester, Morton and Turtle Mountain
19. Eastern -- Pine Falls, Lac Du Bonnet

A 20th catch-all state exists to include all other locations including Northern Manitoba, outside the defined region as well as serving as the "birth" and "death" state for firms coming into existence or going out of existence.

Models of Qualitative Choice

Conceptual Framework

Models of qualitative choice exist to analyze decisions made by individual persons, households or firms to undertake an action or not. A decision to carry out that particular course of action is quantified as the number one, and a decision not to carry out that particular action is quantified as the number zero.

The linear probability model can be written as follows:⁴⁶

$$Y_i = a + BX_i + E_i$$

where:

X_i = the value of a locational attribute of the i th firm

$Y_i = 1$ if the firm undertakes an action

$= 0$ if the firm does not undertake an action

E_i = an independently random variable with 0 mean

The expected value of each Y_i is $a + BX_i$. The probability distribution of Y_i is $P_i = \text{Probability}(Y_i = 1)$ and $1 - P_i = \text{Probability}(Y_i = 0)$. Thus, $E(Y_i) = P_i(1) + (1 - P_i)(0) = P_i$.

The model can be written in the following form:

$$\begin{array}{ll}
 a + BX_i & \text{when } 0 \leq a + BX_i < 1 \\
 P = 1 & \text{when } a + BX_i > 1 \\
 0 & \text{when } a + BX_i < 0
 \end{array}$$

The probability distribution of the error term is shown as follows:

When	E_i has the value:	With Probability:
$Y_i = 1$	$1 - a - BX_i$	P_i
$Y_i = 0$	$-a - BX_i$	$1 - P_i$

transformations being applied currently are the cumulative probability function, and the cumulative logistic probability function. Such transformations are monotonic preserving the ordinal relationship between the dependent and the independent variables. The cumulative probability function is the basis of the PROBIT probability model and the cumulative logistic probability function is the basis of the LOGIT probability model.

The PROBIT model assumes the existence of an index, I_i , which measures the inclination of an individual decision-maker to undertake a specific action. The index is a linear function of attributes of the individual or factors that affect his decision. In this study, the individual is the firm. More accurately, the individual is assumed to be a decision-maker who determines the actions of the firm and the attributes are primarily the locational characteristics of the firm. Such a linear function may be written as:

$$I_i = a + BX_i$$

Furthermore, for each decision-maker, there exists a critical value of I_i , I_i^* , such that the decision-maker will decide to undertake an action if $I_i > I_i^*$. The PROBIT model assumes I_i^* to be normally distributed. This permits the calculation of the probability that I_i^* is less than or equal to I_i . The cumulative probability function assigns to a value of I_i , the probability that any I^* is less than or equal to I_i .

The cumulative normal function is written as:

$$P_i = F(I_i) = (1/\sqrt{2\pi}) \int_{-\infty}^{I_i} e^{-s^2/2} ds$$

$$\text{where: } I_i = F(P_i) = a + BX_i$$

The parameters a , B cannot be measured using ordinary least squares because the function is not linear. They can be estimated using a maximum likelihood estimation procedure which is available in the

SHAZAM computer package at the University of Manitoba.

The LOGIT probability model uses a cumulative logistic probability function to transform the attribute function into probabilities. The cumulative logistic probability function is written:

$$P_i = f(Y_i) = 1/1+e^{-Y_i} = 1/1+e^{-(a+BX_i)}$$

where P_i is the probability an individual will make a choice given the value of X_i . The basic equation may be rewritten into a form that can be estimated:

$$(1+e^{-Y_i}) P_i = 1$$

$$e^{-Y_i} = (1-P_i)/P_i$$

$$e^{Y_i} = P_i/(1-P_i)$$

taking logarithms,

$$Y_i = \log (P_i/1-P_i)$$

$$\text{so } \log (P_i/1-P_i) = a+BX_i$$

Ordinary least squares is not applicable to estimate this function where the dependent variable takes a value of 0 or 1 because, then, $(P_i/1-P_i)$ becomes either 0 or infinity, and the logarithm is undefined.

One alternative is to use a maximum likelihood estimation technique. A maximum likelihood function is one that would generate a population distribution most likely to be the one from which the sample data were drawn. The parameters estimated are consistent and it can be proven that a unique maximum exists.

A second alternative is possible where the data contain observations that are repeated for each value of the explanatory variable. In this study, the firms are aggregated into specific sub-regions each having the same locational characteristics. Then, N_i is the number of individual firms in sub-region i and R_i is the number of firms in sub-region i choosing

to remain in that sub-region. The probability, P_i , can be estimated as $P_i = R_i/N_i$. The LOGIT model may then be estimated in the form:

$$\log(R_i/N_i)/(1-R_i/N_i) = \log(R_i/N_i - R_i) = a^* + B^*X_i$$

using ordinary least squares.

With this approach, the coefficients will only be consistent if the number of repetitions for each value of X_i are arbitrarily large because the dependent variable is not normally distributed when the sample is small. Moreover, continuous data must be arbitrarily partitioned and this can bias the estimates. The model still has the problem of heteroscedasticity.

The method of weighted least squares has been suggested to correct the problem of heteroscedasticity in the LOGIT model using estimated probabilities. However, this is not satisfactory because the heteroscedasticity is inherent in the model, not the data. Furthermore, the method may create a new problem in interpreting the results. Weighted least squares involves dividing data for each observation by the estimated variance for that observation. Since the variances are different values, the units in which the data are expressed are no longer comparable to one another, and may not be meaningful. The ordering of the data may change. An alternate suggestion is to estimate the equation using the ordinary least squares method and, as a criterion for significance of a coefficient, accept a t-value at least twice the value of the criterion for significance if the variance was constant. The differences between the true variances and the estimated variance would not be large enough to cause doubt about the significance of the coefficient.

However estimated, the model should permit the prediction of the odds of an event occurring within the range of the set of real values

of the locational attributes.

Model Specification

All three models of qualitative choice were used in the analysis. The multivariate LOGIT model used data aggregated over 15 sub-regions corresponding roughly to the 19 sub-regions used in the first section of the analysis. Three time periods were used: 1961-1966, 1966-1971, and 1971-1976. Probabilities are estimated for the 45 observations and the method of ordinary least squares is used to estimate the equation. The multivariate PROBIT model uses individual firm data with the dependent variable reflecting the actions of 232 firms in the food processing and beverage sector that were located in the study region in 1971. These firms either remained in the same community until 1976 or left the community to re-locate outside the region or went out of existence. The decision to remain in the community takes the value of 1; any alternative has the value of zero. This section will analyze this event to determine if the characteristics of the firm's location influenced the probability that the firm would have stayed at its 1971 location until 1976. The linear probability model uses the same data as the multivariate PROBIT model. This model is run as a comparison to the multivariate PROBIT model which has a non-linear function. The choice of one model over the other might lead to specification bias.

The focus on a single sector is necessary because differences between sectors may lead to different requirements for a suitable location. While a general set of location factors may exist and could influence decisions of all firms, some factors may have less importance for some sectors than others. For example, labour-intensive light industrial firms

may be more concerned with future labour costs while firms having a capital-intensive weight-losing process might be more concerned with transportation costs.

A sectoral disaggregation of the manufacturing industry in Manitoba for 1975-76 is shown in Table 1. The classification is based on the three digit level of the Standard Industrial Classification. The data indicate that the food processing and beverage sector contained the largest number of firms in any sector and a large proportion (29%) of those outside Metropolitan Winnipeg. This sector is also linked to the agriculture industry which is the major primary industry in the study area. The specific types of firms in the sector are listed in Table 2.

The specific sub-regions used are:

1. Metropolitan Winnipeg
2. Brandon
3. Brandon "Circle"
4. Brandon Hinterland
5. Portage and Hinterland
6. Selkirk and Hinterland
7. Steinbach
8. Steinbach Hinterland
9. Altona, Carman, Morden, Morris, Winkler
10. South Central
11. Dauphin, Roblin, Russell
12. Southern Parklands
13. Northern Parklands
14. Northern Interlake
15. Southwest

Table 1

Sectoral Breakdown of Manufacturing Firms Between Metropolitan
Winnipeg and the Rest of the Province for 1976^a

Sectors	Metropolitan Winnipeg		Rest of Manitoba	
	No.	%	No.	%
1. Food & Beverage	148	10.2	127	29.1
2. Tobacco Products	-	-	-	-
3. Rubber Plastic Products	35	2.4	8	1.8
4. Leather	23	1.6	3	0.7
5. Textiles	66	4.6	9	2.1
6. Knitting Mills	6	.4	1	0.2
7. Clothing	122	8.4	13	3.0
8. Wood	71	4.9	35	8.0
9. Furniture & Fixtures	114	7.9	17	3.9
10. Paper & Allied	43	3.0	8	1.8
11. Printing, Publishing & Allied	179	12.4	29	6.7
12. Primary Metal	21	1.4	6	1.4
13. Metal Fabricating	180	12.4	30	6.9
14. Machinery	81	5.6	25	5.7
15. Transportation Equipment	65	4.8	31	7.1
16. Electrical Products	48	3.3	9	2.1
17. Non-Metallic Mineral Products	58	4.0	44	10.1
18. Petroleum & Coal Products	7	0.5	-	-
19. Chemical & Chemical Products	66	4.6	14	3.2
20. Miscellaneous Manufacturing	<u>116</u>	<u>8.0</u>	<u>27</u>	<u>6.2</u>
	1449	100.0	436	100.0

^aFirms producing products in different sectors are counted more than once. The Standard Industrial Classification codes were included in the 1975 Directory, but omitted in the 1976 Directory. This list covers those firms listed in the 1976 Directory that had their S.I.C. codes included in the 1975 Directory.

Source: Manitoba Department of Industry and Commerce, Manitoba Trade Directory (Winnipeg: Sanford Evans Publishing Ltd., 1975, 1976).

Table 2

Firms in the Food Processing and Beverage Sector

Slaughtering and Meat Processors

Poultry Processors

Fish Products

Fruit and Vegetable Canners and Processors

Frozen Fruit and Vegetable Processors

Dairy Products

Flour and Breakfast Cereal Products

Feed (Animal)

Biscuit Manufacturers

Bakeries

Confectionary Manufacturers

Cane and Beet Sugar Processors

Vegetable Oil Processors

Miscellaneous Food Processors, not elsewhere stated

Soft Drink Manufacturers

Distilleries

Breweries

Wineries

The sub-regions are as defined in the first section of the analysis, with the exception of Portage and Hinterland, Selkirk and Hinterland, and Northern Interlake. Portage and Hinterland is the combined Portage La Prairie and Portage Hinterland sub-regions: Selkirk and Hinterland is the combined Selkirk and Selkirk Hinterland sub-regions: and the Northern Interlake is the combined Gimli-Arborg and Northern Interlake sub-regions. Each pair is combined because one sub-region had an estimated probability of zero as a dependent variable which could not be converted to a logarithmic value. The Eastern sub-region is dropped completely from the analysis. Combining it with an adjacent sub-region might have distorted the results more than excluding it.⁴⁷

The theoretical analysis suggests that a firm's potential profits varies with its location. The initial selection of a location and the firm's ability to survive are related because the entrepreneur is seeking a superior location where future profits will remain adequate for him. If the anticipated profits cannot be realized and no other adjustments possible, the firm must re-locate or cease operations. The study will test the hypothesis that firms in better locations have a better opportunity to survive and are more likely to survive over time. Firm survival is important for regional development since the surviving firms have a more permanent impact in terms of income, employment, and supporting the local tax base. Furthermore, the theoretical analysis discussed in Chapter 2 suggests that it is difficult for firms to select the correct location.

⁴⁷ Excluding the Eastern sub-region leaves out one firm in both the 1961-1966 and 1966-71 periods. The firm in each period does not stay in the sub-region. Four firms are excluded in the 1971-76 period. These are in the communities of Pine Falls or Lac Du Bonnet.

Empirical research has also indicated that many firms, particularly new ones, do not systematically search for a good location.

It may be concluded from the theoretical analysis that the decision variable, Y_i , would be a function of future profits, $(r(y,z))$, if these were not known.

$$(1) Y_i = f(R_{t+1}(y,z), \dots, R_{t+k}(y,z))$$

where y, z denote location co-ordinates.

Future profits are dependent on future prices (P_i) and sales of the firm's products (X_i), and future prices (P_j), and quantities of the material inputs and factor services required (X_j). These variables are location specific.

$$(2) R_t(y,z) = \sum_{i=1}^m P_{it}(y,z)X_{it}(y,z) - \sum_{j=1}^n P_{jt}(y,z)X_{jt}(y,z)$$

where m is the number of products

n is the number of material inputs and factor services

y, z are location co-ordinates signifying these variables are defined for specific locations.

The values for these variables are unknown, but the entrepreneur knows past and current costs and revenues. The entrepreneur can use this information to form expectations of these future values. He may recognize that some of these have a locational component and use this information in making a decision to re-locate or not. An entrepreneur who does not recognize this may remain in a poor location, incur losses or unacceptable profits, and cease operations.

A researcher faces two problems in quantitative analysis. The first problem is reducing the potential number of variables to a reasonable

and meaningful set. The second is deciding what specific measure could represent a variable for which a direct measure does not exist.

The first problem is the large number of possible variables, many of which are interrelated. Unless the majority are eliminated, the consequences will be a sharply reduced number of degrees of freedom and the strong possibility of multicollinearity. Dorf has reviewed the problem of reducing the number of variables used to a reasonable set.⁴⁸ He described three possible techniques - factor analysis, correlation analysis and Theil's extension method. He selected factor analysis for his study, but this method has two drawbacks, one general and one particular to this study. Factor analysis creates a smaller set of new variables which are linear functions of the original set of variables. In general, these new variables do not necessarily have any economic meaning and often include a variable from the original set which is difficult to explain and may be spurious as a principal component. Particular to this study, the new variables cannot be handled as policy instruments because their values are not observable. They cannot be used to simulate the impact of policy changes on the industrial structure of the province.

Correlation analysis and Theil's extension method are appropriate methods to reduce the number of factors into a meaningful set. Ideally, the correlation between the independent variables should be as close to zero as possible. One eliminates a variable from inclusion in the regression equation as an independent variable if the correlation between it and another postulated independent variable approximates or exceeds the individual correlations between the two independent variables and the

⁴⁸Ronald J. Dorf, "An Analysis of Manufacturing Location Factors for Communities 2500 to 50,000 Population In the West North Central Region", Ph.D. Thesis, Kansas State University, 1975, pp.68-70.

dependent one. In Theil's extension method, variables are ordered on an 'a priori' basis of theoretical importance constrained by the maximum number of variables allowed in the regression analysis which is determined by the number of observations. Variables are then sequentially introduced until the additional variables' significance for the regression equation becomes zero or the maximum number of variables is reached.

An added constraint on the choice of the variable set is the objective of evaluating policy alternatives. The inclusion of potential policy instruments might enable the model to indicate guidelines for government decisions to influence the industrial structure of Southern Manitoba.

Variables were selected so at least one represented a major location factor identified by theory and empirical research. Data from secondary sources determined which measures of these factors were available. Secondary sources of data were used to obtain the required historical information.

The principal factors represented were transportation costs and services, labour costs, market potential, and community amenities and services.

An adequate set of firm costs and revenues by location to estimate these functions is unavailable. Since industrial location theory suggests that the locational attributes of a firm cause a systematic variation in costs and revenues over space, it may be possible to use the locational attributes of a firm and their hypothesized impact on potential profits to predict a firm's behaviour without the firm data on costs and revenues. The decision variable may be alternately specified as a function of the firm's locational attributes.

In industrial location theory, three factors have been identified as important: transportation costs, labour costs, and the potential market for the firm's product. Transportation costs incurred in obtaining the raw materials can be regarded as affecting the delivered prices of the raw materials to the production site, the $P_{jt}(y,z)$. Transportation costs incurred in distributing the final products affect their delivered prices to the consumer and influence the quantity sold, $X_{it}(y,z)$. Labour costs are payments for one factor service, a $P_{jt}(y,z)X_{jt}(y,z)$. The potential market for the firm's product is the limit for the $X_{it}(y,z)$.

Empirical research, using survey techniques has expanded the list of factors considered by firms. A list of these factors is presented in Table 3. Some of these are measures of the factors suggested by location theory. Others are measures of community services and amenities available in the community. These community services can affect the costs of operating in the community. Amenities are institutions and services that improve the quality of life for the people residing at the location. Why would a profit-maximizing firm be interested in non-economic amenities? A location decision is part of an investment decision where expected future costs and revenues are important. One possible explanation lies in the fact that future costs are unknown. Amenities provide a means by which the firm can anticipate future labour costs. A community with more amenities and a better environment will tend to have lower labour costs than one that does not. Two reasons are possible. First, workers are willing to forego higher income in another location to enjoy the amenities. Second, the amenities may discourage out-migration and encourage in-migration leading to a greater labour supply and lower labour costs.

Table 3

Locational Factors Considered by Firms

- A. Transportation
 - 1. General availability of rail, truck, air or water transportation
 - 2. Availability of scheduled service
 - 3. Cost of inbound shipments of raw materials
 - 4. Shipping costs of final products to markets
 - 5. Warehousing facilities, capacity, and costs
 - 6. Quality of service
 - a) highway road conditions
 - b) frequency of service
 - c) losses through handling
 - d) rail line quality

- B. Labour
 - 1. Supply of labour
 - a) total labour force within commuting distances
 - b) skill composition of work force
 - c) male/female supply
 - 2. Facilities for training, education
 - 3. Wage rates, fringe benefits
 - 4. Degree of unionization
 - 5. Seasonal fluctuations, migratory trends
 - 6. Reputation for dependability, productivity

- C. Marketing
 - 1. Economic relation to market or main market centre
 - 2. Population of trading area - urban-rural mix
 - 3. Income levels
 - 4. Availability of other firms as outlets for production
 - 5. Location of competitors

- D. Site cost
 - 1. Land value
 - 2. Building costs
 - 3. Space for expansion

- E. Raw Materials
 - 1. What available
 - 2. Assembling costs
 - 3. Quality
 - 4. Reserves
 - 5. Disposal of raw material by-products

- F. Power and Fuels
 - 1. Availability of electric power, coal, gas, oil, etc.
 - 2. Power and fuel costs
 - 3. Disposal of fuel by-products

Table 3 (continued)

-
-
- G. Financial
 - 1. Availability of local capital
 - 2. Adequacy of banking facilities

 - H. Water
 - 1. Availability of adequate supply of proper quality water
 - 2. Costs of water

 - I. Community Influences
 - 1. Housing
 - 2. Local attitudes
 - 3. Physical attractiveness
 - 4. Recreation facilities
 - 5. Fire protection and insurance
 - 6. Social structure

 - J. Government Policy
 - 1. Tax structure
 - 2. Incentives to new firms
-

Sources: N. B. MacDonald, Locational Advantages in the Farm Machinery Industry, Royal Commission on Farm Machinery, Study No. 6, (Ottawa: Queen's Printer, 1970); Industrial Location Determinants 1971-1975, Economic Development Administration, 1973; G. E. McLaughlin, S. Robock, Why Industry Moves South, (Kingsport, Tennessee: National Planning Association, 1949), p. 132-136; F. Olmstead, Basic Location Factors, U.S. Department of Commerce, Area Development Division, Industrial Series No. 74, Revised 1947.

Empirical research has also suggested that firms selecting a location differ in approach. New and small firms often do not select their location based on a systematic planned approach. This is partly due to the lack of resources for such a search procedure and partly due to other problems such as obtaining capital financing, contracting supplies, etc., being of greater concern to the entrepreneur and he will devote most of his effort to them. Inexperience on the part of the entrepreneur may even preclude his undertaking a search. New entrepreneurs often select a familiar locality where they have the necessary personal contacts with potential customers and suppliers.

In large corporations, location studies are conducted.⁴⁹ A committee of executive officers may be delegated the task or outside consultants hired whenever the need arises. Where such decisions are relatively frequent, large corporations employ full-time staff to select suitable locations. Since the corporations have established plants, plant re-location is considered more often. Decisions are made in the context of an overall strategy as part of a multi-plant operation.

Considerable time was spent on resolving the second problem with respect to selecting an appropriate measure for transportation costs. Transportation costs are the most important factor since this part of the study seeks to verify the hypothesis that these costs are significant in influencing a firm to re-locate or forcing it out of business.

A manufacturing firm may provide its own transportation services or purchase these services from public carriers. The carriers are not suitable sources of information on transportation costs despite being

⁴⁹An example of the General Foods Inc. Jell-o plant reported in E. S. Whitman, W. J. Schmidt, Plant Location: A Case History of a Move, American Manufacturers Association, New York, n.d.

primary sources. The structure of freight rates used by the carriers to charge shippers is very complex. Freight rates will vary among modes, commodity types, and size of shipment as well as the distance hauled. Railroad rates are increasingly negotiable and the railways have considerable discretion in rate-making. Rates may vary for the same commodity for different firms due to the volume of traffic on the particular route, the regularity of the shipment and the existence of competition from other modes or carriers. Trucking firms have less discretion, but rates are ratified by one interprovincial and four interprovincial tariff bureaus. Trucking to (from) an extraprovincial location usually involves a short-haul to (from) Metropolitan Winnipeg or Brandon, and a long-haul rate to (from) the extraprovincial location. The shipper may succeed in negotiating a lower long-haul rate based on the total distance if one of the carriers agrees to absorb the difference. Trucking rates can also vary with the type and size of shipment as well as the distance carried. Using the rate data to determine how the transportation costs for the manufacturing industry would vary by location would require a voluminous amount of data, much of it difficult to obtain, and an indeterminable but very large amount of time.

