ECONOMIC EFFECTS OF BRANCH LINE AND ELEVATOR ABANDONMENT ON RURAL COMMUNITIES

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Claude Lussier

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ABSTRACT

ECONOMIC EFFECTS OF BRANCH LINE AND ELEVATOR ABANDONMENT ON RURAL COMMUNITIES

Considerable concern has arisen in recent years regarding the social and economic effects branch line abandonment can have on grain producers, railway and elevator companies. One aspect of rural life that deserves greater study has been the communities and how they are affected by the rationalization of the transportation system.

The main objective of this study was to examine in some detail the economic effects rationalization of branch lines and elevator abandonment can be expected to have on rural communities. Many interested groups indicate that the size and viability of a rural community situated in a grain producing region is associated to some extent with the presence of grain handling facilities. The major purpose of this study was to discover whether such a relationship exists, and if it does, to what extent are its strength and dimensions.

It was hypothesized that the removal of elevator facilities, due to rail line abandonment, will have little economic effect on communities. The findings indicated that, if the grain marketing facilities ceases to operate,

the effects on the size and viability of most communities will be negligible.

The area under study comprised the Brandon trade area of Manitoba as indicated on Figure 1.1. The primary reason for choosing this area was to duplicate a trading area hierarchy similar to the one developed in Christaller's model of central places. The analytical method was a multiple regression and correlation matrix approach. This analytical method was used to investigate what relationships, if any, exist between the grain handling system and the growth or decline of communities.

According to Christaller, the size, number and location of service centres are governed by population density and transportation costs. However, due to farm consolidation and the subsequent rural depopulation, the population of communities in Manitoba has undergone demographic changes. The objective of this study was to examine factors other than the cessation of the grain handling operation that are responsible for the economic and demographic changes in rural communities.

Results from regression and correlation analysis illustrate that the relationships between the grain handling operation and the size and viability of a community are negligible. From these results, the conclusion reached is that removal of the rail and elevator may have little economic impact on any but the smallest of rural communities in the study area.

A major policy implication from this study is that whatever ameliorative policies are implemented in order to lessen the economic impact, their results may have a negligible effect on improving the economic viability of any but the largest of rural communities.

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The author would like to express sincere thanks in particular to Dr. Ed W. Tyrchniewicz, under whose supervision this thesis was written, for his excellent advice during the preparation and formulation of this study. Special thanks are also directed toward Dr. Om Tangri for his suggestions and criticisms. Contributions made by Dr. G. A. Kritjanson of the Faculty of Arts and L. B. Siemens of the Faculty of Agriculture are also deeply appreciated.

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CHAPTER I

INTRODUCTION

STATEMENT OF THE PROBLEM

The demography of the prairies has undergone continuous transformation in the past thirty years. The process of rural demographic adjustment to the dynamic changes in agricultural farm practices is one of the most fundamental of changes in rural prairie life. This change in the agricultural labor force in the prairie provinces is depicted by examining the trends in agricultural labor force participation in Table 1.1.

Table 1.1 shows that Canada and the Prairie Region experienced 25 and 23 percent decreases respectively in the size of the agricultural labor force between 1961 and 1971. Of the three prairie provinces, Saskatchewan experienced the heaviest absolute decrease in agricultural labor force by an amount in excess of thirty-five thousand. Several reasons for the decreasing agricultural labor force can be cited. One major reason is the rapid adoption of agricultural labor-saving production practices. Another reason is the alternative higher paying jobs in the non-farm sector, compounded by the increased mobility provided by a quest for higher education.

At the same time there has been a steady decline in the number of farms in Manitoba. For example, since 1941

Table 1.1

CHANGE IN AGRICULTURAL LABOR FORCE,
CANADA AND PRAIRIE REGION,
1961-1971

	(Thousands)			
			Change	
	1961	1971	Absolute	Percent
Canada	681	510	-171	-25
Prairies	298	231	- 68	-23
Manitoba	63	47	- 16	-25
Saskatchewan	126	91	- 35	-28
Alberta	109	93	- 17	-16

SOURCE:
Statistics Canada, Census Division, The Labor Force (1961, 1971).

the number of farms in Manitoba has decreased from 58,024 to 34,981.[1] Additionally, only farms classified as having over 640 or more acres experienced continuous increase in number over the period 1931 to 1971, as shown by an increase from 5,577 in 1941 to 10,793 in 1971.