The complexity of the freight rate structure is an obstacle to public policy-makers since they might use these prices to affect transportation costs for industrial firms. The complexity prevents analysts from determining exactly what impacts a change in rates will have on transportation costs. Policy recommendations on freight rates may be based on very tenuous grounds.

A possible institutional problem, interlining, has been observed in the Targets for Economic Development in 1969.⁵⁰ It has been a vocal concern for retailers and wholesalers, particularly in the Parklands Regions of Manitoba. Trucking franchises issued by the Manitoba Motor Carrier Board permit the trucking companies to haul from certain districts in rural Manitoba to Winnipeg and back. Shipments between districts may have to be hauled to Winnipeg by one carrier, transferred to a second carrier, and then moved to the destination point, instead of being hauled directly to the destination. Doubt exists about how significant the additional transportation costs are, and whether the volume of interdistrict traffic is sufficient to warrant extending franchises for direct hauling.

The major secondary sources of data on transportation are Statistics Canada and the Canadian Transport Commission. Published data on railways from Statistics Canada are generally on a system-wide basis and operating revenues are reported in a form which cannot be compared to units of output on a regional level. The Canadian Transport Commission produces two publications with information on rail revenues per unit of output - the Waybill Analysis and the Commodity Flow analysis.⁵¹

Only national and provincial data are published in the Commodity Flow Analysis, and the data system is not organized to yield subprovincial data upon request.⁵² The published data in the Waybill Analysis are

⁵⁰ Report of the Commission on Targets for Economic Development, Manitoba To 1980 (T. E. D., Report 1969, (1969) p.376.

⁵¹ Research Branch, Waybill Analysis Carload All-Rail Traffic, Canadian Transport Commission, annual (Information Canada: Ottawa); Traffic and Tariff Branch, Commodity Flow Analysis 1968-1972, and annual supplements Canadian Transport Commission (Information Canada: Ottawa).

⁵² Conversation with Ian Spear, Senior Transportation Economist, Traffic and Tariffs Branch, Canadian Transport Commission July 1978.

divided into three Canadian regions - Western, Eastern, and Maritime and are not suitable for this study. Waybill analysis is based on a 1% sample and any detail that might be requested for Southern Manitoba would be sparse. Statistics Canada publishes information on trucking firm revenues, tons carried and ton-miles in the For-hire Trucking Survey, but again the data are too aggregated to be useful in this study.⁵³

It is not feasible to estimate transportation costs relative to alternative locations even for the food processing and beverage industry.

National data on manufacturing firms from the Census of Manufacturers were used in an attempt to estimate transportation costs based on the weight of input materials received and shipped. Such weights could be estimated, but absence of other pertinent information such as location of markets and sources of raw materials prevented completion of the estimates.

Total transportation charges per shipment always increase as distance increases and generally increase as weight increases. Since the freight rates increase with distance for shipments of all sizes, using distances measured in highway mileages from Metropolitan Winnipeg as a proxy variable for freight charges is possible. The results would establish whether transportation charges (as represented by distance) were significant or not in influencing the likelihood of survival in the particular location. If significant, one might conclude locations closer to Winnipeg were better. Winnipeg is selected because most rail and truck traffic passes through the metropolitan centre.

⁵³ Statistics Canada, For-hire Trucking Survey, Cat. No. 53-224, Annual (Ottawa, Information Canada).

Distance may be a reasonable proxy to measure differences in extraprovincial charges. Extraprovincial shipments would be generally charged a rate equal to or approximately the short-haul rate to or from Winnipeg, plus the long-haul rate in or out of the province. Costs to locations outside Winnipeg generally exceed those to Winnipeg. The relative distances from Winnipeg might approximate these differences in additional rates.

Distance is limited as a proxy variable because the average charge per unit may decrease as the size of the shipment increases. The decrease in average charge may make a significant difference between a new or small firm located outside Winnipeg which attempts to establish or expand its market and an established or large firm located outside Winnipeg which is serving its existing market. The new or small firm may find distributors will only accept small consignments. Average transportation charges per unit will be relatively higher. The established firm shipping larger volumes may pay a lower average charge per unit and may be in a better competitive position. A location outside Winnipeg would not be as disadvantageous to the established or larger firm.

Average wage and salary data were used as measures of labour costs. Indices to increase these payments to approximate shift differentials, overtime, employer contributions, etc. are only available for the food processing and beverage sector for the Prairie Provinces in 1971.

Population data were used as an indicator of market potential. The total market of any individual firm may include local (sub-region), provincial, national and foreign markets, but the extent of each firm's

market could not be readily determined. However the size of the local market could be more significant in the firm's decision to remain in the same locality. A poor local market would certainly induce firms serving a local market only to re-locate or cease operations. For firms serving a larger market, a poor local market may increase the likelihood of re-location to another sub-region, where the local market is better, and sales could be increased. Specifically, change in population in the recent past was hypothesized to influence firms' perception of their future potential sales and consequently their location decision. The rural to urban population movement has resulted in declining population in many areas served from existing urban centres. Firms operating in these centres would have to expand their market area into those of other firms to maintain their threshold level of sales. In the competitive process, some firms would lose the major part of their business to rivals and cease operations.

Empirical research has indicated that the level and quality of transportation services might be important, also. Measures of quality of service are difficult to obtain, but two measures of the level of service were used and are described below.

Indices to measure community services and amenities were available for 1971 and were used in the PROBIT and linear probability models.

Since empirical research indicated differences in the behaviour of certain types of firms in selecting new locations, variables were included to test for this in the decision to remain in the same location. Information was available for the individual firms used as observations in the PROBIT and linear probability models for 1971-76. Two variables were

selected to isolate:

1. local ownership, and
2. owner-operated firms, partnerships, and cooperatives.

A local owner may have a personal attachment to a particular community and this could affect how he makes the decision to re-locate. The remaining firms would likely be branch plants in a national or international chain located in Manitoba. Their decision-makers may likely be people living outside the province. The location decision may be made in the context of an overall strategy which may consider factors not considered by the local decision-maker.

Owner-operated firms, partnerships and cooperatives are more likely to be under control of local residents with ties to the community, although federated cooperatives may not be as responsive to local interests as locally owned cooperatives.

Estimates of average value-added per firm were included as measures of productivity. This firm attribute is included to check if managerial skills may be a cause for a firm's ability to remain in the same location. This information is available for individual firms used in the PROBIT and linear probability models.

The specified models are described in the next section with the variables named and the relevant data sources identified. The three will be described in the following order: multivariate LOGIT model, multivariate PROBIT model, and multivariate linear probability model.

Variables and Data Sources

Multivariate LOGIT Model

The specified model is:

$$\log(R_i/N_i - R_i) = a + bDUM66 + cDUM71 + dDISTANCE_i + eANPOPGRO_i + gTRANEMP_i$$

where:

N_i = the number of individual firms in sub-region i at the beginning of the time period.

R_i = the number of firms in sub-region i that choose to remain in that sub-region until the end of the five year time period.

DUM66 = a dummy variable with a value of 1 if the time period is 1966-71 and 0 if not.

DUM71 = a dummy variable with a value of 1 if the time period is 1971-76 and 0 if not.

DISTANCE $_i$ = the distance in highway mileage from Metropolitan Winnipeg to sub-region i .

ANPOPGRO $_i$ = the average annual rate of population growth in the preceding decade in sub-region i .

SALARY $_i$ = the average wages and salaries per employee paid at the beginning of the time period in sub-region i in the food processing and beverage sector.

TRANEMP $_i$ = employment in the transportation industry in sub-region i at the beginning of the time period.

The dummy variables DUM66 and DUM71, are inserted to isolate changes that are associated with the different time periods.

As discussed above, the variable, DISTANCE $_i$ is a proxy for transportation charges. In the multivariate LOGIT model, where the sub-region i consisted of more than one community, an average distance was calculated: where the sub-region i consisted of a geographic area, a central community was selected and its distance from Winnipeg used.

The average annual population growth rate (ANPOPGRO) is a measure of the market potential of the sub-region *i*. Information on the change in population within the sub-regions are available by rural municipality and urban centres for the years 1951, 1961, 1966, and 1971.⁵⁴ The hypothesis would be that the change in the populations in the respective sub-regions influenced the likelihood of survival for firms so that those in sub-regions gaining less population or losing more are less likely to remain. With the exception of the data set for 1966-71, the variable is the average annual percentage change over the decade prior to the initial year. For the 1966-71 data set, the average annual change is for 15 years prior to the initial year.

The next variable in the multivariate LOGIT model is the average wages and salaries paid in the food processing and beverage sector.⁵⁵ The hypothesis is that a higher price for labour services in a region would tend to encourage the firm to consider an alternate location because it might reduce profits. Average wage and salaries paid in the food processing and beverage sector are available for some census divisions in 1961, 1966, and 1971 and are used where possible. Data at the beginning of each period seem appropriate as one might expect the decisions to be lagged as reactions to past information.

⁵⁴ Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba - Update Part 1A, Volume 1 (Winnipeg, 1975), Tables D1, D1a, D1c, pp.3-33.

⁵⁵ Statistics Canada, Manufacturing Industries of Canada: Geographic Distribution, Cat. No. 31-209, 1961, 1966 (Ottawa: Dominion Bureau of Statistics 1964, 1971) Table 7, and for 1971 (Ottawa: Information Canada, 1975) Table 8.

Now $E(E_i) = (1-a-BX_i) P_i + (-a-BX_i)(1-P_i) = 0$ by the assumption that the mean error is zero. Solving for P_i ,

$$P_i = a + BX_i$$

$$1 - P_i = 1 - a - BX_i$$

The variance of the error term is:

$$\begin{aligned} E(E_i^2) &= (1-a-BX_i)^2 P_i + (a-BX_i)^2(1-P_i) \\ &= (1-a-BX_i)^2 P_i + (a+BX_i)^2(1-P_i) \\ &= ((1-a-BX_i) + (A+BX_i)) (1-a-BX_i) (a+BX_i) \\ &= (1-a-BX_i) (a+BX_i) \\ &\quad (1-P_i) P_i \\ \text{or, } \sigma^2 &= E(E_i^2) = 1-E(Y_i) E(Y_i) \end{aligned}$$

The variance of the error team is heteroscedastic depending on the value of the probability. The variance will be low when the probabilities are near 0 or 1 and will be high when the probabilities are near 0.5.

Two estimation problems exist.. First, a probability is defined as a number within the 0 to 1 range, but the regression estimates can lie outside this range. Defining $P_i = 1$ when $a + BX_i > 1$ and $P_i = 0$ when $a + BX_i < 0$ could lead to the erroneous implication that the behaviour of the individual unit observed becomes a certainty if the value of the locational attribute is above or below a certain number when in fact this is not the case. Second, the heteroscedasticity of the error term reduces efficiency when estimating the parameters, and invalidates those test statistics calculated using an estimate of a variance assumed to be constant.

One method of dealing with the problem of estimates exceeding the bounds of the probability numbers is to transform the function such that the dependent variable can only take values between 0 and 1. Two

Multivariate PROBIT Model (1971-1976)

The specified model is:

$$(1) P_i = F(I_i) = (1/\sqrt{2\pi}) \int_{-\infty}^{I_i} e^{-s^2/2} ds$$

$$(2) I_i = a + b\text{BRANCH} + c\text{OWNER} + d\text{DISTANCE} + e\text{POPCHANGE} \\ + f\text{AVWAGSAL} + g\text{AVVALADD} + h\text{SERVICE}$$

where:

BRANCH = a dummy variable equal to 1 if the firm is owned locally and 0 if not.

OWNER = a dummy variable equal to 1 if the firm is an incorporated company (excluding cooperatives) and 0 if not.

DISTANCE = the distance from the firm's location to Metropolitan Winnipeg in highway miles.

POPCHANG = the percentage change in population, between 1966 and 1971, of the sphere of influence of the urban centre in which the firm is located.

AVWAGSAL = the average 1971 wages and salaries per employee for each firm.

AVVALADD = the average 1971 value added per employee for each firm

SERVICE represents six quality of service indicators for urban centres in which the firms were located.

These six are:

TRANSERV - transportation services

POLFIR - protection services

RECRESERV - recreational services

CULTURE - cultural services

HEALTH - health services

EDUCATE - educational services

All six were highly collinear and were introduced separately into six regression equations.

The observations for the model are the food processing firms located throughout Southern Manitoba in 1971. These firms either remained in the same community until 1976 or left the community to re-locate outside the region or went out of existence.

The dummy variable, BRANCH, is a firm attribute and is used to distinguish locally owned firms.

The dummy variable, OWNER, is a firm attribute to isolate the behaviour of firms such as owner-operated ones, partnerships and cooperatives from incorporated firms.

The variable DISTANCE is a proxy for transportation costs as in the LOGIT model.

The variable, POPCHANGE, is a measure of potential local market growth. The population data for 1966 and 1971 is obtained from the Regional Analysis Program study.⁵⁶ This variable is used for the same reasons as the variable ANPOPGRO in the LOGIT model.

The variable, AVWAGSAL, measures the price of labour. It was observed that considerable variation in average wages and salaries exists among firms of different sizes, and type. This suggested that variation in wages and salaries among different census divisions might be due to a different assortment of firms as well as firms of different sizes.

⁵⁶Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba Working Paper No. 2: Analysis of Community Functions and Relationships. (Winnipeg, 1974).

As part of an unsuccessful attempt at developing a method to estimate transportation costs using data available from published sources, partial profiles of each firm were created using the employment size codes found in the 1971 Manitoba Trade Directory and the information from the Census of Manufactures published by Statistics Canada. Estimates of the average wages and salaries were assigned to each firm based on its size and the sub-sector of the food and beverage sector to which the firm belonged. Thus, firms of the same size and in the same sub-sector were treated as having similar wage costs. Differences across the study area are primarily due to variation in the size of firms and sub-sector composition. National averages were used more frequently and appeared appropriate. Furthermore, average withdrawals per firm were added to the estimated wages and salaries paid by each firm where it was apparent that working owners operated the firm. This total was divided by the number of employees plus the working owner(s).

The variable, AVVALADD, average value added per employee, was calculated using estimated value added data for 1971 per firm from the same firm profiles. Data for Manitoba sub-regions were used wherever available, but mostly national values were used. Variation in these values across the study region is primarily due to differences in firm size and sub-sector composition.

The data for the service variables (TRANSERV, POLFIR, RECRSERV, CULTURE, HEALTH, and EDUCATE) are obtained from an analysis of community services and facilities in 77 communities with a population of 500 or more in 1971.⁵⁷ The 77 urban centres do not include all communities with

⁵⁷ Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba, Working Paper No. 3: Analysis of Community Services and Facilities. (Winnipeg, 1974).

manufacturing firms. Those excluded did not have populations of 500 or more. In this analysis, 17 firms not in the urban centres covered are excluded. Metropolitan Winnipeg was not scored in the original study, but it was given the maximum score possible based on the criteria used.

The variable, TRANSERV, is an index of the quality and frequency of transportation services. The following elements were rated for each centre:

1. quality and number of roads serving the centre;
2. frequency of rail freight service;
3. aerodrome facilities;
4. harbour facilities;
5. scheduled air services;
6. bus service;
7. truck service.

The service scores were reported as total points earned and an index measurement as the total points scored in a community over the total points possible. The total points are the better form in which to enter the data for analysis. The available transport service variable will be the total points scored by the community in which the firm is located. Metropolitan Winnipeg will receive the maximum score.

The Regional Analysis Program report identifies another element of a community's basic infrastructure, protection services. The police and fire-fighting services may be relevant factors for firms already operating in the communities. Better police and fire-fighting services would tend to keep insurance costs down as well as reducing expected losses due to crime or fire. The variable, POLFIR, is assigned the scores rated for those items.

The social infrastructure includes cultural, educational, recreational, and health facilities. The infrastructure of the communities was quantified into indices with a numerical weighting system that described the availability and quality of these services. The weightings were assigned in consultation with the provincial authorities involved. These indices are measures of the social amenities available that existing firms would find advantageous. The raw scores for the amenity measures are used for the variables: CULTURE, EDUCATE, HEALTH, and RECRESERV.

Multivariate Linear Probability Model

The variables are identical to those used in the multivariate PROBIT model.

Summary

The framework of a Markov probability matrix provides a useful and concise method of describing the geographic distribution of firms and their movement over time. The data can be organized into a format suitable for further explanatory analysis. The Markov probability matrix measures the likelihood of a basic unit, the element, moving from one state to another stage. These matrices have four properties:

1. elements can be grouped into distinct states,
2. the probabilities are uniform for all elements,
3. the likelihood that an element is in a particular state depends on where the element was in the previous time period, and,
4. the transitional probabilities are constant over time.

The basic element in this study is the firm which becomes the unit to measure manufacturing activity. To introduce the notion of space into the concept of the firm, it is defined to be similar to the "establishment" as defined by Statistics Canada. The Manitoba Trade Directory is the source of data.

The states are communities in geographic sub-regions in Southern Manitoba and were grouped according to population, their clustering within the province, and distance from Winnipeg. Nineteen sub-regions are defined. A twentieth state includes all other locations as well as a birth and death state for firms coming into and going out of existence. The time periods on which the matrices are based are 1961-66, 1966-71, and 1971-76.

To analyze the location decisions of manufacturing firms, models of qualitative choice appear useful. There attempts to relate the decision of individual units (such as firms) to carry out an action or not with factors hypothesized to influence the decision. Since the decision is binary, it can be measured as a 0 or 1. The results are expressed as a probability that a course of action will be taken.

These models have two estimation problems. First, the estimation procedure, ordinary least squares, is not restricted by the definition of probability as a value between 0 and 1 and can produce estimates outside this range. To correct this, the relationship can be specified in the form of either a cumulative probability function or a cumulative logistic probability function which take values between 0 and 1. Second, heteroscedasticity is inherent in the model.

A PROBIT model, based on the cumulative probability function, uses individual firm observations and is estimated using a maximum like-

likelihood technique. The LOGIT model, based on the cumulative logistic probability function, can use either grouped data, or individual observations. With grouped data, ordinarily least squares can be utilized to estimate the relationship. A maximum likelihood technique must be used for the individual observations.

Firms in the food processing and beverage sector were selected for explanatory analysis. Grouped data for the time periods, 1961-66, 1966-71, and 1971-76 were analyzed using the LOGIT model. Individual firm data between 1971-76 were analyzed using the PROBIT model. With the LOGIT model, data for three time periods were required to have sufficient observations; but with the PROBIT model, two hundred and sixty individual observations were available.

The explanatory variables were selected to measure major locational attributes: distance from Metropolitan Winnipeg, average cost of labour, and population change. Distance is used as a proxy for transportation charges. Average wages and salaries serve as measures of the average cost of labour. Population change is a measure of the change in market potential. The other variables are specified in the chapter.

Chapter 5

DISCUSSION OF RESULTS

The investigation undertaken to examine the role of transportation in regional development has focused on its possible impact on influencing location decisions of manufacturing firms in Southern Manitoba for the time period 1961-1976. The region is subdivided into communities or clusters of communities. The data are organized using the format of a Markov probability matrix. Three matrices are constructed for the years 1961-66, 1966-71, and 1971-76. The second step of the investigation was to verify the hypothesis that the likelihood of a firm's ability to survive in a particular community could be explained by that community's locational characteristics. The specific locational factors were distance from Winnipeg, used as a proxy for transportation charges, and measures of transportation services although other factors were represented. Models of qualitative choice related a firm's decision to remain in its location to locational and firm attributes.

The first section of this chapter is an overview of the research discussing the theory and method of analysis. The second section presents the results from the Markov probability model followed by the results of the models of qualitative choice, and discusses the meanings of the measured probabilities. Data limitations are elaborated.

Overview

In Canada, concern and debate continues about the policy objective of using transportation policies and programs as instruments to encourage regional development. Analytical tools to measure the effectiveness of transportation policies in achieving this end are lacking. Much of the debate focuses on freight rate regulation and subsidies for historical and economic reasons.

This thesis describes the investigation to assess the impact of transportation on industrial development in Southern Manitoba. This region is characterized by a single metropolitan centre surrounded by a predominantly agricultural hinterland containing much smaller urban centres, with manufacturing activity in some of them.

The investigation focuses upon the influence of transportation on entrepreneurial decisions regarding firm location. These decisions are made at the individual firm level. While industrial location theory suggests that transportation will influence these individual decisions, it has to be demonstrated that a discernible and beneficial aggregate effect will occur. An increase in the cost of transporting an input may be harmful to a local firm that uses the input, but beneficial to another that produces a substitute. One theory of regional development, growth centre theory, suggests that a beneficial aggregate effect occurs through the concentration of firms in certain urban centres.

This macro-theory lacks explicit spatial focus and relies on external economies as an explanation for firm concentration in specific communities. This leaves unresolved the question of how firms, separately making decisions without collusion, are motivated.

The research was designed to examine entrepreneurial behaviour in space with the concept of space explicitly introduced into the analysis. Entrepreneurs are important decision-makers. If transportation policy is to be used to achieve the objective of industrial development, then its instruments should be chosen to influence their decisions. Related to this, public agencies provide economic information on communities to firms considering new locations. The question is does this information benefit the communities?

The principal theoretical consideration is that potential profits for the firm vary across space. An entrepreneur selecting a location uses expected future profits as a criterion since he is making a significant investment decision simultaneously. Uncertainty prevents an exact decision. Potential profits may not be realized due to changing conditions. The site can become unsuitable and re-location necessary. The firm may not find a suitable alternate location. The decisions about initial location, re-location or not, or no location (going out of existence) are interrelated.

For policy-makers to use transportation policy as part of a general strategy of industrial development, then it should be possible to generalize anticipated impacts for most or all firms. The locational attributes, particularly the transportation-related ones, should be important to many, if not all, firms.

The method of analysis employs both a descriptive and an explanatory model. The descriptive model organized information on firms into sub-regions based on individual communities and groups of communities. The data were arranged into a Markov probability matrix format so that firm movement through time and space could be observed. This procedure recognizes the reality of the present

spatial organization of society and the distribution of firms within it. The explanatory model went beyond other studies of industrial location. It did not just attempt to measure the relationship between indicators of manufacturing activity with locational attributes, but attempted to relate entrepreneurial behaviour to these locational characteristics.

Descriptive Results

The basic data for the three pairs of years are shown in Tables 4 to 6. Reading across the rows, each cell indicates where firms went in each pair of years and the row total indicates the total number of firms in the particular state in the first year of each pair. The column of row totals, (e.g. under 'Total 1961', Table 4) gives the distribution of firms among the sub-regions in that year. The sum of the entries in that column for the 19 sub-regions is the total number of firms in Southern Manitoba in that year. Reading down the columns, each cell indicates where firms came from in each pair and the column total indicates the total number of firms in the particular state in the second year of each pair.

The row of column totals (e.g. beside 'Total 1966', Table 4) gives the distribution of firms among the sub-regions in that year. The sum of the entries in that row for the 19 sub-regions is the total number of firms in Southern Manitoba in that year. The row total in state 20 or "Elsewhere" is the number of firms leaving the study area or exiting the industry. The column total in state 20 is the number of firms entering the study area or entering the industry.

Table 4
Location and Movement of Manufacturing Firms in Southern Manitoba 1961-1966

Location in 1966 to which firms in Southern Manitoba Went	Winnipeg	Brandon	Brandon "Circle"	Brandon Hinterland	Portage La Prairie	Portage Hinterland	Selkirk	Selkirk Hinterland	Steinbach	Steinbach Hinterland	Morden, Winkler, Altona, Morris, Carman	South Central	Dauphin, Roblin, Russell	Southern Parklands	Northern Parklands	Gimli-Arborg	Northern Interlake	Southwest	Eastern	Elsewhere	Total	1961	
																							Location in 1961 from where Firms in Southern Manitoba Came
Winnipeg	860	2	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	306	1,172
Brandon	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	58
Brandon "Circle"	0	1	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	38
Brandon Hinterland	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	34
Portage La Prairie	1	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	30
Portage Hinterland	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	14
Selkirk	1	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12
Selkirk Hinterland	2	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	17	27
Steinbach	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	4	14
Steinbach Hinterland	2	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	12	22
Morden, Winkler, Altona, Morris, Carman	1	1	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	17	43
South Central	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	17	23
Dauphin, Russell, Roblin	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	18	30
Southern Parklands	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	23	34	
Northern Parklands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	9	14	
Gimli-Arborg	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	7	
Northern Interlake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	12	20	
Southwest	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	8	0	0	0	18	27	
Eastern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	10	
Elsewhere	290	18	6	1	6	4	2	7	3	3	7	6	2	3	3	0	1	2	4	4	-	368	
Total 1966	1,159	58	25	12	24	6	9	15	13	13	32	13	14	14	8	2	9	10	10	10	551	1,997	

Table 5

Location and Movement of Manufacturing Firms in Southern Manitoba 1966-1971

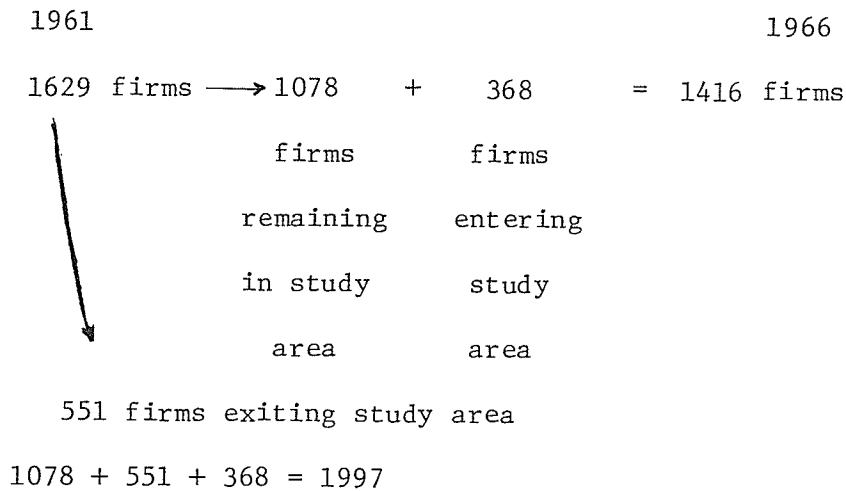
Location in 1971 to which Firms in Southern Manitoba where Firms in 1966 from Southern Manitoba Came	Winnipeg	Brandon	Brandon "Circle"	Brandon Hinterland	Portage La Prairie	Portage Hinterland	Selkirk	Selkirk Hinterland	Steinbach	Steinbach Hinterland	Morden, Winkler, Altona, Morris, Carman	South Central	Dauphin, Roblin, Russell	Southern Parklands	Northern Parklands	Gimli-Arborg	Northern Interlake	Southwest	Eastern	Elsewhere	Total 1966	
Winnipeg	858	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	298	1,159
Brandon	0	40	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	58
Brandon "Circle"	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	25
Brandon Hinterland	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	12
Portage La Prairie	2	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	24
Portage Hinterland	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Selkirk	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9
Selkirk Hinterland	1	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	6	15
Steinbach	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	2	13
Steinbach Hinterland	1	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	4	13
Morden, Winkler, Altona, Morris, Carman	0	0	0	0	0	0	0	0	0	0	15	1	0	0	0	0	0	0	0	0	16	32
South Central	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	7	13
Dauphin, Russell, Roblin	0	0	0	0	0	0	1	0	0	0	0	0	12	0	0	0	0	0	0	0	1	14
Southern Parklands	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	5	14	
Northern Parklands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4	8	
Gimli-Arborg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	
Northern Interlake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	1	9	
Southwest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	3	10	
Eastern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2	10	
Elsewhere	400	22	20	7	6	5	10	10	3	10	34	11	11	3	4	10	2	8	4	-	580	
Total 1971	1,263	62	38	13	25	10	17	18	14	18	49	18	24	12	8	12	10	15	12	388	2,026	

Table 6

Location and Movement of Manufacturing Firms in Southern Manitoba 1971-76

Location in 1976 to which Firms in Southern Manitoba Went	Location in 1971 from where Firms in Southern Manitoba Came																Total 1971					
	Winnipeg	Brandon	Brandon "Circle"	Brandon Hinterland	Portage La Prairie	Portage Hinterland	Selkirk	Selkirk Hinterland	Steinbach	Steinbach Hinterland	Morden, Winkler, Altona, Morris, Carman	South Central	Dauphin, Roblin, Russell	Southern Parklands	Northern Parklands	Gimli-Arborg		Northern Interlake	Southwest	Eastern	Elsewhere	
Winnipeg	880	1	0	0	1	0	1	0	0	2	1	0	0	0	0	0	0	1	0	0	374	1,263
Brandon	0	43	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	17	62
Brandon "Circle"	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	38
Brandon Hinterland	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	13
Portage La Prairie	1	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	25
Portage Hinterland	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10
Selkirk	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	5	17
Selkirk Hinterland	3	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	7	18
Steinbach	1	0	0	0	1	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	4	14
Steinbach Hinterland	1	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	8	18
Morden, Winkler, Altona, Morris, Carman	1	1	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	19	49
South Central	1	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	3	18
Dauphin, Russell, Roblin	3	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	8	24
Southern Parklands	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	4	12
Northern Parklands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6	8
Gimli-Arborg	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	9	0	0	0	0	2	12
Northern Interlake	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	0	4	10
Southwest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	3	15
Eastern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	3	12
Elsewhere	320	22	8	7	4	4	5	10	3	15	19	5	8	1	4	6	0	5	2	-	844	
Total 1976	1,211	76	53	51	12	8	20	91	11	26	49	19	21	9	7	15	5	18	11	499	2,086	

The grand totals of 1997, 2026, and 2086 are the number of different firms that operated in the study area during the period indicated. A simplified illustration using data from Table 4 clarifies the point.



The table indicates that re-location between places within the study area is much less prevalent than firms entering and exiting the industry or the study area. It appears reasonable to assume that the majority of the elements in the "Elsewhere" state reflect the birth and death of firms. The number of firms leaving the study area or the industry as a percentage of the number of firms in the first year of each time period were 33.8%, 26.8% and 30.5% respectively. The number of firms entering the study area or the industry as a percentage of the number of firms in the first year of each time period were 22.6%, 40.1% and 27.3% respectively. Comparable figures were found by Collins using Statistics Canada data for Southern Ontario between 1961-65 where 'deaths' were 30.8% of the 1961 figure.⁵⁸ Buskirk and Vaughn⁵⁹ cite a

⁵⁸ L. Collins, Industrial Migration in Ontario, p.87, Table 5.1.

⁵⁹ R. Buskirk and P. Vaugh, Managing New Enterprises, (West Publishing Co., St. Paul, 1976) p.25.

Dun and Bradstreet report which indicated that from 1953 to 1963, 'birth' of all commercial firms in the United States averaged 9.2% per year, while 'deaths' were 7.8% per year.

The data can be tested for the Markov property. The test is adopted from Collins.⁶⁰ The Markov property holds that the transition probability of being in a specific state in time period t depends on what state the element was, in a previous time period, and this is dependent on the probability of being in the previous state. The null hypothesis is that the marginal probability, or that of being in the previous state and the individual probabilities are independent. The marginal probability is defined as: $F_{i.}/F_{..}$.

$$\text{where } F_{i.} = \sum_{j=1}^n F_{ij}$$
$$F_{..} = \sum_{i=1}^n \sum_{j=1}^n F_{ij}$$

F_{ij} is the number of observations in each cell.

The test statistics is $-2 \log_e \lambda$ which has an asymptotic Chi-square distribution with $(n-1)^2$ degrees of freedom. The test equation is written as:

$$-2 \log_e \lambda = 2 \sum_{i=1}^n \sum_{j=1}^n F_{ij} (\log_e (F_{ij} F_{..}) / (F_{i.} F_{.j}))$$

$$\text{where: } F_{.j} = \sum_{i=1}^n F_{ij}$$

and the other terms are defined above.

The test criterion is a value of the Chi-square distribution for $(n-1)^2$ degrees of freedom at which the probability that the test

⁶⁰L. Collins, Industrial Migration in Ontario, p.144.

statistic will exceed the value is less than a specified level if the null hypothesis is true. Two test criteria were selected for the 5 percent and 1 percent level.

The test criterion formula for the Chi-square distribution with degrees of freedom exceeding 100 is:⁶¹

$$\chi^2 = v(1 - 2/9v + X\sqrt{2/9v})^3$$

where:

X = 1.9600 at the 5 percent probability level

= 2.3263 at the 1 percent probability level

v = degrees of freedom

As shown in Table 7, the test statistics greatly exceed the test criteria. Since the probability of this would be much less than 1 percent if the null hypothesis is true, the null hypothesis that the marginal and individual probabilities are independent is rejected. The matrices exhibit the Markov property. This implies that the initial choice of location and the ability to survive are not random, but dependent on the location itself.

A test to see if the three matrices are homogeneous is possible. If the matrices are homogeneous and have the property of stationarity, then the matrices could be interpreted as being three realizations of the same underlying "true" transitional matrix that characterizes Southern Manitoba. The test statistics are:⁶²

⁶¹E. S. Pearson, H. O. Hartley, ed., Biometrika Tables for Statisticians, Volume No. 1, (3rd ed.) (Cambridge, Eng.: Cambridge University Press, 1966), p.137.

⁶²Ibid., p.146. Collin's reference was Kullback, S., Kupperman, M., and Ku, H. H., "Tests for Contingency Tables and Markov Chains", Technometrics, Volume 4, No. 4 (1962), pp.572-608.

Table 7
Chi-Square Values for Markov Property Test

Time Period	Test-Statistic	Test Criterion
1961-1966	2,259.686	415.51 (5 percent level)
1966-1971	2,159.632	426.45 (1 percent level)
1971-1976	2,402.621	

Component Due to	Expression	Degrees of Freedom
1. Homogeneity	$2 \sum_{k=i}^r \sum_{i=1}^n Fki \cdot \log \frac{(F...Fki.)}{(Fk..F.i.)}$	$(r-1)(n-1)$
2. Conditional homogeneity	$2 \sum_{k=1}^r \sum_{i=1}^n \sum_{j=1}^n Fkij \log \frac{(FkijF.j.)}{(Fki.F.ij)}$	$n(r-1)(n-1)$

where:

$Fkij$ = is the number of observations in cell (i,j) in the kth matrix

$$F... = \sum_{k=1}^r \sum_{i=1}^n \sum_{j=1}^n Fkij$$

$$Fki. = \sum_{j=1}^n Fkij$$

$$Fk.. = \sum_{i=1}^n \sum_{j=1}^n Fkij$$

$$F.i. = \sum_{k=1}^r \sum_{j=1}^n Fkij$$

$$F.ij = \sum_{k=1}^r Fkij$$

The test statistics are additive.

As indicated in Table 8, the test statistics exceed the test criteria so the null hypothesis that the matrices are homogeneous can be rejected. Differences among similar cells in the three matrices are not due just to random error and the spatial distribution of manufacturing firms in Southern Manitoba may have altered significantly during the 15 year period.

The non-homogeneous nature of the three matrices is illustrated in Table 9 by the differences in the number of entrant and emigrant firms for Southern Manitoba disaggregated by region. Stability over the three time periods is exhibited by Steinbach (9) only. The overall

Table 8
Chi-Square Values for Homogeneity Test

Degrees of Freedom	Probability =.05	Probability =.01	Test Statistic
30	43.7730	50.8922	133.393
40	55.7585	63.6907	with 38 degrees of freedom
	Conditional	Homogeneity	
760	833.6	849.0	1,212.463

^aThe test criteria are obtained from Table 8 of Biometrika Tables For Statisticians, Volume 1, p.137.

Table 9
 The Number of Firms Entering or Exiting Southern Manitoba Including New Firms
 Entering or Exiting the Industry by Region

Region	Entrants			Emigrants			Net Change		
	1961-66	1966-71	1971-76	1961-66	1966-71	1971-76	1961-66	1966-71	1971-76
1	290	400	320	306	298	374	-16	102	-54
2	18	22	22	23	17	17	-5	5	5
3	6	20	8	18	6	11	-12	14	-3
4	1	7	7	22	6	6	-22	1	1
5	6	6	4	12	4	9	-6	2	5
6	4	5	4	12	1	6	-8	4	-2
7	2	10	5	4	4	5	-2	6	0
8	7	10	10	17	6	7	-10	4	3
9	3	3	3	4	2	4	-1	1	-1
10	3	10	15	12	4	8	-9	6	7
11	7	34	19	17	16	19	-10	18	0
12	6	11	5	17	7	3	-11	4	2
13	2	11	8	18	1	8	-15	10	0
14	3	3	1	23	5	4	-20	-2	-3
15	3	4	4	9	4	6	-6	0	-2
16	0	10	6	3	1	2	-3	9	4
17	1	2	0	12	1	4	-11	1	-4
18	2	8	5	18	3	3	-16	5	2
19	4	4	2	4	2	3	0	2	-1
TOTAL	368	580	448	551	388	499	-183	192	-51

change in 1961-66 and 1966-71 periods almost cancel one another (-183) and (192), but while the 1961-66 decrease is spread among the regions, the 1966-71 gain is concentrated in Winnipeg. The increase in the number of firms entering the Gimli-Arborg area (10) may be due to the introduction of the Gimli industrial park to replace the air force base. Further analysis of the changes may be useful. Many of the entrant firms are branch plants of existing firms.

Tables 10 to 12 are the transitional probability matrices derived from the data in Tables 4 to 6. The probabilities of the main diagonal and those of the last row are of greatest interest and will be subject to further analysis. The probabilities of the last column are inversely related to those in the main diagonal, both sets reflecting the probability of firms to continue operating in a particular state or region.

The probabilities of survival of manufacturing firms by sub-region taken from the main diagonals of Tables 10 to 12 are listed in Table 13. Individual rankings fluctuate without any pattern. The Spearman rank correlation coefficient for the periods 1961-66 and 1966-71 is 0.33, and for the periods 1966-71 and 1971-76 is -0.26. The average probability of survival increases from (0.4) in 1961-66 to (0.6) in 1971-76. Five sub-regions have probabilities above the average for all three time periods: Winnipeg, Brandon, Brandon 'Circle', Portage La Prairie and Eastern. Four sub-regions have probabilities below the average for all three time periods: Brandon Hinterland, Selkirk Hinterland, Steinbach Hinterland, and Northern Parklands. The absolute probability of survival increased successively for Brandon, Brandon Hinterland, South Central, Southern Parklands, Gimli-Arborg, and South-

Table 10
 Transitional Matrix Probabilities 1961-1966

	Winnipeg	Brandon	Brandon "Circle"	Brandon Hinterland	Portage La Prairie	Portage Hinterland	Selkirk	Selkirk Hinterland	Steinbach	Steinbach Hinterland	Altona, Carmen, Jordan, Morris, Winkler	South Central	Dauphin, Roblin, Russell	Southern Parklands	Northern Parklands	Gimli-Arborg	Northern Interlake	Southeast	Eastern	Elsewhere
1. Winnipeg	0.7338	0.0017			0.0009	0.0009	0.0009		0.0009		0.0009								0.0017	0.2594
2. Brandon		0.6034																		0.3966
3. Brandon "Circle"		0.0263	0.4737																	0.5000
4. Brandon Hinterland			0.3235				0.0294													0.6471
5. Portage La Prairie					0.5667															0.4000
6. Portage Hinterland						0.1429														0.8571
7. Selkirk		0.0333				0.5000														0.3333
8. Selkirk Hinterland		0.0741					0.2963													0.8571
9. Steinbach								0.7143												0.6296
10. Steinbach Hinterland		0.0909							0.3636											0.2857
11. Altona, Carmen, Jordan, Morris, Winkler		0.0233	0.0233							0.581										0.5455
12. South Central											0.2609									0.3953
13. Dauphin, Russell, Roblin												0.4000								0.7191
14. Southern Parklands													0.4000							0.6000
15. Northern Parklands														0.3235						0.6765
16. Gimli-Arborg															0.3571					0.6429
17. Northern Interlake		0.4857														0.2857				0.4286
18. Southeast																	0.3500			0.6500
19. Eastern												0.0370						0.2953		0.6667
20. Elsewhere	0.7880	0.0489	0.0163	0.0027	0.0163	0.0109	0.0054	0.0190	0.0082	0.0190	0.0163	0.0163	0.0054	0.0082	0.0082	0.0000	0.0027	0.0054	0.5000	0.5000

Table 11
 Transitional Matrix Probabilities 1966-1971

	Winnepeg	Brandon	Brandon "Circle"	Brandon Hinterland	Portage La Prairie	Portage Hinterland	Selkirk	Selkirk Hinterland	Steinbach	Steinbach Hinterland	Altona, Carman, Winkler, Morris, Winkler	South Central	Dauphin, Roblin, Russell	Southern Parklands	Northern Parklands	Gimli-Arborg	Northwest Interlake	Southeast	Eastern	Elsewhere
1 Winnepeg	0.7403						0.0009													0.2571
2 Brandon		0.6552			0.0172															0.3276
3 Brandon "Circle"			0.6400																	0.2400
4 Brandon Hinterland				0.5000																0.5000
5 Portage La Prairie					0.7500															0.1667
6 Portage Hinterland						0.8333														0.1667
7 Selkirk							0.4444													0.5556
8 Selkirk Hinterland								0.5133												0.4000
9 Steinbach									0.8462											0.1538
10 Steinbach Hinterland										0.6154										0.3077
11 Altona, Carman, Winkler, Morris, Winkler											0.4688	0.0315								0.5000
12 South Central													0.4615							0.5385
13 Dauphin, Russell, Roblin							0.0714							0.7857						0.1429
14 Southern Parklands															0.6429					0.3571
15 Northern Parklands																0.5000				0.5000
16 Gimli-Arborg																	0.5000			0.5000
17 Northwestern Interlake																		0.7000		0.1250
18 Southwest																			0.7000	0.3000
19 Eastern																			0.7778	0.2222
20 Elsewhere		0.6897	0.0779	0.0345	0.0121	0.0103	0.0086	0.0172	0.0052	0.0172	0.0586	0.0190	0.0190	0.0052	0.0069	0.0172	0.00138	0.00138	0.0069	--

Table 12
 Transition Matrix Probabilities 1971-1976

	Winnipeg	Brandon	Brandon "Circle"	Brandon Hinterland	Portage La Prairie	Portage Hinterland	Selkirk	Selkirk Hinterland	Steinbach	Steinbach Hinterland	Altona, Carman, Morden, Morris, Winkler	South Central	Dauphin, Russell, Roblin	Southern Parklands	Northern Parklands	Gimli-Atborg	Northern Interlake	Southeast	Eastern	Flaeshere	
1. Winnipeg	0.6968	0.0008																			0.2961
2. Brandon		0.6885			0.0008		0.0008	0.0008	0.0008	0.0016	0.0008				0.0008		0.0008				0.2787
3. Brandon "Circle"			0.7105								0.0164										0.2895
4. Brandon Hinterland				0.5385																	0.4615
5. Portage La Prairie	0.0004				0.6000																0.3600
6. Portage Hinterland						0.4000															0.6000
7. Selkirk							0.7059														0.2941
8. Selkirk Hinterland	0.1667							0.4444													0.3889
9. Steinbach	0.1429								0.5000												0.2859
10. Steinbach Hinterland	0.0556				0.0714					0.5000											0.4444
11. Altona, Carman, Morden, Morris, Winkler	0.0204	0.0204									0.5714										0.3878
12. South Central	0.0556											0.7778									0.1667
13. Dauphin, Roblin, Russell	0.1250												0.5417								0.3333
14. Southern Parklands														0.8667							0.3333
15. Northern Parklands															0.2500						0.7500
16. Gimli-Atborg																0.7500					0.1667
17. Northern Interlake							0.0833										0.444				0.4444
18. Southwest							0.1111														0.2000
19. Eastern																					0.2727
20. Flaeshere	0.7143	0.0451	0.0179	0.0156	0.0089	0.0089	0.0112	0.0223	0.0067	0.0335	0.0424	0.0112	0.0179	0.0022	0.0089	0.0134	0.0000	0.0112	0.8000	0.7273	0.0043

Table 13

Probabilities of Survival for Manufacturing Firms By Sub-Region

Sub-Region	1961-66		1966-71		1971-76	
	Value Relation To Average		Value Relation To Average		Value Relation To Average	
Winnipeg	0.7338	Above	0.7403	Above	0.6968	Above
Brandon	0.6034	Above	0.6552	Above	0.6885	Above
Brandon 'Circle'	0.4737	Above	0.7200	Above	0.7105	Above
Brandon Hinterland	0.3235	Below	0.5000	Below	0.5385	Below
Portage La Prairie	0.5667	Above	0.7500	Above	0.6000	Above
Portage Hinterland	0.1469	Below	0.8333	Above	0.4000	Above
Selkirk	0.5000	Above	0.4444	Below	0.7059	Above
Selkirk Hinterland	0.2963	Below	0.5333	Below	0.4444	Below
Steinbach	0.7143	Above	0.8462	Above	0.5000	Below
Steinbach Hinterland	0.3636	Below	0.6154	Below	0.5000	Below
ACMMW#1	0.5581	Above	0.4688	Below	0.5714	Below
South Central	0.2609	Below	0.4615	Below	0.7778	Above
Dauphin, Roblin, Russell	0.4000	Below	0.7857	Above	0.5417	Below
Southern Parklands	0.3235	Below	0.6429	Below	0.6667	Above
Northern Parklands	0.3571	Below	0.5000	Below	0.2500	Below
Gimli-Arborg	0.2857	Below	0.5000	Below	0.7500	Above
Northern Interlake	0.3500	Below	0.8750	Above	0.4444	Below
Southwest	0.2963	Below	0.7000	Above	0.8000	Above
Eastern	0.5000	Above	0.7778	Above	0.7273	Above
Average	0.4239		0.6500		0.5955	
Median	0.3636		0.7000		0.6667	

#1 Altona, Carman, Morden, Morris, Winkler

west for the three time periods, but did not decrease successively for any sub-region. With respect to the existence of a relationship between the probability of firm survival and location, these results are inconclusive.