Table 1.2 demonstrates that in most census divisions absolute losses in population were experienced between 1961 and 1971. For example, Manitoba census division 3, 8 and 11 had 13.6, 17.9 and 18.5 percent decreases in population respectively. Some of the largest decreases in population by census division have occurred in regions where grain sales accounted for more than 49 percent of agricultural income. A closer look at population trends of communities under study may provide some added insight into changes in rural prairie life. In the grain producing areas of Manitoba, most towns and villages have experienced and are still experiencing population declines. A brief review of Table 1.3 demonstrates actual losses in population over the period from 1951 to 1971. Table 1.3 illustrates the change in population size of the communities in the Brandon area. Service centres (communities) in the categories of hamlet,[2]

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[1] Canada Grains Council, Canadian Grains Industry Statistical Handbook 76, Winnipeg, Manitoba, 1976.

[2] A hamlet is defined as a community with 3 to 10 services. Source: Prairie Regional Studies in Economic Geography, Agriculture Canada.

Table 1.2

POPULATION CHANGES BY CENSUS DIVISION
IN MANITOBA
(1961-1971)

Census Division	1961 Population	1971 Population	Actual Change	Percent Change
	921,686	988,247	66,561	7.22
1	28,734	30.308	1,574	5.6
* 2	36,105	33,115	-2,990	- 8.3
* 3	21,980	18,985	-2,995	-13.6
* 4	14,217	12,473	-1,744	-12.3
5	31,402	32,777	1,375	4.4
* 6	30,929	30,260	- 669	- 2.2
* 7	49,536	52,515	2,979	6.0
* 8	21,617	17,750	-3,867	-17.9
9	11,832	11,826	- 6	- .1
*10	19,296	17,731	-1,565	- 8.1
*11	13,447	10,958	-2,489	-18.5
12	28,686	26,603	-2,083	- 7.3
*13	12,880	11,309	-1,571	-12.2
*14	6,702	5,818	- 884	-13.2
*15	14,906	13,062	-1,844	-12.4
16	46,781	69,218	22,437	48.0
*17	21,323	20,514	- 809	- 3.8
18	15,403	13,374	-2,029	-13.2
19	19,921	19,389	- 532	- 2.7
20	475,989	540,262	64,273	13.5

* Grain sales accounted for more than 49 percent of agricultural income.

SOURCE:

Dominion Bureau of Statistics, 1971 Census of Canada, Queen's Printer, Ottawa, 1973.

Table 1.3

COMMUNITIES[a] IN BRANDON STUDY AREA
(1951-1971)

Name of Settlement	Population Size			
	1951	1961	1966	1971
Alexander	261	169	197	193
Belmont	388	378	341	286
Boissevain	1,015	1,303	1,473	1,506
Brookdale	156	108	104	85
Deloraine	874	916	910	957
Douglas	170	289	251	237
Dunrea	221	196	185	177
Elgin	N/A	N/A	301	175
Forrest	36	31	63	58
Franklin	108	73	62	38
Glenboro	600	797	776	699
Griswold	176	137	112	100
Hartney	538	592	621	579
Holmfield	169	122	73	61
Kemnay	48	81	68	89
Kenton	202	202	223	201
Killarney	1,262	1,729	1,836	2,074
Lauder	111	72	56	57
Lenore	130	98	75	65
Margaret	76	78	64	47
Medora	115	90	80	88
Melita	781	1,038	1,101	1,131
Minnedosa	2,085	2,211	2,305	2,621
Minto	171	171	135	108
Napinka	222	178	191	135
Neepawa	2,895	3,197	3,229	3,216
Nesbitt	80	86	77	53
Ninette	630	673	560	436
Ninga	176	129	108	90
Oak Lake	467	430	389	332
Oak River	242	243	247	201
Pipestone	211	226	225	145
Rapid City	391	467	449	371
Reston	532	529	556	551
Rivers	1,209	1,574	1,685	1,175