The probabilities in the last row indicate the likelihood of new firms going to the particular sub-region. These are listed by rank in Table 14. The Spearman rank correlation coefficient is 0.52 for the 1961-66 and 1966-71 time periods, and 0.91 for the 1966-71 and 1971-76 time periods. The latter implies the relative attractiveness of the sub-regions are similar for the later periods. A number of observations can be made. The sub-regions, Winnipeg; Brandon; and Altona, Carman, Morden, Morris, and Winkler are the highest ranking with Winnipeg dominating with over 70% of all new firms choosing that sub-region. The proportion of firms selecting Winnipeg declines from 79% in the early 1960's to 71% in the later ten years. No single sub-region gains from this shift, but the following areas appear to have particularly benefited; Altona, Carman, Morden, Morris, and Winkler; Gimli-Arborg; and Dauphin Roblin, Russell. Brandon and Portage La Prairie do not gain. The proportion of firms selecting Portage La Prairie, Northern Interlake, and Southern Parklands decrease. Steinbach, despite being one of the larger urban centres, does not attract a significant proportion of firms. The absence of a railway may be a factor.

Results of The Explanatory Models

The results for the multivariate LOGIT probability model,⁶²

⁶²A weighted least squares version was estimated without improving the results.

Table 14
Distribution of New Manufacturing Firms by Sub-Region

Sub-Region	1961-66		1966-71		1971-76	
	Value	Rank	Value	Rank	Value	Rank
Winnipeg	0.7880	1	0.6897	1	0.7143	1
Brandon	0.0489	2	0.0379	3	0.0491	2
Brandon 'Circle'	0.0163	6	0.0345	4	0.0179	6.5
Brandon Hinterland	0.0027	17.5	0.0121	12	0.0156	8
Portage La Prairie	0.0163	6	0.0103	13	0.0089	14
Portage Hinterland	0.0109	8.5	0.0086	14	0.0089	14
Selkirk	0.0054	15	0.0172	8.5	0.0112	11
Selkirk Hinterland	0.0190	3.5	0.0172	8.5	0.0223	5
Steinbach	0.0082	11.5	0.0052	17.5	0.0067	16
Steinbach Hinterland	0.0082	11.5	0.0172	8.5	0.0335	4
ACMMW#1	0.0190	3.5	0.0586	2	0.0424	3
South Central	0.0163	6	0.0190	5.5	0.0112	11
Dauphin, Roblin, Russell	0.0054	15	0.0190	5.5	0.0179	6.5
Southern Parklands	0.0082	11.5	0.0052	17.5	0.0022	18
Northern Parklands	0.0082	11.5	0.0069	15.5	0.0089	14
Gimli-Arborg	0.0000	19	0.0172	8.5	0.0134	9
Northern Interlake	0.0027	17.5	0.0034	14	0.0000	19
Southwest	0.0054	15	0.0138	11	0.0112	11
Eastern	0.0109	8.5	0.0069	15.5	0.0045	17

#1 Altona, Carman, Morden, Morris, and Winkler

PROBIT probability model, and linear probability model are presented in Tables 15, 16 and 17.

In the multivariate LOGIT model using aggregated firm data for 1961-1976, the dummy variable for the 1971-76 period appears to be significant, reflecting the finding in the descriptive analysis that the relative attractiveness of certain sub-regions may be changing over time. The variable, for the 1966-71 period, may not be significant. As discussed above, the inherent heteroscedasticity invalidates the test statistics calculated so that caution must be exercised in interpreting a coefficient as being significant.

Distance from Winnipeg, as a proxy for transportation costs and transportation employment were statistically insignificant.

Average wages and salaries and average annual population growth may be significant, but it cannot be stated with certainty that the variables are significant due to heteroscedasticity.

The PROBIT and linear probability models analyze individual firms during the period 1971-76. Six separate equations were estimated, each with a different locational index of a particular community service. These are identified in Chapter 5. The three firm attributes, BRANCH, OWNER, and AVVALADD, were not significant. The change in population in the community sphere of influence was also insignificant. The six different measures of community services, including the transportation service index, were also statistically insignificant. Distance from Winnipeg, the proxy for transportation costs was statistically insignificant in both models. The locational characteristics of the community, including distance and transportation services, do not appear to influence the probability of a firm in the food processing and beverage sector remaining in its location. The hypothesis that firm

Table 15
 Multivariate LOGIT Model
 Coefficients With T-Value in Parenthesis

Dependent Variable	$\log(P/1-P) = \log(r_i/n_i - r_i)$	
Constant Term	-1.51	(2.58)
<u>Independent Variables</u>		
Dummy Variable 1966-1971	0.87	(1.95)
Dummy Variable 1971-1976	1.06	(3.49)
Distance from Winnipeg	0.000067	(0.05)
Average Annual Population Growth	0.11	(2.02)
Average Wages and Salaries	0.27	(1.78)
Transportation Industry Employment	-0.02	(0.12)

T-Value of significance with 95 percent confidence, if χ^2 was constant = 1.684 with 38 degrees of freedom.

Table 16
Multivariate PROBIT Probability Model 1971-76
Coefficients with (Coefficient/Standard Error) in Parentheses

Equation:	(1)	(2)	(3)	(4)	(5)	(6)
Constant Term	-0.43 (0.65)	-0.87 (0.75)	-0.34 (0.54)	-0.43 (0.73)	-0.34 (0.57)	-0.09 (0.75)
Dependent Variables:						
BRANCH	-0.21 (0.97)	-0.23 (1.02)	-0.22 (0.98)	-0.22 (1.01)	-0.22 (0.98)	-0.21 (0.97)
OWNER	0.07 (0.30)	-0.02 (0.10)	0.07 (0.33)	0.04 (0.20)	0.07 (0.32)	0.09 (0.42)
DISTANCE	0.002 (0.92)	0.002 (0.89)	0.002 (0.93)	0.002 (0.88)	0.002 (0.95)	0.002 (0.99)
POPCHANGE	0.002 (0.08)	-0.004 (0.20)	0.003 (0.17)	0.008 (0.04)	0.003 (0.16)	0.012 (0.49)
AVWAGSAL	0.13 (1.68)	0.13 (1.67)	0.13 (1.70)	0.13 (1.67)	0.13 (1.72)	0.13 (1.75)
AVVALADD	-0.009 (0.87)	-0.009 (0.86)	-0.009 (0.85)	-0.009 (0.85)	-0.009 (0.85)	-0.009 (0.47)
TRANSERV	0.016 (0.52)					
POLFIR		0.15 (1.20)				
RECRSERV			0.009 (0.33)			
CULTURE				0.003 (0.79)	0.005 (0.40)	
HEALTH						-0.03 (0.26)
EDUCATE						
Log-Likelihood ^a						
Ratios	7.5	8.7	7.1	7.8	7.4	7.3
Log-Likelihood ^a						
Criterion (95 percent)	15.5	15.5	15.5	15.5	15.5	15.5

^aThese test the hypothesis that all the coefficients equal zero. If the log-likelihood exceeded 15.5, one could accept the hypothesis with a probability of error of 0.05. Since they do not, not all the coefficients equal zero.

Table 17
 Multivariate Linear Probability Model 1971-76
 Coefficients with T-values^a in Parentheses

Equation:	(1)	(2)	(3)	(4)	(5)	(6)
Constant Term	0.35 (1.50)	0.20 (0.77)	0.39 (0.77)	0.35 (1.72)	0.38 (1.69)	0.47 (1.77)
Dependent Variables:						
BRANCH	-0.07 (0.93)	-0.07 (0.97)	0.07 (0.97)	-0.07 (0.94)	-0.07 (0.96)	-0.07 (0.93)
OWNER	0.03 (0.34)	0.01 (0.14)	0.03 (0.14)	0.02 (0.36)	0.03 (0.25)	0.04 (0.36)
DISTANCE	0.0008 (0.93)	0.0008 (0.91)	0.0008 (0.91)	0.0008 (0.95)	0.0008 (0.90)	0.0009 (0.95)
POPCHANGE	0.0001 (0.01)	-0.001 (0.01)	0.001 (0.16)	0.00002 (0.21)	0.001 (0.003)	0.004 (0.16)
AVWAGSAL	0.05 (1.69)	0.04 (1.68)	0.05 (1.68)	0.04 (1.72)	0.05 (1.68)	0.05 (1.73)
AVVALADD	-0.003 (0.80)	-0.003 (0.79)	-0.003 (0.79)	-0.003 (0.79)	0.05 (0.78)	0.05 (0.79)
TRANSERV	0.006 (0.50)					
POLFIR		0.05 (1.17)				
RECRSERV			0.003 (0.27)			
CULTURE				0.01 (0.73)		
HEALTH					0.002 (0.38)	
EDUCATE						-0.01 (0.26)

^aOther statistics calculated in regression package are not meaningful.

survival is related to location is not supported.

The average wages and salaries variable, AVWAGSAL, deserves attention. In the linear probability model, its coefficient has the highest t-value associated with any variable. In the PROBIT model, the variable has the highest coefficient over standard error ratio and is responsible for the log-likelihood ratios indicating a significant equation. The variable becomes significant when the other variables are dropped from the various equations. When this variable is dropped, the other variables remain insignificant. However, the variable was selected to represent labour costs and location theory suggests that its coefficient should be negative. The estimated coefficient has a positive sign. The implication from the results is that higher average labour costs increase the likelihood of a firm staying in a location. This does not appear reasonable.

The variable was regressed against estimated firm employment representing firm size, the population in the sphere of influence of the community in 1971, and six dummy variables to isolate firms in six of the larger (in terms of number of firms) sub-sectors. The results are presented in Table 18. These variables were all statistically significant. Larger firms tend to have higher wages and salaries. Firms in more populated areas tend to have higher wages and salaries. Significant variations in wages and salaries occur between sub-sectors.

The fact that higher wages and salaries are associated with larger firms and a greater likelihood of survival may be interpreted that larger firms are more likely to survive. However, since surviving firms have the opportunity to grow in size, a causal relationship is not obvious. An interrelationship is possible with growth being necessary to survival.

Table 18

Factors Influencing Variation in Average Wages and Salaries Per Firm

Coefficients with T-Values in Parenthesis

Dependent Variable:	Average Wages and Salaries Per Firm	
Constant Term	4.48	(26.08)
Independent Variables		
Average Employment Per Per Firm	0.0035	(6.27)
Population of Sphere of Influence	0.000002	(4.90)
Firm in Feed Sub-sector	0.80	(3.74)
Firm in Dairy Sub-sector	1.12	(5.32)
Firm in Fruit & Vegetable Processing Sub-sector	-0.66	(2.06)
Firm in Flour & Breakfast Cereal Sub-sector	1.29	(3.72)
Firm in Beverages Sub-sector	2.08	(8.71)
F-ratio =24.96 $R^2=0.44$		

The percentage population change and absolute size of population were highly correlated (0.93). Population change appeared to have been the better measure to use. The simple correlation between population size of the sphere of influence and survival is small (-0.018). When average wages and salaries were dropped from the estimates, the significance of population change did not improve. (See Table 28 in Appendix A for one of the estimates without the wages and salaries variable). No relationship between population size and the probability of survival is indicated in the probabilities shown in Table 13. It is not possible to relate the survival of firms to population size from the relationship between average wages and salaries, and population of the sphere of influence.

One possible explanation may lie in the differences in wages and salaries between sub-sectors, and the distribution of firms among various locations.

The significant differences in wages and salaries between sub-sectors within the food processing and beverage sector suggest that this grouping of firms is too heterogenous to be aggregated together for the purpose of explaining firm behaviour. This possibility may also be reflected in the different distribution of firms among census divisions for each sub-sector shown in Table 19. The data for the PROBIT and linear probability models were analyzed without reference to individual sub-sector or region. The applied analysis of industrial location decisions may be restricted to groupings of firms producing very similar if not identical products.

Table 19
Distribution of Firms Used in PROBIT and Linear Probability Models by Census Division

Sub-sector	Census Divisions																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Slaughtering, Meat Processors	1	2	2			1						1	1	1						32
Fish Products Industry				1																10
Fruit & Vegetable Processors		3				2	1										1			9
Dairy Products		3	1	1	2	3	3	2	5	3	3	1	1	1	1		2			12
Flour & Breakfast Cereal Products	1																			9
Feed Industry	3	8	2	1		1	2	1	2	1	1	1				1	1			12
Biscuit Manufacturers																				3
Bakeries	1					1	2													12
Confectionary Manufacturers																				14
Sugar Processors																				1
Mac. Food Processors	1	1				1	2													11
Soft Drink Manufacturers					1	1	1	1								3				6
Distilleries												1								1
Breweries																				8
Wineries												1								1

Source: Table 25

The Meaning of the Probabilities

Both analyses use probability estimates. How can these probabilities be interpreted? This question is difficult because statisticians disagree on the intuitive meaning of probabilities and this is the basis of controversy.⁶³ Three theories about the meaning of probability exist. The classical or logical theory postulates that the probabilities are based upon logical reasoning and can result from the nature of the subject matter. An example is the tossing of a coin or die. A balanced coin that is tossed will land on one of two sides. Hence, the probability that it will land on a particular side is $\frac{1}{2}$. The empirical or objectivist theory postulates that probabilities measure the frequency at which an event occurs. The probabilities are measured as the number of actual occurrences over the number of possible occurrences. The personal or subjective theory suggests that probability is a measure of the degree of belief that a particular statement is true.

The Markov probabilities may be interpreted from the perspective of the objectivist theory. Using terminology from statistics, a firm evaluating a new location or re-evaluating its present location is conducting an experiment. Locating in one of the twenty states in the Markov model are the possible outcomes of that experiment. An event occurs when a firm selects one of the twenty states. The probability of the event is measured as the number of times the state is selected

⁶³ A. N. Halter, G. W. Dean, Decisions Under Uncertainty With Research Applications, (Cincinnati, Ohio: South-Western Publishing Co., 1971) pp.19-22. Michael J. Webber, Impact of Uncertainty on Location, (Sydney, Halstead Press, 1972) pp.92-93.

divided by the total number of possible choices that could be made. These could also be interpreted as expressions of belief by entrepreneurs that a particular location is best. Both the objectivist and the subjectivist interpretation of the Markov probabilities could be made.

The probabilities that are estimated with the models of qualitative choice cannot mean the same thing. They are measures of a degree of belief, but not belief by the entrepreneur, rather belief about him and his actions. The study hypothesized that the firm behaviour would be influenced by a set of locational characteristics of the communities where the firms were situated. The results of the explanatory models imply that the locational characteristics used in the model cannot provide policy analysts with information to anticipate firm behaviour.

Data Limitations

The data used in the analysis have limitations. Four data problems exist. First, complex concepts with many components require measurement. Transportation costs were one example depending on the commodity hauled, distance, mode, size of shipment, etc. Second, sub-provincial data were sparse. Third, the study needed historical data that were consistent with respect to the details published over time. Fourth, the quality of data obtained from secondary sources is beyond the control of the researcher.

In this study, distance from Winnipeg was used as a proxy for transportation costs, and average population growth was used as a proxy for market potential. These measures may not reflect the concepts closely in general. For specific firms, differences in distance to Winnipeg may not accurately reflect differences in their transportation costs. Some

firms serve a local market only; some firms export from the province. The information available was insufficient to distinguish firms exporting from Manitoba and those not doing so. Some sub-sectors of the food and beverage sector, such as the feed industry sell to other businesses rather than consumers directly, and average annual population growth as a measure of market potential could only be regarded as an indirect and weak indicator. One might find a better indicator of market potential for each sub-sector, but this would increase the number of variables in the analysis.

The sparseness of sub-provincial data is a problem. In the case of wages and salaries, and value added, the study used sub-provincial data wherever possible, but frequently relied on national data to derive firm estimates. Actual firm information was not available.

The need for historical and consistent data for the analysis resulted in some data sources and their information being rejected. Statistics Canada stopped listing firms surveyed for the Census of Manufactures temporarily. Before 1971, this information was not stored on computer tapes, but on addressograph plates which have been since destroyed. The Manitoba Trade Directory was utilized instead for information on firms and their location. Its coverage is wide, but not total, and occasionally firms recorded in a previous year might be missed although still in the same location. These oversights have been corrected wherever possible. The Community Reports, published by the Manitoba Department of Industry and Commerce provide information on specific communities, but reports for less than half of the communities currently reported were prepared in the 1960's. Not all the information within a current year is comparable from community to community.

Consequently, this study used the Regional Analysis Program reports for 1971 which were at least consistent across a set of communities.

Using secondary sources such as the Regional Analysis reports reduced the time and money costs for gathering community data, but restricted the analysis to using the kind of information collected by the responsible study group. Control of the quality of the information was limited. The indices of community services were based on availability of services more than quality measures. The criteria, the point system, and the weightings were selected by the study group with the advice of presumably knowledgeable authorities. Why the particular ranking scales were chosen is not explained. No objective analysis determined the choice of various measures of a service.

Further Comments

It may be asked if the results might have been different had some excluded factor been included. This is possible, but measures of the major factors were included. Other possible factors, such as location incentive grants provided by the Department of Regional Economic Expansion (DREE) or municipal tax concessions are not relevant. The location grants are available for all locations within the study area.⁶⁴ Municipal tax concessions to firms are not legal.⁶⁵

⁶⁴ DREE provided a list of firms receiving grants which showed 25 firms used in the PROBIT model received grants. Twenty-one or 83% of these were survivors compared with 156 out of 232 or 67% of all the food processing and beverage firms analyzed.

⁶⁵ Mr. E. Stephanson, General Manager, Interlake Regional Development Corporation, personal interview, Arborg, Manitoba, March 29, 1976.

The exclusion of entrepreneurial ability must be explained since most of the non-surviving firms probably ceased operations and did not re-locate outside the study area. The author considered the necessity of including a measure of entrepreneurial ability in the analysis. Entrepreneurial ability and "goodness" of location interact so that it may not be possible to distinguish the two. The choice of location is a matter of entrepreneurial judgement. One possible outcome is that good entrepreneurs select good locations and poor entrepreneurs select poor locations, and the quality of entrepreneur and location are closely correlated. A more likely scenario is entrepreneurial ability is more randomly dispersed, but poor locations create more problems which good entrepreneurs may overcome and which poor entrepreneurs cannot. Good locations, on the other hand, provide an environment in which a poor entrepreneur may survive despite his imperfection. After puzzling about the dilemma of distinguishing the influence of entrepreneurial ability, the author chose the analytical device of advancing the hypothesis that location was the critical determinant of firm survival as a null hypothesis excluding entrepreneurial ability as a variable.

Treating the manufacturing industry or even the food processing and beverage sector as an aggregate certainly posed a problem. Transportation costs, based on commodity rates, and labour costs could vary among sub-sectors as much as among locations.

The study region, Southern Manitoba, is primarily defined by political boundaries. Data collection is often geographically organized to coincide with political boundaries. Much of the sub-regional data were in this form. However, market areas for products are defined as

indicated in Chapter 2 by transportation costs. The inconsistency may be the source of problems.