(Continued)

Table 1.3 (continued)

Name of Settlement	Population Size			
	1951	1961	1966	1971
Souris	1,584	1,841	1,829	1,674
Stockton	67	61	64	58
Virden	1,746	2,708	2,933	2,823
Waskada	395	297	282	246
Wawanesa	447	456	512	485
Wellwood			79	69

[a] Not all settlements are represented in this sample list; but it includes a large part of the population.

N/A = not available

village[3] and town[4] have experienced a decline in population over a sustained period of time.

In addition to severe demographic and economic stresses on rural communities caused by rural depopulation and the consolidation of farm enterprises, several controversial issues related to the grain handling and transportation system on the prairies are adding further stress. The rationalization[5] of the grain handling and transportation system, the plea by rail companies for the abolition of Crows Nest Pass grain rates, the possible ramifications rail abandonment may have on elevator companies; and the social and economic effects abandonment or rationalization may have on farmers, rural dwellers and townspeople, only to name the most important, have come to the attention of public policy makers. In 1975, a commission on grain handling and transportation (Hall Commission) was given the task of evaluating 6,284 miles of branch lines. One

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[3]A village is a community with 11 to 35 services. Source: Prairie Regional Studies in Economic Geography, Agriculture Canada.

[4]A town is a community with 36 to 75 services, and a prairie farm city is a community with 76 or more services.

[5]Rationalization of the grain handling system refers to the reorganization, consolidation and/or abandonment of uneconomic low density branch lines and the resulting abandonment of country elevators located on these branch lines. In addition, the consolidation of the grain handling facilities also form part of the rationalization issue.

of the specific term of reference of the Hall Commission was to consider implications of adjustments in the grain handling and transportation as it relates to producers, grain companies, railways and rural communities. In addition, the socio-economic impact of rationalization was also considered by the Hall Commission. A major portion of this study considers the effects branch line and elevator abandonment may have on the economy of rural communities.[6]

NATURE OF THE RATIONALIZATION ISSUE

In the past several years much of the debate on the western Canadian grain handling and transportation system has centered on the possible effects rationalization might have on the railways, grain companies, grain producers, regulatory bodies and prairie communities. Railways contend that continuing the existing services on low density branch lines will only compound their financial difficulties. The economic effects of the statutory Crow's Nest Pass rates and various federal subsidies on the financial stability of the two national rail companies are important issues with respect to the rationalization issue. Grain handling companies contend that rationalization or

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[6] A community is a concentration of individuals with a common interest living in a compactly settled area as distinguished from surrounding rural territory. Source: Webster's New Collegiate Dictionary, A Merriam-Webster.

abandonment of certain elevators which are operating at less than throughput capacity can lessen the financial burden. Grain company interests may or may not coincide with railway interests. For example, an elevator that has a high throughput capacity ratio may be situated on an uneconomic branch line for which the rail company has made application for abandonment. More likely, however, uneconomic elevator facilities are located on uneconomic branch lines.

Grain producers maintain that the additional distances they would have to travel to the next nearest elevator facility would increase their transport costs significantly. The Canadian Wheat Board is discovering that rationalization of the present grain handling and transportation system will force it to re-evaluate the co-ordinating mechanisms under the present block shipping system. Their co-ordinating task of the quota and block shipping system may have to be altered to accommodate the proposed changes in the movement of grain.

Most communities located on low density branch lines are concerned with the possible socio-economic effects rationalization can have, perhaps eventually causing their demise. The primary reason for believing that rationalization of the grain handling system may seriously hamper the economic viability of communities is that most of these communities were historically, and to a certain extent, still are linked to the grain production system.

It is for this reason that in the event of abandonment of elevator facilities, some communities may fail to play a "central trade"[7] function for the grain producers, inevitably leading to the demise of communities.