Summary

In the descriptive analysis using the Markov probability matrix, it was found:

1. that most of the industrial change within Southern Manitoba was due to firms entering or leaving Southern Manitoba, and firms coming into and going out of existence with movements of plants from one community in Southern Manitoba to another being infrequent,
2. that firms entered and exited individual sub-regions in every time period with large gross changes masking the net changes,
3. that the ability of a firm to survive and the likelihood of a new firm selecting a particular area of the province were related to its location (Markov property), and
4. that the basic spatial pattern and movement of firms is changing over time, and the Markov transition matrices are limited in their forecasting ability, with large errors being possible beyond a five year projection.

The explanatory models of qualitative choice tested the hypothesis that the likelihood of a firm surviving is related to the locational characteristics of the community within which it is situated. The analysis did not verify the hypothesis. Of particular interest to this study, distance from Winnipeg, as a proxy for transportation costs, and a transportation service index were not significant.

Chapter 6

SUMMARY AND CONCLUSIONS

Summary

This research study has been directed to resolving the issue of whether government could encourage industrial development in rural areas by utilizing their jurisdiction over the transportation industry to influence location decisions of manufacturing firms.

From an economic perspective, space is an obstacle which society must utilize resources to overcome. Societies are expected to organize such that these resources, i.e., the costs of transportation, are minimized freeing the saved resources for the production of desired goods and services.

Regional development theories are based on the idea that economic change does not occur uniformly across space. The thesis of growth centre theory is that higher rates of change occur in specific communities. The micro-economic foundations of growth centre theory are spatial theories such as industrial location theory. Growth centre theorists have relied on interindustrial linkages and agglomeration to explain spatial concentrations and growth at the macro-economic level. Agglomeration is a phenomenon that bridges micro-analysis and macro-analysis of firm behaviour in space, although the theoretical concepts are not rigorous.

To understand the relationship between costs of transportation and regional development, an analysis should examine the location decisions of firms. Industrial location theorists have suggested that costs of transportation play a significant but complex role in the choice of a location for the firm. The cost of procuring materials and supplies

to a production site affect the cost of production, and the cost of distributing the final product affects sales. The theoretical framework presented in Chapter 2 suggests that transportation costs among other locational factors cause a firm's potential profits earned at the production site to vary across space. Since its return on investment, profits, may vary across space, the firm's investment decisions are coincidental with the choice of location. The decision to remain in a particular location or to re-locate to another location is based on the entrepreneur's perception of potential profits at his present location and alternate ones. The factors affecting both decisions are the same. The entrepreneur makes this decision under uncertainty because:

1. the volume of sales at different locations is unknown,
2. the actions of rivals can alter his potential profits, but are unknown,
3. large volumes of information may be required to assess alternate production sites exactly, but are not available or easily interpreted, and
4. potential profits are affected by future events that can only be anticipated using past and present data.

Two methods of analysis can be used. Firms may be contacted directly or observed indirectly. Direct contact using surveys can encounter many problems. Among them are the following examples. It may be difficult to isolate complex factors because surveys require precise wording of questions avoiding unclear terminology. A word may have one meaning to the researcher, and another meaning to respondents. The survey may ask leading questions that suggest a response from the subject.

Historical information cannot be easily obtained without jeopardizing the

response rate. Historical data are needed to establish a causal relationship.

Macro-economic models such as input-output models are used to show aggregate impacts on a regional economy. However, these models require detailed disaggregation and should be dynamic. They are costly to construct in terms of time and money. Furthermore, they lack a spatial focus. Macro-economic models in general obscure the behaviour of individual firms.

Linear programming models can be constructed for individual firms or industries, but the optimization algorithm under certainty is an abstraction from reality which the researcher did not want to make.

An alternative approach is first using a descriptive model to document the behaviour of all firms over a sufficiently long period of time, and then use an explanatory model to discover why the firms behaved that way. The descriptive model selected is based on the Markov probability matrix. Such a model is capable of describing movement through time and space jointly and was thus suitable for the purpose of this study. Models of qualitative choice relate the actions of individuals to hypothesized causal factors, and may be applied to the analysis of firm behaviour.

The descriptive model uses data taken from the Manitoba Trade Directory on manufacturing firms for the years 1961, 1966, 1971, and 1976. The study area selected is Southern Manitoba where most of these firms are located. The number of firms located in communities in Northern Manitoba and excluded due to their isolation was approximately 30-40 firms. The study area is divided into 19 sub-regions consisting of single communities or groups of communities. The sub-regions were

selected on the basis of population size, and distance from the metropolitan centre, Winnipeg. Communities were placed in the same sub-region based on proximity to one another.

Organizing the data into Markov probability matrices required defining three time periods 1961-66, 1966-71 and 1971-76. For each time period, a matrix of twenty states was constructed with nineteen states representing the nineteen sub-regions and the twentieth state - the catch-all state representing all other locations and the 'birth' and 'death' state for firms. Each firm was represented as an element or unit in the matrix, the row indicating its location at the beginning of the period, the column indicating its location at the end of the period. The probabilities are calculated by dividing each entry in a row by the row total.

Models of qualitative choice are used to analyze decisions made by individuals, - persons, households, or firms to undertake an action or not. A decision to carry out that particular action is quantified as the number one: and a decision not to carry out that particular action is quantified as the number zero. A decision not to act is assumed to be a positive action decision, not one of inaction or indecision.

The study advances the principal hypothesis that firms in better locations will have a greater opportunity of survival and are more likely to survive over time. This is important for development because from among the firms that enter a region and that are created locally, it is those that survive that have the permanent impact on the region's development. The location decisions of the individual firms are analyzed to verify this hypothesis.

The analyses focus on a single sector within the manufacturing industry, the food processing and beverage sector. This sector is the largest in terms of the number of firms with a large proportion outside Metropolitan Winnipeg, the principal urban centre in the study region.

In the models of qualitative choice with firms as the unit of observation, the dependent variable has a value of 1 if the firm has remained in its location from the beginning of the selected time period until the end of that period.

Several models may be specified.

The linear probability model is a linear function estimated using the ordinary least squares method of estimation. The estimated values of the dependent variable may be interpreted as the probability that the course of action is undertaken.

The model may be written in the following form:

$$P_i = \begin{cases} a + BX_i & \text{when } 0 \leq a + BX_i \leq 1 \\ 1 & \text{when } a + BX_i > 1 \\ 0 & \text{when } a + BX_i < 0 \end{cases}$$

Two estimation problems exist. The first occurs because a probability is a number within the 0 to 1 range, while the regression estimates can lie outside this range. Defining $P_i = 1$ when $a + BX_i > 1$ and $P_i = 0$ when $a + BX_i < 0$ could lead to the erroneous implication that the behaviour of the individual unit observed becomes a certainty if the value of the locational attribute is above or below a certain value when in fact this is not the case. The second problem is the heteroscedasticity of the error term which is inherent in the model. Heteroscedasticity reduces efficiency when estimating the parameters, and invalidates the test statistics calculated using an estimate of a variance assumed to be constant.

One method of dealing with the problem of estimates exceeding the bounds of the probability numbers is to transform the function such that the dependent variable can only take values between 0 and 1. Two transformations being applied currently are the cumulative probability function and the cumulative logistic probability function. Such transformations are monotonic preserving the ordinal relationship between the independent variable and the dependent variable. The cumulative probability function is the basis of the PROBIT probability model and the cumulative logistic probability function is the basis of the LOGIT probability model.

Using individual firm data, the PROBIT and LOGIT models must be estimated using maximum likelihood methods. The LOGIT model may be estimated using the ordinary least squares technique if the data are aggregated into different groups and a probability calculated for each group.

In this study, three models were estimated. A LOGIT model with firm data aggregated into groups corresponding to the sub-regions of the study area was estimated using OLS for the periods 1961-66, 1966-71, and 1971-76. Individual firm data for 1971-76 were used in a linear probability model using OLS and a PROBIT model using a maximum likelihood technique.

Conclusions

1. Strategies to encourage rural industrialization should focus not only on means of attracting new firms to rural regions, but also on means of aiding existing firms to survive. Firm survival rates were high in the major urban centres of Winnipeg, Brandon, and Portage La

throughout 1961-76 while those for Gimli-Arborg, the South Central, Southwest, and Southern Parklands improved significantly over the period. The small number of firms actually re-locating from one place to another within the study region may imply that persuading firms to re-locate from Winnipeg may not be worthwhile.

2. If distance is a reasonable measure of transportation costs, then both transportation costs and services appear unlikely to influence the decision of a firm to remain in a particular location. Thus, the aggregate impact of any change in them on a regional economy in terms of benefits such as increased employment and additional income may not occur.
3. The enormous volume of information required to utilize freight rates to obtain transportation costs make it difficult to use the freight rate structure as a general instrument of public transportation policy directed towards industrial development. Policy analysts would not be able to measure and compare the costs and benefits of specific decisions. A transportation policy based on its likelihood to encourage industrial development has little support from this dissertation.
4. The aggregation of manufacturing firms producing different products may not be useful for locational analysis. The micro-economic principles developed in industrial location theory may provide decision-rules for firms that are not observable using aggregate data.
5. The Markov probability matrix is a useful analytical tool in analyzing data involving changes over time and space. The usefulness of models of qualitative choice to predict behaviour remains uncertain.

Suggestions for Further Research

1. The usefulness of using models of qualitative choice to analyze firm decisions should be investigated further.
2. The concept of external economies and their role in inducing firm concentration and growth should be investigated. A related subject, the role of industrial parks in regional development should be explored.
3. A survey of manufacturing firms should be conducted to estimate relative differences in transportation costs among locations. The results should be standardized for product type and market size. Follow-up of the firms' progress might provide more conclusive evidence of the impact of transportation costs of firm survival.

APPENDIX A

Data Tables

The data used in the explanatory models are presented in the following tables.

Table 20 lists all the data used in the LOGIT model. Table 21 lists the 232 firms and branches in the food processing sector used in the PROBIT and linear probability model. The employment code was important in compiling the firm profiles used to estimate the average wages and salaries, and value added used in the study. The number codes are used for reference in the next table, but the first four digits are Standard Industrial Classification numbers, the next two indicate Census Division, the next two usually are a community code,⁶⁶ and finally a separate number for the firm.

Table 22 lists the dependent variable and other firm data used in the analysis. Average wages and salaries and average value added (per firm) were estimated with firm profiles developed from the Census of Manufacturing data. The Manitoba Trade Directory contained an employment code for each firm (Table 21). These codes do not correspond exactly to the Census of Manufacturers employment code. For example, the Manitoba Trade Directory has in its smallest classification, firms employing 10 or fewer people; Statistics Canada splits firms in that category into three groups. The first two include those with 4 or less employees and those between 5 and 9 employees. Those with 10 employees

⁶⁶ Statistics Canada, Standard Geographical Classification, Volume II-
The Numerical Index, Catalogue Number 12-546.

exactly would go into a third category (10-19). Table 23 lists firms surveyed by the Census of Manufactures in Manitoba by size and sector. This information was used as a guide to selecting the appropriate estimates of wages and salaries, and value added. The estimates chosen were the provincial census division average (Table 24) or the national averages for the size category (Table 25). The sub-sector and size category indicated by the employment code were the criteria used. Information on working owners (Table 25) was also used in selecting an appropriate size category. The Manitoba Trade Directory indicated whether firms were operated by single owners or partners. Since working owners operated firms employing four or fewer people, an unincorporated firm with employment code A and a working proprietor would tend to be in that smaller size category.

Table 26 indicates the distances and percentage changes in population used for firms located in the communities listed.

Table 27 shows the community scores for the available service levels.

Table 20

Data Used in LOGIT Model

Sub-region Name	Number of Firms ¹ at Beginning of Period	Number of These Remaining at End of Period	Annual Population Change (%) ²
1961-66			
Winnipeg	157	117	3.34
Brandon	18	8	3.67
Brandon 'Circle'	16	5	2.12
Brandon Hinterland	22	7	-0.42
Portage & Hinterland	25	11	0.29
Selkirk & Hinterland	15	5	0.71
Steinbach	5	3	7.35
Steinbach Hinterland	17	5	-0.10
ACMMW ⁴	25	11	3.84
South Central	15	3	-0.86
Dauphin, Roblin, Russell	18	5	2.26
Southern Parklands	22	6	-1.38
Northern Parklands	10	4	-0.68
Northern Interlake	17	3	-0.68
Southwest	17	3	-0.38
1966-71			
Winnipeg	121	102	2.84
Brandon	14	8	3.04
Brandon 'Circle'	7	5	1.80
Brandon Hinterland	7	4	-0.48
Portage & Hinterland	12	10	0.10
Selkirk & Hinterland	6	2	0.90
Steinbach	6	5	7.71
Steinbach Hinterland	8	6	0.0
ACMMW ⁴	14	6	2.92
South Central	7	4	-0.81
Dauphin, Roblin, Russell	8	6	2.96
Southern Parklands	6	2	-1.37
Northern Parklands	4	2	-0.62
Northern Interlake	6	5	-0.14
Southwest	3	2	-0.55
1971-76			
Winnipeg	114	93	1.37
Brandon	12	10	1.06
Brandon 'Circle'	10	9	0.13
Brandon Hinterland	5	4	-1.89
Portage & Hinterland	11	6	-0.91
Selkirk & Hinterland	6	3	-0.37
Steinbach	5	2	3.90
Steinbach Hinterland	8	5	-0.12
ACMMW ⁴	14	9	1.08

Table 20 (continued)

Sub-region Name	Number of Firms ¹ at Beginning of Period	Number of These Remaining at End of Period	Annual Population Change (%) ²
South Central	5	3	-1.47
Dauphin, Roblin, Russell	8	5	2.16
Southern Parklands	3	2	-1.13
Northern Parklands	2	1	-1.77
Northern Interlake	11	7	-0.79
Southwest	7	6	-1.18

Table 20 (continued)

Sub-Region Name	Dummy Variable 1966-71=1	Dummy Variable 1971-76=1	Average Salaries & Wages Per Employee ³
1961-66			
Winnipeg	0	0	4210
Brandon	0	0	3820
Brandon "Circle"	0	0	2380
Brandon Hinterland	0	0	2380
Portage & Hinterland	0	0	3450
Selkirk & Hinterland	0	0	2540
Steinbach	0	0	1309
Steinbach Hinterland	0	0	5250
ACMMW	0	0	2690
South Central	0	0	2690
Dauphin, Roblin, Russell	0	0	2310
Southern Parklands	0	0	2310
Northern Parklands	0	0	2140
Northern Interlake	0	0	3150
Southwest	0	0	2170
1966-71			
Winnipeg	1	0	4950
Brandon	1	0	4350
Brandon "Circle"	1	0	2480
Brandon Hinterland	1	0	2480
Portage & Hinterland	1	0	3180
Selkirk & Hinterland	1	0	3320
Steinbach	1	0	3340
Steinbach Hinterland	1	0	3450
ACMMW	1	0	3540
South Central	1	0	3540
Dauphin, Roblin, Russell	1	0	3620
Southern Parklands	1	0	3620
Northern Parklands	1	0	2800
Northern Interlake	1	0	3480
Southwest	1	0	3870
1971-76			
Winnipeg	0	1	6890
Brandon	0	1	6170
Brandon "Circle"	0	1	4960
Brandon Hinterland	0	1	4960
Portage & Hinterland	0	1	4900
Selkirk & Hinterland	0	1	3900
Steinbach	0	1	4510
Steinbach Hinterland	0	1	5760
ACMMW	0	1	5180
South Central	0	1	5180
Dauphin, Roblin, Russell	0	1	4950

Table 20 (continued)

Sub-region Name	Dummy Variable 1966-61=1	Dummy Variable 1971-76=1	Average Salaries & Wages Per Employees ³
Southern Parklands	0	1	4950
Northern Parklands	0	1	4550
Northern Interlake	0	1	6100
Southwest	0	1	5000

Table 20 (continued)

Sub-Region	Employment In Transportation Industry
1961	
Winnipeg	26812
Brandon	2086
Brandon "Circle"	4131
Brandon Hinterland	4131
Portage & Hinterland	886
Selkirk & Hinterland	318
Steinbach	575
Steinbach Hinterland	1475
ACMMW#4	1288
South Central	915
Dauphin, Roblin, Russell	915
Southern Parklands	650
Northern Parklands	447
Northern Interlake	392
Southwest	
1966-71	
Winnipeg	27551
Brandon	2008
Brandon "Circle"	3735
Brandon Hinterland	3735
Portage & Hinterland	718
Selkirk & Hinterland	279
Steinbach	552
Steinbach Hinterland	1367
ACMMW#4	1154
South Central	1154
Dauphin, Roblin, Russell	885
Southern Parklands	885
Northern Parklands	547
Northern Interlake	404
Southwest	356
1971-76	
Winnipeg	28290
Brandon	1930
Brandon "Circle"	3340
Brandon Hinterland	3340
Portage & Hinterland	550
Selkirk & Hinterland	240
Steinbach	530
Steinbach Hinterland	1240
ACMMW#4	1000
South Central	855
Dauphin, Roblin, Russell	855
Southern Parklands	445
Northern Parklands	360

Table 20 (continued)

Sub-region	Employment In Transportation Industry
Northern Interlake	360
Southwest	320

Table 20 (continued)

Sub-Region Name	Distance From Winnipeg
Winnipeg	0
Brandon	134
Brandon "Circle"	138
Brandon Hinterland	152
Portage & Hinterland	52
Selkirk & Hinterland	25
Steinbach	40
Steinbach Hinterland	38
ACMMW	62
South Central	98
Dauphin, Roblin, Russell	223
Southern Parklands	232
Northern Parklands	310
Northern Interlake	76
Southwest	202

Footnotes:

- ¹ Firms in the food processing and beverage industry.
- ² Except for 1966-71, value is for average annual percentage change over the decade prior to initial year. For 1966-71, annual average change is for 15 years prior to initial year
- ³ Wherever possible data are for food processing and beverage firms; elsewhere for entire manufacturing industry.
- ⁴ Altona, Carman, Morden, Morris, Winkler.

Sources: Manitoba Department of Industry and Commerce, Manitoba Trade Directory, (Winnipeg: Sanford Evans Publishing Ltd., 1962, 1970-1, 1975, 1976) Manitoba Trucking Association, Ship By Truck Directory Issue, 1974, (Winnipeg) pp. Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba - Update Part 1A, Volume 1, (Winnipeg, 1975) Tables D1, D1a, D1c, pp.3-33 Statistics Canada, Manufacturing Industries of Canada: Geographic Distribution Cat. No. 31-209, 1961, 1966, (Ottawa, Dominion Bureau of Statistics, 1964, 1971) Table 7, and for 1971 (Ottawa, Information Canada, 1975) Table 8.

Table 21

Firms Used in PROBIT and Linear Probability Models

Firm Name	Location	Employ- ment Code	Number Code
Acme Poultry Service	Steinbach	A	101201091
Acme Produce	Winnipeg	B	101220151
Alfalfa Products Ltd.	Winnipeg	B	106020151
Altona Feed Service	Altona	A	106002091
Arctic Drink Mfg.	Winnipeg	A	109120150
Arctic Ice Co. Ltd.	Winnipeg	C	108920150
B. C. Pea Growers Ltd.	Portage L. P.	B	103006110
Beausejour Creamery Co. Ltd.	Beausejour	A	104005061
Beavis, J., Allan	Crystal City	A	108903090
Bell Bottling Co. Ltd.	Winnipeg	C	109120151
Best, Herb Beef Ltd.	Winnipeg	C	101120151
Blackwoods Beverages Ltd.	Winnipeg	E	109120152
Blackwoods Beverages Ltd.	Brandon	?	109107240
Blackwoods Beverages Ltd.	Dauphin		109117110
Bodner Fish Distributors	Winnipeg	C	102020150
Bond & Ronald Ltd.	Winnipeg	D	108120150
Brooke Bond Foods	Winnipeg	B	108920151
Buffalo Packers Ltd.	Winnipeg	A	101120152
Burns Foods Ltd.	Winnipeg	F	101120153
Calvert's of Canada Ltd.	Gimli	D	109212140
Campbell Soup Co.	Portage L. P.	F	103006111
Canada Dry Ltd.	Winnipeg	C	109120153
Canada Malting Co. Ltd.	Winnipeg	D	109320150
Canada Packers Ltd.	Winnipeg	H	101120154
Canada Packers Ltd.	Manitou	?	101103041
Canada Safeway Ltd.	Winnipeg	E	104020150
Canada's Man. Distillery Ltd.	Minnedosa	C	109210160
Canadian Breweries Manitoba	Winnipeg	F	109320150
Canadian Fish Producers	Winnipeg	A	102020151
Canadian Northland Foods Ltd.	Winnipeg	A	102020152
Carman Creamery	Carman	?	104002290
Carnation Foods Co. Ltd.	Carberry	F	103007310
Catelli-Five Roses Ltd.	Winnipeg	A	105020150
Central Grain Co. Ltd.	Winnipeg	B	106020152
Cham Food Service Ltd.	Winnipeg	C	101220152
Cham Food Service Ltd. 2	Winnipeg	E	101220153
Chicago Kosher Mfg. Co.	Winnipeg	D	101120155
Christie Brown & Co. Ltd.	Winnipeg	D	107120150
City Bread Co. Ltd.	Winnipeg	B	107220150
Coca-Cola Ltd.	Winnipeg	E	109120154
Consolidated Candy Mfg.	Winnipeg	B	108120151
Constant Macaroni Products	Winnipeg	B	105020151
Cookieland Ltd.	Winnipeg	A	107220151

Table 21 (continued)

Firm Name	Location	Employ- ment Code	Number Code
Crescent Creamery Ltd.	Winnipeg	E	104020151
Crescent Creamery Ltd.	Swan River	?	104015081
Crescent Creamery Ltd.	Gladstone	?	104010040
Cressy, John R. Co. Ltd.	Altona	A	108902090
Custom Abattoir Ltd.	Winnipeg	C	101120156
Danforth Estates	Gimli	C	109412140
Dauphin Alfalfa Products Ltd.	Dauphin	A	106017111
Del's Chocolates	Winnipeg	B	108120152
Del's Specialty Meats Ltd.	Winnipeg	A	101120157
Donut House	Winnipeg	C	107220152
Dubois Wild Rice Ltd.	Winnipeg	A	103020150
Dunn-Rite Food Products	Winnipeg	C	101220154
Dutch Maid Dairy & Ice Cream	Winnipeg	C	104020152
East-West Packers Ltd.	Winnipeg	C	101120158
Elman's Food Products	Winnipeg	A	103020151
Empire Spice Mills	Winnipeg	A	108920152
European Meat & Sausage Co.	Winnipeg	A	101120159
European Pastry Shop	Winnipeg	A	107220153
Fairway Milling & Grain	Winnipeg	B	105020152
Farmers Abattoir	Winnipeg	D	101120161
Federal Grain Ltd.	Winnipeg	E	106020153
Federated Fine Foods Ltd.	Winnipeg	D	108920153
Feed Rite Mills	Winnipeg	C	106020154
Feed Rite Mills	Brandon	?	106007241
Flying Dutchman Kitchens	Brandon	A	107207240
Forever Industries Ltd.	Winnipeg	A	108920154
Friendly Family Farms Ltd.	Steinbach	D	106001091
Galpern, L. Candy Co. Ltd.	Winnipeg	B	108120153
Gardenland Cannery	Winkler	C	103002140
Gardenland Cannery	Altona	?	103002090
Gardenland Packers Ltd.	Altona	?	103002091
Glacier Food Services Ltd.	Winnipeg	B	101120162
Gladstone Creamery Co.	Gladstone	B	104010041
Gateway Packers Ltd.	Winnipeg	C	101120162
Gretna Feed Mill	Gretna	A	106002081
Grushko, H. & Sons	Winnipeg	B	101103161
Gunn's Homemade Cakes/Pastry	Winnipeg	A	107220154
Halparin's Wholesale Meat	Winnipeg	A	101120177
Harder's Seed Service Ltd.	Plum Coulee	A	106002111
Hicks Abattoir & Processing	Killarney	A	101103161
Independent Fish Company	Winnipeg	C	102020153
Inter-Ocean Grain Co. Ltd.	Winnipeg	B	106020155
Inter-Ocean Grain Co. Ltd.	Morden	?	106002161
Inter-Ocean Grain Co. Ltd.	Winkler	?	106002141
Jeanne's Bakery Ltd.	Winnipeg	B	107220155
Jeanne's Bakery Ltd.	Winnipeg	?	107220155

Table 21 (continued)

Firm Name	Location	Employ- ment Code	Number Code
Johnson Nut & Confection Co.	Winkler	?	106002141
Jonespac	Winnipeg	A	108120155
Kady-Lo Farm Services	Shoal Lake	A	106019921
Keller Feed & Seed Co. Ltd.	Niverville	B	106001101
Kenmore Industries Ltd.	Winnipeg	A	106020156
Kiewel Brewery Ltd.	Winnipeg	D	109320152
Kosher Meat Canning Co. Ltd.	Winnipeg	B	101120165
Kroeker Seeds Ltd.	Winkler	B	106002142
Labatt's Manitoba Brewey	Winnipeg	E	109320153
Lakeland Dairies Ltd.	Selkirk	B	104005160
Lindenberg Seeds Ltd.	Brandon	B	108907240
Lowe, Joe, Ltd.	Winnipeg	A	107120151
Loveday Mushroom Farms Ltd.	Winnipeg	B	103020152
Macey Foods Ltd.	Brandon	C	108907241
MacGregor Fish Bloc	Winnipeg	A	102020154
Main Baking Co.	Winnipeg	C	107220157
Main Fisheries Ltd.	Winnipeg	A	102020155
Manco Cheese Ltd.	Winnipeg	A	104020154
Manco Cheese Ltd.	Rosburn	?	104011260
Man. Coop. Honey Producers	Winnipeg	C	108920156
Man. Dairy & Poultry Co-op.	Winnipeg	F	104020155
Man. Dairy & Poultry Co-op.	Brandon	?	104007240
Man. Dairy & Poultry Co-op.	Dauphin	?	104017110
Man. Dairy & Poultry Co-op.	Elkhorn	?	104008180
Man. Dairy & Poultry Co-op.	Russell	?	104013290
Man. Dairy & Poultry Co-op.	Winkler	?	104002140
Man. Dairy & Poultry Co-op.	Portage L. P.	?	104006110
Man. Dairy & Poultry Co-op.	Roblin	?	104014090
Man. Dairy & Poultry Co-op.	Rosburn	?	104011260
Man. Dairy & Poultry Co-op.	Swan River	?	104015080
Man. Dairy & Poultry Co-op.	Shoal Lake	?	104011120
Manitoba Sausage Mfg. Ltd.	Winnipeg	D	101120166
Manitoba Sugar Co. Ltd.	Winnipeg	E	108220150
Man-Out Poultry Farm Eggs	Winnipeg	C	101220155
Maple Leaf Mills Ltd.	Winnipeg	F	101120167
McCallister Pea & Seed	Portage L. P.	B	108906110
McGavin Toastmaster Ltd.	Winnipeg	F	107220158
McGavin Toastmaster Ltd.	Brandon	D	107207241
McIntosh Farm	Lac Du Bonnet	A	106019241
McKenzie-Stephenson Ltd.	Winnipeg	A	105020153
Medo-Land Dairy Products	Winnipeg	C	104020153
Melita Creamery	Melita	?	104004160
Melrose Foods Ltd.	Winnipeg	C	108920157
Mid-Central Fish Co.	Winnipeg	A	102020156
Midgie Company	Winnipeg	A	103020153

Table 21 (continued)

Firm Name	Location	Employ- ment Code	Number Code
Milady Confection Mfg. Ltd.	Winnipeg	B	108120156
Miracle Bakery	Winnipeg	A	107220159
Modern Dairies Ltd.	Winnipeg	G	104020156
Modern Dairies Ltd.	Brandon	?	104007241
Modern Dairies Ltd.	Glenboro	?	104007180
Molson's Brewery	Winnipeg	D	109320154
Morden Creamery	Morden	?	104002160
Mound View Dairy Ltd.	Pilot Mount	A	104003080
Nabisco Foods Limited	Winnipeg	A	105020156
Naleway Foods Ltd.	Winnipeg	C	105020157
National Grain Co. Ltd.	Winnipeg	G	106020157
Neepawa Creamery Ltd.	Neepawa	B	104010110
Neepawa Food Processors Ltd.	Neepawa	C	101210111
Neptune's Fisheries Ltd.	Winnipeg	B	102020157
North Mushroom Growers Ltd.	Winnipeg	B	103020154
North Star Co-op Cheese	Arborg	A	104012170
North Star Co-op Creamery	Arborg	A	104012171
North Star Cold Storage	Winnipeg	B	101120168
North West Beverages Ltd.	Dauphin	A	109117111
Northern Lakes Fisheries	Winnipeg	B	102020158
Northern Sales Ltd.	Winnipeg	B	103020155
Northern Fisheries Ltd.	Winnipeg	D	102020159
Northland Wild Rice Ltd.	Winnipeg	A	103020156
Northland Wild Rice Ltd.	Lac Du Bonnet	?	103019240
North-West Bakery Ltd.	Winnipeg	C	107220160
Notre Dame Alfalfa Farms	Notre Dame	A	106007041
Nutsweet Packing Co.	Winnipeg	A	108120157
Oasis Delicatessen Ltd.	Winnipeg	B	108920158
Ogilvie Flour Mills Ltd.	Winnipeg	F	105020154
O'Keefe Brewing Col. Ltd.	Winnipeg	D	109320155
Old Dutch Foods Ltd.	Winnipeg	E	103020157
Pachal's Beverages	Dauphin	A	109117112
Parrish & Heimbecker	Winnipeg	?	106020158
Parrish & Heimbecker	Boissevain	?	106004041
Parrish & Heimbecker	Brandon	?	106007241
Parrish & Heimbecker	Gimli	?	106012141
Parrish & Heimbecker	Gladstone	?	106010041
Parrish & Heimbecker	Neepawa	?	106010111
Paulin Chambers Co. Ltd.	Winnipeg	C	109320156
Pembina Poultry Packers Ltd.	Morden	D	101202041
People's Co-op. Ltd.	Winnipeg	E	104020157
People's Co-op. Ltd.	Minnedosa	?	104010160
Pepsi-Cola Co. Ltd.	Winnipeg	E	109120155
Pilot Pets Foods Ltd.	Pilot Mound	A	106003081
Portage Creamery	Portage L. P.	C	104006111

Table 21 (continued)

Firm Name	Location	Employ- ment Code	Number Code
Portage Feed Mill	Portage L. P.	A	106006111
Portage Soda Water Works	Portage L. P.	A	109106110
Pragnell Bakery Ltd.	Portage L. P.	A	107206110
Prairie Abattoir Ltd.	Winnipeg	B	101106111
Prairie Maid Cereal Ltd.	Winnipeg	B	105020155
Prairie Produce Co. Ltd.	Winnipeg	B	101220156
Progress Candy (1963) Ltd.	Winnipeg	C	108120158
Quality Sausage Mfg. Ltd.	Winnipeg	A	101120169
Riediger's J. P. & Sons Ltd.	Morden	A	106002162
Riediger's Feed & Seed	Manitou	B	106003041
Riverton Co-op. Creamery	Riverton	B	104012190
Robertson Shortbread Co. Ltd.	Winnipeg	A	108120159
Roblin Meat Processors Ltd.	Roblin	A	101114081
Royal Crest Foods	Winnipeg	C	104020159
Royal Dairies Ltd.	Winnipeg	C	104020158
Russell Meat Processors Ltd.	Russell	A	101113291
St. Boniface Abattoir	Winnipeg	?	101120177
St. Boniface Hide & Wool	Winnipeg	B	101120171
St. Claude Creamery	St. Claude	?	104006060
St. Joseph's Dairy Ltd.	Winnipeg	B	104020160
St. Rose Creamery	Ste. Rose	A	104017040
Schneider, J. M. Ltd.	Winnipeg	D	101120172
Scott-Bathgate Ltd.	Winnipeg	F	108120160
Selkirk Beverages Ltd.	Selkirk	A	109105160
Selkirk Fish Meal Co.	Selkirk	A	102005160
Silverwood Dairies Ltd.	Winnipeg	D	104020161
Smith's Corned Beef & Sausage	Winnipeg	A	101120173
Soo Line Mills Ltd.	Winnipeg	C	106020160
Souris Seed & Feed Ltd.	Souris	A	106008041
Standard Brands	Winnipeg	D	106020159
Star Foods Products	Winnipeg	D	101120174
Steinbach Bakery Ltd.	Steinbach	a	107201090
Steinbach Hatchery Ltd.	Steinbach	A	106001091
Steinbach Flour Mills Ltd.	Steinbach	A	105001090
Superior Cheese Canada Ltd.	Souris	A	104008040
Swift Canadian Feeds	Winnipeg	G	106020161
Swift Canadian Edible Oils	Winnipeg	B	106008041
Tasty Sunflower Seeds	Winnipeg	A	103020158
Twin City Packers Ltd.	Winnipeg	C	101120176
Uncle Ben's Breweries	Winnipeg	D	109320157
Valley Rouge Wines Ltd.	Winnipeg	A	109420150
Victor Fox Foods Ltd.	Winnipeg	A	106020162
Vu-Pak Company, The	Winnipeg	B	108120161
Watkins Products Inc.	Winnipeg	D	108920159
Weinshenker, B. & Sons Candy	Winnipeg	A	108120162

Table 21 (continued)

Firm Name	Location	Employ- ment Code	Number Code
Western Super-Pufft Popcorn	Winnipeg	A	108120163
Western Vinegars Ltd.	Winnipeg	B	108920160
Weston Bakeries Ltd.	Winnipeg	F	107220161
Winkler Feed Service	Winkler	A	106002143
Winkler Wholesale Meats	Winkler	A	101102141
Winnipeg Central Milling Ltd.	Winnipeg	A	105020158
Winnipeg Rendering Co. Ltd.	Winnipeg	A	101120178

Footnote: ¹ Employment Code: A=0-10, B=11-25, C=26-50, D=51-100, E=101-200, F=201-500, G=501-1000, H=1000+. A'?' indicates employment unknown, generally it is assumed that employment is under 10.

Source: Manitoba Department of Industry and Commerce, Manitoba Trade Directory, (Winnipeg: Sanford Evans Publishing Ltd., 1971).

Table 22
Date Used in PROBIT and Probability Models

Firm Number	Dependent Variable	Branch Variable	Owner Variable	Wages & Salaries Per Firm 000's	Average Number of Employees Per Firm	Value Added Per Firm 000's
101201091	0.	1.	0.	17.	3.9	28.
101220151	1.	1.	1.	63.	14.9	94.
101220152	0.	1.	1.	141.	31.6	243.
101220153	0.	1.	1.	1065.	133.7	1579.
101220154	1.	1.	1.	141.	31.6	243.
101220155	1.	1.	1.	141.	31.6	243.
101202141	1.	1.	1.	335.	69.8	590.
101220156	1.	1.	1.	63.	14.9	94.
101120151	1.	1.	1.	209.	30.3	391.
101120152	0.	1.	1.	15.	3.2	34.
101120153	1.	0.	1.	2313.	292.7	3453.
101120154	1.	0.	1.	14039.	1606.2	20590.
101103041	1.	0.	1.	19.	3.4	43.
101120155	0.	1.	1.	497.	70.0	1035.
101120156	1.	1.	1.	209.	30.3	391.
101120157	1.	1.	1.	15.	3.2	34.
101120158	1.	1.	1.	209.	30.3	391.
101120159	1.	1.	0.	47.	8.1	62.
101120161	0.	1.	1.	497.	70.0	1035.
101120162	0.	1.	1.	78.	13.8	157.
101120163	1.	1.	1.	209.	30.3	391.
101120164	0.	1.	1.	78.	13.8	157.
10113161	1.	1.	0.	9.	4.0	25.
101120165	0.	1.	1.	78.	13.8	157.
101120166	1.	1.	1.	497.	70.0	1305.
101120167	1.	0.	1.	2313.	292.7	3453.
101120168	0.	1.	1.	78.	13.8	157.
101106111	1.	1.	1.	31.	6.3	62.
101120169	1.	1.	1.	31.	6.3	62.
101114081	1.	1.	1.	12.	2.6	19.
101113291	1.	1.	1.	12.	2.6	19.
101120170	0.	1.	1.	31.	6.3	62.
101120171	1.	1.	1.	7.	1.6	19.
101120172	1.	0.	1.	497.	70.0	1035.
101120173	1.	1.	1.	31.	6.3	62.
101120174	0.	1.	0.	18.	3.5	19.
101120175	1.	0.	1.	78.	13.8	157.
101120176	0.	1.	1.	209.	30.3	391.
101102141	1.	1.	0.	13.	2.6	19.
101120177	1.	1.	1.	31.	6.3	31.
101120178	0.	1.	1.	31.	6.3	31.
106020151	1.	1.	1.	138.	20.3	406.

Table 22 (continued)

Firm Number	Dependent Variable	Branch Variable	Owner Variable	Wages & Salaries Per Firm 000's	Average Number of Employees Per Firm	Value Added Per Firm 000's
10600291	1.	1.	0.	13	2.7	25.
106020152	1.	1.	1.	138.	20.3	381.
106017111	1.	1.	1.	33.	6.4	66.
106020153	0.	1.	1.	1184.	150.7	2704.
106020154	1.	1.	1.	191.	28.5	381.
106007241	1.	0.	1.	33.	6.4	66.
106001091	0.	1.	1.	513.	71.4	1639.
106002081	1.	1.	0.	9.	2.7	25.
106002111	1.	1.	1.	33.	6.4	66.
106020155	0.	1.	1.	82.	13.6	163.
106002161	0.	0.	1.	9.	1.9	25.
106002141	0.	0.	1.	9.	1.9	25.
106011121	1.	1.	0.	14.	2.9	25.
106001101	0.	1.	1.	107.	22.8	163.
106020156	1.	1.	1.	33.	6.4	66.
106002142	1.	1.	1.	82.	13.6	163.
106019241	0.	1.	0.	14.	2.9	25.
106020157	0.	1.	1.	1184.	150.7	2704.
106007041	0.	1.	0.	50.	9.0	107.
106020158	1.	1.	1.	138.	20.3	381.
106004041	1.	0.	1.	38.	7.0	107.
106007241	0.	0.	1.	38.	7.0	107.
106012141	0.	0.	1.	33.	6.4	66.
106010041	1.	0.	1.	38.	7.0	107.
106010111	1.	0.	1.	38.	7.0	107.
106003081	0.	1.	1.	9.	1.9	25.
106006111	1.	1.	0.	14.	2.7	25.
106002162	1.	1.	1.	33.	6.4	66.
106003041	1.	1.	1.	82.	13.6	163.
106020159	1.	0.	1.	512.	71.4	1639.
106020160	1.	1.	1.	191.	28.5	381.
106001091	1.	1.	1.	9.	1.9	25.
106008041	0.	1.	0.	38.	7.0	107.
106020161	1.	1.	1.	1184.	150.0	2704.
106002143	1.	1.	1.	38.	10.0	76.
106020162	1.	1.	1.	9.	1.7	25.
104005061	1.	1.	1.	32.	6.5	68.
104020150	1.	0.	1.	1008.	140.1	1891.
104002290	1.	1.	1.	157.	29.7	322.
104020151	1.	1.	1.	1008.	140.1	1891.
104010040	0.	0.	0.	32.	6.5	68.
104015080	1.	0.	0.	32.	6.5	68.
104020152	1.	1.	1.	224.	33.9	426.
104010041	1.	1.	0.	90.	14.8	130.
104005160	1.	1.	1.	71.	13.2	123.
104020153	1.	1.	1.	224.	33.9	426.
104020154	1.	1.	1.	32.	6.5	68.
104011260	0.	0.	1.	10.	2.2	24.
104020155	1.	1.	0.	613.	88.9	847.
104006110	1.	0.	0.	157.	29.7	322.

Table 22 (continued)

Firm Number	Dependent Variable	Branch Variable	Owner Variable	Wages & Salaries Per Firm 000's	Average Number of Employees Per Firm	Value Added Per Firm 000's
108120162	1.	1.	1.	40.	8.2	45.
108120163	1.	1.	1.	26.	6.2	45.
109120150	1.	1.	0.	86.	9.5	195.
109120151	0.	1.	1.	198.	30.5	411.
109120152	1.	1.	1.	744.	97.8	1806.
109107240	1.	0.	1.	77.	14.0	185.
109117110	1.	0.	1.	77.	14.0	185.
109120153	0.	0.	1.	198.	30.5	411.
109120154	1.	0.	1.	1109.	148.2	2237.
109117111	0.	1.	1.	77.	14.0	185.
109117112	0.	1.	1.	77.	14.0	185.
109120155	1.	0.	1.	1109.	148.2	2237.
109106110	0.	1.	1.	148.	30.5	411.
109105160	0.	1.	1.	77.	14.0	185.
109320150	0.	0.	1.	661.	74.6	2041.
109320151	0.	0.	1.	3669.	400.8	20839.
109320152	1.	1.	1.	661.	74.6	2041.
109320153	1.	1.	1.	1547.	176.8	3575.
109320154	1.	0.	1.	1547.	176.8	3575.
109320155	0.	0.	1.	1547.	176.8	3575.
109320156	0.	1.	1.	318.	36.0	1055.
109320157	1.	0.	0.	661.	74.6	2041.
109420150	1.	1.	1.	69.	11.6	1051.
109412140	0.	0.	1.	221.	30.3	531.
109210160	1.	1.	1.	250.	30.2	2079.
109212140	1.	1.	1.	809.	101.0	2581.
108920150	1.	1.	1.	225.	33.4	1747.
108903090	1.	1.	0.	19.	4.0	43.
108920151	1.	0.	1.	88.	14.4	240.
108902090	1.	1.	1.	39.	6.8	57.
108920152	1.	1.	0.	13.	2.2	21.
108920153	0.	1.	1.	512.	71.0	1409.
108920154	1.	1.	1.	39.	6.8	57.
108906110	1.	1.	1.	88.	14.4	240.
108907240	1.	1.	1.	88.	14.4	240.
108907241	1.	1.	1.	88.	14.4	240.
108920155	1.	1.	0.	225.	33.4	653.
108920156	1.	1.	0.	225.	33.4	653.
108920157	1.	1.	1.	225.	33.4	653.
108920158	1.	1.	1.	88.	14.4	240.
108920159	1.	0.	1.	512.	71.0	1409.
108920160	0.	1.	1.	88.	14.4	240.

Table 22 (continued)

Firm Number	Dependent Variable	Branch Variable	Owner Variable	Wages & Salaries Per Firm 000's	Average Number of Employees Per Firm	Value Added Per Firm 000's
104013290	0.	0.	0.	90.	14.8	130.
104002140	1.	0.	0.	157.	29.7	322.
104017110	1.	0.	0.	32.	6.5	68.
104014090	1.	0.	0.	32.	6.5	68.
104010280	1.	0.	0.	46.	8.3	74.
104008180	1.	0.	0.	39.	8.0	66.
104007240	1.	0.	0.	90.	14.8	130.
104011120	1.	0.	0.	90.	14.8	130.
104011260	1.	0.	0.	90.	14.8	130.
104012170	1.	1.	0.	32.	6.5	68.
104012171	1.	1.	1.	32.	6.5	68.
104002160	1.	0.	1.	157.	29.7	322.
104020156	1.	1.	1.	2895.	374.1	6227.
104007241	1.	0.	1.	90.	14.8	130.
104003080	1.	1.	1.	90.	14.8	130.
104010110	1.	1.	1.	90.	14.8	130.
104007180	0.	0.	1.	90.	14.8	130.
104004160	1.	0.	0.	90.	14.8	130.
104020157	1.	1.	0.	1008.	140.1	1891.
104020158	1.	1.	1.	224.	33.9	426.
104020159	1.	1.	1.	224.	33.9	426.
104012190	0.	1.	0.	77.	13.6	361.
104020160	0.	1.	1.	77.	13.6	361.
104006060	1.	0.	0.	15.	2.8	24.
104008040	1.	1.	1.	39.	8.0	66.
104010160	1.	0.	0.	46.	8.3	74.
104017040	0.	1.	0.	90.	14.8	130.
104006111	1.	1.	1.	157.	13.7	322.
104020161	1.	0.	1.	613.	88.9	847.
102020150	0.	1.	1.	129.	30.3	205.
102020151	0.	1.	1.	52.	13.7	100.
102020152	0.	1.	1.	9.	2.8	29.
102020153	1.	1.	1.	129.	27.8	100.
102020154	0.	1.	0.	15.	3.8	29.
102020155	0.	1.	1.	9.	2.8	29.
102020156	0.	1.	0.	10.	2.6	29.
102020157	1.	1.	1.	52.	13.7	100.
102020158	0.	1.	1.	52.	13.7	100.
102020159	0.	1.	1.	359.	100.2	643.
102005160	0.	1.	0.	10.	2.4	22.
108220150	1.	1.	1.	976.	134.2	2304.
107220150	1.	1.	1.	57.	12.5	87.
107220151	0.	1.	1.	16.	3.7	22.
107220152	1.	1.	1.	150.	16.4	227.
107220153	1.	1.	0.	38.	7.9	45.
107207240	1.	1.	0.	31.	6.9	39.
107220154	1.	1.	1.	24.	5.9	39.
107220155	1.	1.	1.	24.	5.9	39.
107220156	0.	1.	1.	57.	12.5	87.

Table 22 (continued)

Firm Number	Dependent Variable	Branch Variable	Owner Variable	Wages & Salaries Per Firm 000's	Average Number of Employee Per Firm	Value Added Per Firm 000's
107220157	0.	1.	0.	150.	28.1	227.
107220158	1.	0.	1.	2321.	342.4	3893.
107207241	1.	0.	1.	430.	67.8	679.
107220159	1.	1.	0.	24.	5.9	39.
107220160	1.	1.	1.	150.	28.1	227.
107206110	0.	1.	1.	16.	3.4	15.
107201090	0.	1.	1.	31.	6.4	39.
107220161	1.	0.	1.	2321.	342.4	3893.
107120150	1.	0.	1.	781.	148.6	1351.
107120151	0.	1.	1.	12.	2.8	26.
107120152	1.	1.	1.	2383.	418.0	5044.
103006110	1.	0.	1.	62.	14.2	142.
103006111	1.	0.	1.	1875.	285.3	1782.
103007310	1.	0.	1.	1914.	387.0	4177.
103020150	1.	1.	1.	8.	1.8	54.
103020151	1.	1.	0.	11.	2.8	54.
103002140	0.	1.	0.	154.	31.9	311.
103002090	0.	0.	0.	32.	6.9	75.
103002091	0.	1.	1.	32.	6.9	75.
103020152	1.	1.	1.	62.	14.2	142.
103020153	0.	1.	0.	11.	2.8	18.
103020154	0.	1.	1.	62.	14.2	142.
103020155	1.	1.	1.	62.	14.2	142.
103020156	1.	1.	1.	32.	6.9	75.
103019240	1.	0.	1.	8.	1.8	18.
103020157	1.	1.	1.	737.	138.5	1782.
103020158	1.	1.	0.	11.	2.8	18.
105020150	0.	0.	1.	45.	7.8	99.
105020151	0.	1.	0.	113.	15.8	322.
105020152	0.	1.	0.	177.	25.0	509.
105020153	1.	1.	1.	45.	7.8	99.
105020154	1.	0.	1.	1083.	145.2	2385.
105020155	1.	0.	1.	113.	15.8	322.
105020156	1.	0.	1.	45.	7.8	99.
105020157	1.	1.	1.	419.	48.8	322.
105001090	1.	1.	1.	45.	7.8	99.
105020158	1.	1.	1.	45.	7.8	99.
108120150	0.	1.	1.	430.	67.8	679.
108120151	0.	1.	1.	133.	26.0	303.
108120152	0.	1.	1.	133.	26.0	303.
108120153	0.	1.	1.	133.	26.0	303.
108120154	1.	0.	1.	157.	30.4	370.
108120155	1.	1.	1.	5.	1.3	12.
108120156	0.	1.	1.	60.	12.3	101.
108120157	0.	1.	1.	26.	6.2	45.
108120158	1.	1.	1.	157.	30.4	370.
108120159	1.	1.	1.	26.	6.2	45.
108120160	1.	1.	1.	1571.	271.8	3629.
108120161	1.	1.	1.	157.	30.4	370.

Table 23

Number of Establishments By Total Employed By Industry For Manitoba

Industry Name	Employment Size Group									1000 + Total
	0 -4	5 -9	10 -19	20 -49	50 -99	100 -199	200 -499	500 -999		
Slaughtering & Meat Process.	6	7	3	4	4	1	-	2	1	28
Poultry Processors	1	-	1	4	2	1	-	-	-	9
Fish Products	3	1	2	2	1	-	-	-	-	9
Fruit/Veget. Cann./Preserv.	1	-	3	1	-	1	-	-	-	6
Frozen Fruit	-	-	-	-	-	-	1	-	-	1
Dairy Prod.	13	11	12	8	2	3	1	-	-	50
Flour/Breakfast Cereal Products	-	2	1	1	-	2	-	-	-	6
Feed	15	12	14	5	1	-	-	-	-	47
Biscuit Mfg.	1	-	-	-	-	1	-	-	-	3
Bakeries	66	28	13	6	2	1	1	-	-	117
Confectionary Manufacturers	3	2	-	2	-	-	-	-	-	7
Sugar Processors	-	-	-	-	-	1	-	-	-	1
Vegetable Oil Mills	-	1	-	-	1	-	-	-	-	2
Misc. Food Processors	3	2	2	4	2	2	1	-	-	16
Soft Drinks	-	-	3	3	-	3	-	-	-	9
Distilleries	-	-	-	1	-	1	-	-	-	2
Breweries	-	-	-	-	1	1	2	-	-	4

Source: Statistics Canada: Manufacturing Industries of Canada: Type of Organization and Size of Establishments 1971, (Ottawa: Information Canada, 1975) Appendix I, pp.85-88.

Table 24
Average Principal Statistics Per Establishment for Manitoba, 1971

Industry & Census Division	No. of Establishments	Working Owners and Partners	Withdrawal Per Owners	Average Employment	Average Wages & Salaries \$000's	Average Value Added \$000's
C. D. 1 Bakeries	5	5	x ²	12.0	43	82
C. D. 2 & 6 Dairy Prod. Bakeries	3 9	- 8	- 6000	29.7 4.4	157 19	351 31
C. D. 8 Dairy Prod.	3	-	-	8.0	39	66
C. D. 10 Dairy Prod.	3	-	-	8.3	46	76
C. D. 16 Bakeries	4	-	-	4.8	18	35
C. D. 20 Meat/Poul.	22	2	x	133.7	1065	921
Dairy Prod.	9	-	-	88.9	613	406
Feed	14	-	-	20.3	138	176
Bakeries	50	47	4700	16.2	109	1850
Soft Drinks	5	1	x	97.8	744	3597
Breweries	4	-	-	176.8	1547	739
Region 1 = C. D. 1, 5, 19 Dairy Prod.	5	-	-	13.2	71	128
Feed	11	4	x	10.0	38	83
Bakeries	10	10	6500	7.9	30	55
Region 3 - C. D. 3-4, 7-8, 10-11, 13 Dairy Prod.	16	2	x	14.8	90	166
Feed	10	7	3000	7.0	38	121
Region 4 = C. D. 14, 15, 17, 18 Bakeries	9	7	9500	4.9	22	38

Footnotes: ¹ Sub-provincial information is available for these specific industries. This information was occasionally used instead of national averages.

² Information not reported

Source: Statistics Canada Cat. No. 31-209, Manufacturing Industries of Canada: Geographical Distribution 1971 (Ottawa: Information Canada, 1975) Tables 8-9.

Table 25

Average Principal Statistics Per Establishment 1971 - Canada

Industry And Size By Total Employed	No. of Estab- lish- ments	Work- ¹ ing Owners	With- drawal per Owner	Ave. ² Employ- ment	Ave. ² Wages & Salaries \$ 000's	Ave. ² Value Added \$ 000's
Slaughtering & Meat Processing						
-4	135	121	5400	1.6	7	19
5-9	71	34	8100	6.3	31	62
10-19	71	10	x ³	13.8	78	163
20-49	78	1	x	30.3	209	408
50-99	44	-	-	70.0	497	1068
100-199	27	-	-	145.7	809	2216
200-499	20	-	-	292.7	2313	3720
500-999	9	-	-	641.8	5219	8944
1000+	5	-	-	1606.2	14039	21588
Poultry Processors						
0-4	4	13	4400	1.7	7	15
5-9	5	1	x	6.8	31	64
10-19	12	-	-	14.9	63	97
20-49	25	6	x	31.6	141	250
50-99	22	2	x	69.8	335	609
100-199	18	-	-	145.8	802	1231
200-499	8	-	-	289.1	1538	2408
Fish Products Industry						
0-4	72	49	6000	1.6	4	22
5-9	51	27	6000	6.4	24	51
10-19	57	6	x	13.7	52	101
20-49	71	2	x	30.3	129	225
50-99	44	-	-	100.2	359	685
100-199	31	-	-	142.2	510	979
200-999	22	-	-	326.7	1574	3246
Fruit & Vegetable Canners & Processors						
-4	35	24	3000	1.8	8	18
5-9	27	7	6000	6.9	32	76
10-19	42	5	5000	14.2	62	156
20-49	61	-	-	31.9	154	359
50-99	19	-	-	68.1	343	801
100-199	29	-	-	138.5	737	1960
200-499	10	-	-	285.3	1875	4893
500+	3	-	-	870.0	6596	16769
Frozen Fruit & Vegetable Processors						
-9	9	1	x	4.4	17	44
10-19	9	-	-	13.9	53	89
20-49	5	-	-	31.2	155	435
50-99	6	-	-	81.2	403	1037
100-199	4	-	-	150.3	774	1692
200+	3	-	-	701.7	3434	7744

Table 25 (continued)

Industry And Size By total Employed	No. of Estab- lish- ments	Work- ¹ ing Owners	With- drawal per Owner	Ave. ² Employ- ment	Ave. ² Wages & Salaries \$ 000's	Ave. ² Value Added \$ 000's
Dairy Products Industry						
-4	172	87	5000	2.2	10	25
5-9	162	46	7000	6.5	32	72
10-19	163	15	x	13.6	77	153
20-49	167	4	x	33.9	224	480
50-99	79	-	-	71.7	473	1014
100-199	47	-	-	140.1	1008	2110
200+	19	-	-	374.1	2895	7122
Flour & Breakfast Cereals						
-4	5	2	x	2.6	12	30
5-9	5	1	x	7.8	45	105
10-19	6	-	-	15.8	113	326
20-49	12	3	x	48.8	419	821
50-99	5	-	-	76.4	526	932
100-199	12	-	-	145.2	1083	2623
200+	3	-	-	351.7	2762	7544
Feed Industry						
-4	273	169	5000	1.9	9	27
5-9	263	50	7000	6.4	33	80
10-19	147	7	7000	13.6	82	196
20-49	77	-	-	28.5	191	483
40-99	19	-	-	71.4	513	1814
100-499	7	-	-	150.7	1184	3233
Biscuit Manufacturers						
-4	4	4	6000	1.8	6	26
5-19	4	-	-	12.5	49	61
20-49	9	-	-	33.5	193	387
50-99	9	-	-	70.0	351	617
100-199	8	-	-	148.6	781	1472
200-499	10	-	-	418.0	2383	5039
Bakeries						
-4	886	895	5000	1.4	6	15
5-9	437	375	7000	5.9	24	39
10-19	268	134	8000	12.5	57	90
20-49	123	10	8000	28.1	150	241
50-99	52	-	-	67.8	430	744
100-199	35	-	-	142.7	948	1575
200-499	20	-	-	342.4	2321	4053
500-999	3	-	-	705.0	4604	8159
Confectionary Manufacturers						
-4	46	41	4000	1.2	5	12
5-9	22	10	x	6.2	26	45
10-19	8	1	x	12.3	60	105
20-49	24	-	-	30.4	157	413
50-99	6	-	-	64.2	290	535
100-199	7	-	-	153.0	926	2082
200-499	11	-	-	271.8	1571	3640
500+	5	-	-	837.0	5163	11242

Table 25 (continued)

Industry And Size By Total Employed	No. of Estab- lish- ments	Work- ¹ ing Owners	With- drawal per Owner	Ave. ² Employ- ment	Ave. ² Wages & Salaries \$ 000's	Ave. ² Value Added \$ 000's
Cane & Sugar Beet Processors						
-49	4	-	-	15.8	116	288
50-199	5	-	-	134.2	976	2396
200-499	5	-	-	386.6	3376	11045
Vegetable Oil Mills						
5-199	10	-	-	75.0	575	2158
Misc. Food Processors, n.e.s.						
-4	59	39	6000	1.2	7	21
5-9	38	4	x	6.8	39	77
10-19	48	3	x	14.4	88	244
20-49	58	-	-	33.4	225	706
50-99	38	-	-	71.0	512	1483
100-199	22	-	-	140.0	953	3087
200-999	20	-	-	355.9	2550	10433
Soft Drink Manufacturers						
-4	38	20	3000	1.8	8	17
5-9	38	11	6000	6.9	30	53
10-19	119	12	9000	19.0	77	145
20-49	131	-	-	30.5	198	449
50-99	34	-	-	67.3	484	1012
100-199	17	-	-	148.2	1109	2396
200-999	8	-	-	889.8	6375	26083
Distilleries						
-49	13	-	-	30.2	250	2122
50-199	6	-	-	101.0	809	2681
200+	10	-	-	400.8	3699	22955
Breweries						
10-49	8	-	-	36.0	318	1081
40-99	12	-	-	74.6	661	2045
100-199	7	-	-	125.6	1109	3970
200-499	8	-	-	250.9	2312	8539
500+	6	-	-	857.3	3518	32191
Wineries						
5-19	9	-	-	11.6	69	1051
20-49	7	-	-	30.3	221	1061
50-199	7	-	-	97.9	782	2529

Footnotes: ¹Total number
²Average means per establishment
³Information not published

Source: Statistics Canada, Cat. No. 31-210 Manufacturing Industries of Canada, Type of Organization and Size of Establishments 1971 (Ottawa: Information Canada, 1975) Table 9 pp.32-35.

Table 26
Community Data Used in PROBIT and LINEAR Probability Models

Community	Distance From Winnipeg	Percentage Change in Populations of Sphere of Influence 1966-71
Altona	69	-10.24
Arborg	75	- 5.98
Beausejour	38	+ 4.09
Boissevain	164	- 8.15
Brandon	131	- 7.06
Carberry	101	+14.64
Carman	50	- 6.02
Crystal City	120	-12.66
Dauphin	201	- 8.21
Elkhorn	192	- 3.94
Erickson	161	-11.96
Gimli	60	-15.02
Gladstone	99	- 5.61
Glenboro	104	-10.96
Gretna	87	-10.91
Killarney	148	- 5.45
Lac Du Bonnet	68	+10.51
Manitou	98	- 7.92
Melita	207	- 8.72
Minnedosa	135	- 7.37
Morden	76	- 7.36
Neepawa	122	-11.34
Niverville	25	16.06
Notre Dame	80	+ 4.10
Pilot Mound	118	- 5.17
Plum Coulee	73	-13.64
Portage La Prairie	52	- 1.52
Riverton	79	- 7.53
Roblin	262	-12.22
Rossubrn	205	- 6.76
Russell	225	- 9.43
St. Claude	60	- 1.07
Ste. Rose Du Lac	181	- 7.90
Selkirk	25	- 4.21
Shoal Lake	179	-10.73
Souris	151	-12.27
Steinbach	40	+ 1.40
Swan River	310	- 7.69
Winkler	81	- 2.28
Winnipeg	0	13.50

Source: Distances - Manitoba Trucking Association, Ship by Truck Directory 1975, (Winnipeg, 1976).

Population Change - Manitoba Department of Industry and Commerce Regional Analysis Program Southern Manitoba, Analysis of Community Functions & Relationships Working Paper No. 2 For Metropolitan Winnipeg - Manitoba Department of Industry and Commerce Regional Analysis Program Southern Manitoba, Update Volume 1.

Table 27
Community Scores for Service Indices

	Transportation	Police & Fire	Education	Recreation	Culture	Health
Maximum Score = Community	21	6	8.5	21	12	36
Altona	7	4	3.25	11	4	14
Arborg	7	4	4.25	8	5	14
Beausejour	7	5	4.25	11	5	14
Boissevain	11	4	4.25	13	9	14
Brandon	18	6	6.25	21	12	36
Carberry	12	4	4.25	17	4	14
Carman	11	4	4.25	7	8	14
Crystal City	8	4	5.0	5	3	13
Dauphin	18	6	5.25	19	12	34
Elkhorn	10	3	3	6	2	11
Erickson	9	2	4.25	8	3	11
Gimli	13	4	4.25	10	5	14
Gladstone	13	4	4.25	10	7	14
Glenboro	9	4	4.25	10	7	12
Gretna	7	3	2.25	7	2	3
Killarney	11	5	4.25	14	10	14
Lac Du Bonnet	8	4	4.25	13	2	0
Manitou	10	4	4.25	9	3	13
Melita	12	3	5.25	9	6	14
Minnedosa	14	5	4.25	12	7	14
Morden	10	5	4.25	11	8	30
Neepawa	14	5	4.25	15	7	16
Niverville	5	2	4.25	5	2	0
Notre Dame	6	1	4.25	6	1	11
Pilot Mound	9	4	4.25	10	7	12
Plum Coulee	7	3	2.0	3	3	0
Portage La Prairie	15	6	4.25	21	12	20
Riverton	8	3	4.25	6	4	13
Roblin	11	4	4.25	9	4	14
Rosburn	10	3	4.25	5	2	0
Russell	11	5	4.25	13	8	14
St. Claude	8	3	4.25	6	3	14
Ste. Rose du	9	3	4.25	8	2	16
Selkirk	18	6	5.25	19	7	16
Shoal Lake	9	3	4.25	6	4	14
Souris	12	4	4.25	13	8	14
Steinbach	9	4	5.25	12	9	32
Swan River	12	5	5.25	16	10	32
Winkler	10	4	3.25	10	5	16
Winnipeg	21	6	8.5	21	12	36

Source: Department of Industry and Commerce, Regional Analysis Program: Southern Manitoba Working Paper #3, Analysis of Community Services and Facilities (Winnipeg, 1974), Tables A2, A3, B1, B2, B3, B4.

Table 28

PROBIT Model Without Average Wages and Salaries^a

Coefficients With (Coefficient/Standard Error) in Parenthesis

	With Wages and Salaries	Without Wages and Salaries
Constant Term	-0.36 (-0.56)	0.16 (0.30)
Branch	-0.22 (-1.02)	-0.31 (-1.44)
Owner	-0.054 (0.24)	0.08 (0.36)
Transportation Services	-0.016 (0.51)	0.02 (0.68)
Distance from Winnipeg	-0.002 (0.92)	0.002 (0.82)
Population Change	-0.0004 (0.02)	-0.0001 (- .006)
Average Wages and Salaries	0.10 (1.45)	

^a Average Value Added was also dropped because its significance would automatically increase when Average Wages and Salaries is excluded.

Appendix B

DESCRIPTION OF AVAILABLE DATA BASE

Regional Analysis Program Southern Manitoba⁶⁷

There are a series of reports and working papers prepared by the Regional Analysis Group in the Manitoba Department of Industry and Commerce.

Volume One presents socio-demographic data and data from a community interrelations survey. The main source of data is the 1971 Statistics Canada census, including both published and unpublished material. The geographic breakdown of the data presented is Canada, Manitoba, the Winnipeg Census Metropolitan Area and six Official Data Collection Regions, rural municipalities, Indian reserves, and urban settlements with populations of 50 or greater. Some data are presented only for settlements with populations of 50 or greater. Some data are presented only for settlements with populations of 300 or 500 and greater. The number of settlements of 500 or more excluding Winnipeg is seventy-seven. The information presented includes population size change be-

⁶⁷Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba - Update Part 1A (Volumes I and II) Winnipeg, Manitoba, 1975).

_____, Regional Analysis Program Southern Manitoba Working Paper #1 Economic Characteristics (Winnipeg, 1975).

_____, Regional Analysis Program Southern Manitoba Working Paper #2, Analysis of Community Functions & Relationships (Winnipeg, 1974).

_____, Regional Analysis Program Southern Manitoba Working Paper #3, Analysis of Community Services & Facilities (Winnipeg, 1974).

_____, Regional Analysis Program Southern Manitoba Working Paper #4, Analysis of Population Change 1951-71 Southern Manitoba (Winnipeg, 1976).

tween 1951-1971, average family size, education grouping of the school-attending population between 1961-71, the educational level of the general population, the population divided into five year age groups, and housing characteristics. The community interrelations survey deals with communities with populations of 300 or greater. Information available deals with family size, religion, languages spoken, schooling, and shopping patterns for various services. Other questions dealt with community satisfaction and involvement.

Volume Two presents economic data. Geographic breakdown of the data is similar to that of Volume One. The information provided includes income data from tax returns 1967-1972, employment by occupation groups 1971, and employment by industry division 1971. The tables reporting values of building construction 1971-1974 exclude Indian reserves and rural municipalities. Information on average farm size, farm population, and farm revenue is presented for Canada, Manitoba, Metropolitan Winnipeg, and the six Official Data Collection Regions, rural municipalities, and Indian reserves. Employment in the manufacturing and processing sector is presented for communities of 50 and more for the year 1973. The labour force employment status of the population for 1971 is available for all geographic areas, excluding urban centres of less than 500 people. Finally, total family income is presented for all areas.

The Working Paper #1 presents economic characteristics for the six official data collection regions with some details for urban centres. The description includes population statistics, employment in manufacturing and other sectors for 1961, 1971 and 1973. Average personal income per tax returns, gross farm revenues, and average farm sizes are also indicated. Trading area populations are specified for 77 communities (500+)

based on information from the total study.

The study also divided Manitoba communities into a hierarchy based on the types and number of services available following central place theory principles. Five settlement types are defined. Stop-off centres are characterized by populations of 50-300 with an average of 6 service outlets. One hundred and eighty-six stop-off centres are identified. Eight-two convenience centres with populations between 100-500 and averaging 23 service outlets are identified. The next level of settlement type is the local centre with a population between 500-1000 and averaging 52 service outlets each. The study suggests that there are 52 of these in the Province. Seventeen market centres exist with populations of 1000-3000 and an average of 112 service outlets. At the top of the hierarchy (excluding Brandon and Winnipeg) are five regional centres with populations of 3300 to 15,000 and averaging 209 service outlets.

The working paper #2 is an analysis of community functions and relationships based on the services available in the urban settlements of 50 or more plus any service activities within five miles of the settlement. The study derives a functional index for all communities which is a weighted average of the number of all service activities available. The weightings are the fractions that one outlet of each service activity is of all outlets of that service activity in the province. Threshold populations for particular services are estimated by regressing the number of outlets in a particular activity in every community against community population, and using the derived coefficients. The general formulae are:

$$y_i = a + bX_{ij}$$

$$y_i^* = a + b (X_j = 1) \text{ where}$$

y_i is the population of community i

x_{ij} is the number of outlets of activity j in community i

y_j^* is the threshold population for activity j

a, b are the estimated coefficients.

Spheres of influence for communities are defined and indicated by map, but the procedure is not explained.

The factors used were:

1. the functional indices;
2. the threshold populations;
3. the results of the Shopping Preference Survey;
4. locational attributes (such as accessibility);
5. infrastructure;
6. electrical energy consumption;
7. population size in 1971 and changes between 1951-1971;
8. analysis of the Regional Development Corporations (1972);
9. telephone toll calling patterns (1972);
10. highway traffic movement patterns (1970).

The population within a sphere of influence is available.

Working Paper #3 is an analysis of community services and facilities in 77 communities with a population of 500 or more in 1971. The report analyzed the service infrastructure of the communities. The basic infrastructure contains three elements, utility, transportation, and protection and administration services. Utilities included electrical, natural gas, telephone, bulk oil, sewage, and water. Transportation contains road surface, rail, truck, air and bus service, and whether aerodrome or harbour facilities exist. Judicial, fire-fighting, ambulance and provincial government services are included as part of protection and

administration services. The social infrastructure examined considers educational, health, cultural, recreational, and public and aged/infirm housing facilities. The infrastructure of the communities was quantified into indices with a numerical weighting system that described the availability and quality of these services. The weightings were assigned in consultation with provincial authorities involved. A service infrastructure index was calculated to measure the diversity and number of thirty possible commercial services.

The seventy-seven urban centres do not include all communities with manufacturing and processing facilities. Those excluded did not have populations of 500 or more.

The fourth working paper analyzes population change in southern Manitoba between 1951 and 1971. The geographic areas are functional areas served by Winnipeg, Brandon, and four regional centres, Selkirk, Steinbach, Dauphin, and Swan River. The population changes were analyzed in terms of natural growth (births minus deaths) and net migration. Net in-migration or out-migration was measured as the difference between the actual population and what would have been the population given natural growth.

Another source of information is the annual Census of Manufactures conducted by Statistics Canada.⁶⁸ Information is presented for sub-provincial areas. The data include number of establishments, employees and salaries (divided into manufacturing and non-manufacturing activities), value added (similarly divided), inventories, value of shipments, cost of materials and costs of electricity and fuel. The Census attempts to in-

⁶⁸ Statistics Canada, Manufacturing Industries of Canada; Sub-provincial Areas. Cat. No. 31-209 Annual (Ottawa, Information Canada).

clude all firms. For major cities, the data are disaggregated by size of firm measured in terms of employment and value of shipments. The data are also disaggregated by industry categories which permit some analysis of sectoral differences. Limitations of the data are the netting out of transportation costs and the variation in the type of geographic region for which data are reported. The census data are useful to derive average wage information.

Another Statistics Canada publication provides data on labour costs, gross payrolls and the total wage package, indexed above basic rates for wage and salary earners.⁶⁹ Gross payroll includes overtime, split shift differential, sick benefits, etc. The total package includes employers' contributions. The data presented for the Prairie Region are disaggregated into some specific sectors. Provincial data are divided into durable and non-durable categories.

The Manitoba Trucking Association publishes a directory which contains the current intraprovincial freight rate schedule, the terms of franchises for trucking firms operating in the province and other information relating to rules of carriage and miscellaneous charges.⁴ From this publication, trucking rates applicable to 1971 and 1976 are available.

⁶⁹ Statistics Canada and Department of Labour, *Labour Costs in Canada, Manufacturing* (Cat. No. 72-612), (Ottawa, Information Canada, 1975).

⁷⁰ Manitoba Trucking Association, Ship by Truck, Directory Issue, annual (Winnipeg).

BIBLIOGRAPHY

- Alonso, W., "A Formulation of Classical Location Theory and Its Relation to Rent Theory", Regional Science Association Papers, Vol. 19, 1967, pp.23-44.
- Appana, M. "An Analysis of Factors Influencing the Location of Manufacturing Industries in the Prairies", unpublished M.A. Thesis, Department of Geography, University of Manitoba.
- Batie, Sandra S. "Discussion: Determinants of Manufacturing Industry in Rural Areas", Southern Journal of Agricultural Economics, Vol. 10, No. 1, pp.33-37.
- Bogue, Don J., The Structure of the Metropolitan Community, (University of Michigan, 1949).
- Bonsor, N. C., Transportation Rates and Economic Development in Northern Ontario, (Toronto: University of Toronto Press, 1977).
- Burrows, J. C., and C. E. Metcalf, "The Determinants of Industrial Growth at the County Level: An Econometric Analysis", Essays in Regional Economics, J. F. Kain and J. R. Meyer, ed., (Cambridge: Harvard University Press, 1971), pp.352-401.
- Buskirk, R., and P. Vaughn, Managing New Enterprises, (West Publishing Co., St. Paul, 1976).
- Canada, Bill C-33 30th Parliament, 2nd Session (1976-7) First Reading, January 27, 1977 Section 1.
- Chisholm, M., P. O'Sullivan, Freight Flows and Spatial Aspects of the British Economy, (London, Cambridge University Press, 1973).
- Christaller, W., Central Places in Southern Germany, Carlisle W. Baskin, trans. (Englewood Cliffs, New Jersey: Prentice Hall, 1966).
- Clark, Colin, "Industrial Location and Economic Potential", Lloyds Bank Review, October 1966, No. 82, pp.1-17.
- Clark, C., F. Wilson, and J. Bradley, "Industrial Location and Economic Potential in Western Europe", Regional Studies, Vol. 3, No. 2, 1969 pp.197-212.
- Collins, L. Industrial Location in Ontario, Statistics Canada, Cat. No. 31-509, (Ottawa: Information Canada, 1972).
- Collins, L., "A Procedure for Forecasting Changes in Manufacturing Activity", Location Dynamics of Manufacturing Activity, ed. L. Collins, D. F. Walker, (London: John Wiley & Sons, 1975).

- Commission on the Costs of Transporting Grain By Rail Volume I (1976), Volume II (Supply and Services Canada, Ottawa, 1977).
- Czamanski, S. Regional Science Techniques in Practice, (Lexington: D. C. Heath & Co., 1972)
- Czamanski, D. Z., Ellis, S. B., Study of Clustering of Industries, (Institute of Public Affairs, Dalhousie University, 1974).
- Daniellson, Albert. "The Locational Decision From The Point of View of The Individual Company", Swedish Journal of Economics, Vol. 66, June, 1964.
- Darling, H., "What Belongs in Transportation Policy?", Canadian Public Administration, Vol. 18, No. 4, 1975, pp.659-668.
- Domencich, T. and D. McFadden, Urban Travel Demand: A Behavioural Analysis, (Amsterdam: North Holland, 1975).
- Douglas, P. G., and J. A. MacMillan, Simulation of Area and Social Impacts of Highway Expenditures, Research Report No. 9 (Winnipeg: Centre for Transportation Studies, University of Manitoba, 1972).
- Douglas, P. G., "Potential Economic Impacts of an Area Transportation Program", M.Sc. Thesis, Department of Agriculture Economics, University of Manitoba, Winnipeg, October, 1971.
- Dorf, Ronald J., "An Analysis of Manufacturing Location Factors For Communities 2500 to 50,000 Population In the West North Central Region", Ph. dissertation, Kansas State University, 1976.
- Edwards, Clarke, "The Political Economy of Rural Development: Theoretical Perspectives", American Journal of Agriculture Economics, December 1976, Proceedings Issue, pp.914-921.
- Fogel, Robert W., Railroads and American Economic Growth: Essays in Econometric History (Baltimore, Maryland: John Hopkins Press, 1964). p.1.
- Fuller, Stephen W., Randolph, Paul, and Klingman D., "Optimizing Sub-industry Marketing Organizations: A Network Analysis Approach", American Journal of Agricultural Economics, August 1976, pp.425-436.
- Ginsberg, Ralph, B., "Critique of Probabilistic Models: Application of the Semi-Markov Model To Migration" and "Incorporating Causal Structure and Exogenous Information with Probabilistic Models: With Special Reference to Choice, Gravity, Migration, and Markov Chains", Journal of Mathematical Sociology, Vol. 2, No. 1, (London: Gordon and Breach Science Publishers, January, 1972), pp.63-103.
- Greenhut, M. L. Ohta H., Theory of Spatial Prices and Market Areas (Durham Duke University Press, 1975).

- Greenhut, M. L., Micro-economics and the Space Economy, (Chicago: Scott Foreman and Co., 1963)
- Greenhut, M. L., "Size of Markets Versus Transport Costs in Industrial Location Surveys and Theory", Journal of Industrial Economics, Vol. 8, 1960, pp.172-189.
- Halter, A. N., Dean, G. W., Decisions Under Uncertainty With Research Applications, (Cincinnati, Ohio: South Western Publishing Co., 1971).
- Harris, C., The Urban Economies, 1985: A Multi-Industry Forecasting Model, (Lexington: D. C. Heath & Co., 1973).
- Harris, C., and F. E. Hopkins, Location Analysis: An Interregional Econometric Model of Agriculture, Mining, Manufacturing, and Services, (Lexington: D. C. Heath & Co., 1972).
- Harris, C. Regional Economic Effects of Alternative Highway Systems, (Cambridge, Mass.: Bellinger, 1974).
- Hoover, Edgar M., Location Theory and the Shoe and Leather Industries, (Cambridge, Mass.: Harvard University, 1937).
- Hoover, Edgar M., The Location of Economic Activity, 1948, rpt., (New York: McGraw-Hill, paperback edition, 1963).
- Hoover, R. A., Dynamic Programming and Markov Processes, (Cambridge, Mass.: M.I.T. Press, 1960).
- Impact of Infrastructure Investment on Industrial Development, ECMC Round Table No. 25, European Conference of Ministers of Transport March 1974, Paris, Centre de Recherches Economiques, 1975.
- Kent, Tom, "The Structure of Canadian Regional Programs", Incentives, Location and Regional Development, P. Phillips, ed., (Proceedings of a Conference sponsored by the Manitoba Economic Development Board), Winnipeg, 1975.
- Klaasen, Leo H., Methods of Selecting Industries For Depressed Areas: Developing Job Opportunities, Vol. II (Paris: Manpower & Social Affairs Directorate, O.E.C.D., 1967).
- Krumme, Gunter, "Toward a Geography of Enterprise", Economic Geography, Vol. 45, No. 1, January, 1969, pp.30-40.
- Kullback, S., M. Kupperman, and H. H. Ku, "Tests for Contingency Tables and Markov Chains", Technometrics, Vol. 4, No. 4, 1962, pp.573-608.
- Lefebvre, L., Allocation in Space: Production, Transport and Industrial Location, (Amsterdam, North Holland, 1958).
- Legislation and Public Policy, Atlantic Provinces Transportation Study, Vol. V, (Ottawa: Queen's Printer, 1967).
- Losch, A. The Economics of Location, W. G. Woglom, W. F. Stoper, trans. (New Haven: Yale University Press, 1954).

- MacDonald, Neil B., Locational Advantages in the Farm Machinery Industry, Royal Commission on Farm Machinery, Study No. 6, (Ottawa: Queen's Printer, 1970).
- McKenzie, Roderick D., "Part IV Dominance and The Region", On Human Ecology, Amos H. Hawley, ed., (Chicago: University of Chicago Press, 1968) pp.205-305.
- McKnee, David L., Dean, Robert D., Leahy, William H., ed. Regional Economics: Theory and Practice, (New York: The Free Press, 1970).
- McLaughlin, Glenn E., Stefan Robock, Why Industry Moves South, (Kingsport Tennessee: National Planning Association, 1949).
- MacMillan, J. A., "Framework for Simulation of Area Economic Growth With Urban Consolidation", Regional Science Perspectives, 1:121-143, No. 1, 1971.
- MacMillan, J. A., "Regional Development Theory and Practice", in Transportation and Regional Development Conference Proceedings, (Winnipeg: Centre for Transportation Studies, University of Manitoba, May, 1970), pp.10-38.
- MacMillan, J. A. and P. G. Douglas, "Measuring Public Service Effectiveness: The Contributions of Highway Expenditures to the Regional Economic Goal", Proceedings of the Seminar Series on Transportation 1971-1972, (Winnipeg: Centre for Transportation Studies, University of Manitoba, 1972). pp.35-38.
- MacMillan, J. A., F. L. Tung and John R. Tulloch, "Migration Analysis and Farm Number Projection Models: A Synthesis", American Journal of Agricultural Economics, Vol. 56, No. 2 May 1974, pp.292-299.
- McMillan, T. E., "Why Manufacturers Choose Plant Locations Vs. Determinants of Plant Locations", Land Economics, Vol 41, 1965, pp.239-246.
- Manitoba Department of Industry and Commerce, Regional Analysis Program Southern Manitoba - Update Part 1A, Volumes I and II, (Winnipeg, Manitoba, 1975).
- , Regional Analysis Program Southern Manitoba Working Paper No. 1, Economic Characteristics, (Winnipeg, 1975).
- , Regional Analysis Program Southern Manitoba Working Paper No. 2, Analysis of Community Functions and Relationships, (Winnipeg, 1974).
- , Regional Analysis Program Southern Manitoba Working Paper No. 3, Analysis of Community Services and Facilities, (Winnipeg, 1974).
- , Regional Analysis Program Southern Manitoba Working Paper No. 4, Analysis of Population Change 1951-1971 Southern Manitoba, (Winnipeg, 1976).

- Manitoba Department of Industry and Commerce, Manitoba Trade Directory, (Winnipeg: Sanford Evans Publishing Ltd., 1970-1, 1975, 1976).
- Manitoba Trucking Association, Ship by Truck Directory Issue, Annual, (Winnipeg).
- Moses, Leon N., "Location and The Theory of Production", Quarterly Journal of Economics, Vol. LXIII, (May 1958) pp.259-272.
- Myrdal, G., Economic Theory and Underdeveloped Regions, (London: Gerald Duckworth & Co. Ltd., 1957).
- Olmstead, Frederic W., Basic Industrial Location Factors, U.S. Department of Commerce, Area Development Division, Industrial Series No. 74, revised June, 1947.
- von Oppen, Matthias, Scott John T., "A Spatial Equilibrium Model For Plant Location and Interregional Trade", American Journal of Agricultural Economics, August 1976, pp.437-445.
- Owen, W., Distance and Development, (Washington: Brookings Institution, 1968).
- Pearson, E. S., H. O. Hartley, ed., Biometrika Tables For Statisticians, Vol. 1, (3rd ed.) (Cambridge, Eng. Cambridge University Press, 1966).
- Pindyck, R. S., and D. L. Rubinfeld, "Models of Qualitative Choice", Chapter 8, Econometric Models and Economic Forecasts, (New York: McGraw-Hill, 1976) pp.237-264.
- Rees, J., Industrial Demand for Water: A Study of South East England, London School of Economics and Political Science, Research Monograph 3, (London: Wiedenfeld and Nielson, 1969).
- Regional Planning and Development Branch, Community Reports, Annual, (Winnipeg, Department of Industry and Commerce).
- Report of the Commission on Targets for Economic Development, Manitoba To 1980, T.E.D. Report 1964, (1969).
- Research Branch, Waybill Analysis Carload All-Rail Traffic, Canadian Transport Commission, Annual, (Ottawa: Information Canada).
- Richardson, Harry W., Regional Economics, (London, Weidenfield and Nicolson, 1969).
- Roberts, Paul O. "Interregional Transport Models", Discussion Paper No. 48, Program on Regional and Urban Economics, Harvard University, July, 1969.
- Roberts, Paul O., and D. T. Kresge, Simulation of Transport Policy Alternatives for Columbia, (Cambridge: Harvard University, 1967).

Smith, David M., Industrial Location: An Economic Geographic Analysis, (New York: John Wiley & Sons, 1971).

Smith, D. Eldon, Brady J. Denton, David R. Kelch, "Locational Determinants of Manufacturing Industry in Rural Areas", Southern Journal of Agricultural Economics, Vol. 10, No. 1. pp.23-32.

Statistics Canada, For-hire Trucking Survey, Cat. No. 53-224, Annual, (Ottawa: Information Canada).

-----, Labour Costs in Canada - Manufacturing 1971, Cat. No. 76-612, Annual/Various.

-----, Manufacturing Industries of Canada: Subprovincial Areas 1974, Cat. No. 31-209, (Ottawa: March 1978).

-----, Manufacturing Industries of Canada: Geographic Distribution, Cat. No. 31-209 1961, 1966, (Ottawa: Dominion Bureau of Statistics, 1965, 1961) and for 1971 (Ottawa: Information Canada, 1975).

-----, Standard Geographical Classification, Volume II The Numerical Index, Cat. No. 12-546 (Ottawa).

-----, Manufacturing Industries of Canada: Type of Organization and Size of Establishments 1971, (Ottawa: Information Canada, 1975).

Stollsteimer, J. F., "A Working Model for Plant Numbers and Locations", Journal of Farm Economics Vol. 45 (1963) pp.631-645.

Straszheim, M., "Transportation Policy as an Instrument for Altering Regional Development Patterns", Land Economics Vol. 48, 1972, pp.212-219.

Studnicki-Gizbert, K. W., "Transport Policy: Objectives and Policy Instruments", Issues in Canadian Transport Policy, Studnicki-Gizbert, ed., (Toronto: MacMillan of Canada, 1974) pp.361-407.

-----, "The Administration of Transport Policy: The Regulatory Problem", Canadian Public Administration, Vol. 18, No. 4, 1975, pp. 642-658.

Thomas, M. D., "Regional Economic Growth: Some Conceptual Aspects", Land Economics, Vol. 45, February 1969, pp.43-51.

Townroe, P. M., Industrial Location Decisions, Centre for Urban and Regional Studies, University of Birmingham, Occasional Paper No. 15, 1971.

Toyne, P. Organization Location and Behaviour, (New York: John Wiley & Sons, 1974).

- Traffic and Tariff Branch, Commodity Flow Analysis: 1968-1972 and annual supplements, Canadian Transport Commission, (Ottawa: Information Canada).
- Tyrchniewicz, E. W., and J. A. MacMillan, "Transportation in Agriculture Farm Expense, Public Service, Subsidy, or Regional Development Instrument?" The Agrologist, January-February, 1974.
- U.S. Department of Commerce, Industrial Location Determinants 1971-1975, Economic Development Administration, (Washington, D.C.: 1973).
- Vasseen, Leonard C., Plant Location, (New York: American Research Council, 1960).
- Webber, M. J., Impact of Uncertainty on Location, (Cambridge: M.I.T. Press, 1972).
- Weber, A., Theory of Location of Industries, C. J. Friedrich, trans., (Chicago: University of Chicago Press, 1929).
- Whitman, E. S., W. J. Schmidt, Plant Location: A Case History of a Move, American Manufacturers Association, New York, n.d.
- Wilson, George W., "Transportation and Price Stability", American Economic Review, Vol. 59, Papers and Proceedings, 1969, pp.261-269.
- , and Darby, L., Transportation on the Prairies, Supporting Study No. 2, Royal Commission on Consumer Problems and Inflation, n.p., n.d.
- , et. al., The Impact of Highway Investment on Development, (Washington D.C., The Brookings Institution, 1966).
- Yeates, M. H., P. R. Lloyd, Impact of Industrial Incentives: Southern Georgian Bay Region, Ontario, Geographic Paper No. 44, Policy and Planning Branch, Department of Energy, Mines and Resources, (Ottawa: 1963).