Opposition to elevator abandonment is also prominent amongst local governments. Their primary concern rests with the incidence of municipal taxes and the subsequent loss of revenue if the rail and/or elevator are abandoned.

Grain producers, municipal governments, and communities all have an interest in branch line abandonment which lies beyond the issues of grain transportation. These considerations pose constraints that must be considered in studying the overall issue of the grain handling system.

There are two relevant topics that lend themselves to some recognition. Firstly, it must be recognized that many small communities such as hamlets and villages have already ceased to be viable centres to shop or enjoy social amenities, with only the country elevator remaining. Social amenities are, for example, social gatherings, clubs, associations and recreation facilities. There can

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[7]According to central place theory, the role of a trade centre is to act as a service centre for its hinterland, providing it with central goods and services. A summary of recent theoretical and empirical work in central place theory is found in B. J. L. Berry, Geography of Market Centres and Retail Distribution (Englewood Cliffs, N.J.: Prentice-Hall, 1967).

be no doubt that the removal of the elevator would hamper the future of declining communities; but were they economically viable communities to live in, in the first place? Conversely, it is not uncommon to notice small villages or hamlets which have appeared to be losing their commercial attractiveness to larger centres but have retained an important social function for the local citizens. This social function is the second important element in rural community life that must be considered. It is becoming obvious that the social amenities such as the local hockey arena, curling rink, weekend dance hall and social church programs provide a "raison d'être" for some communities that have been abandoned as viable growth centres because of losses in commercial establishments. Consequently, for any community to be analyzed thoroughly, the social aspects must also be considered, but this is beyond the scope of the terms of reference of this study.

PREVIOUS STUDIES AND POTENTIAL CONTRIBUTIONS

The effects that rationalization of the grain handling system has on rural communities have been studied generally and specifically by several interested persons. Hodge, who specifically investigated the effects of branch line abandonment, concluded that "most Saskatchewan centres have a better-than-even chance of not sustaining significant or long lasting disruption with the termination of

branch line rail service."[8] Other studies conducted by the same author[9] appear to indicate that the grain handling system is fairly disassociated from the growth or demise of service centres.

Stabler, in studying the economic effects of rationalization on prairie communities, indicated that removal of rail and/or elevator services would not have an adverse effect on any but the very smallest of centres which will most likely cease to exist as communities in the near future.[10]

Zimmerman and Moneo, in studying the prairie community system, concluded that the changing morphology of the prairie service centres is brought about predominantly by a good road network, schools and hospitals.[11]

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[8]Gerald A. Hodge, "Grain, Trains and Towns," Transportation Research Forum, Ninth Annual Meeting, ed. G. C. Vietsch (Oxford: The Richard B. Cross Company, 1968), p. 310.

[9]An expanded version of these arguments is found in Gerald Hodge, "Do Villages Grow" and "Community Structure and Community Growth." Papers presented to the Urban Economics Seminar, University of Western Ontario, February 13, 1967.

[10]J. C. Stabler, Economic Effects of Rationalization of Grain Handling and Transportation System on Prairie Communities (Saskatoon: Underwood, McLellan and Associates Ltd., 1972), p. 90.

[11]Carle J. Zimmerman and Garry Moneo, The Prairie Community System (Ottawa: Agricultural Economics Research Council of Canada, 1970), pp. 26-42.

Currently the grain handling system plays only a minor role in supporting the existence of most communities. Such findings are supported to a certain extent in the study of service centres conducted by Brown and Olsen. Brown and Olsen came to the conclusion that "growth centres have grown at the expense of smaller centres in the area, due to their ability to provide a wider range of services."[12] They go on to say that the success of a service centre is largely attributable to its ability to provide public and community services such as schools, hospitals and welfare facilities. Their regression analysis indicated that a positive relationship existed between population, good road accessibility, services and public facilities. No relationship was indicated between the grain handling system and growth or demise of service centres.

Mosersky[13] studied some of the problems that could arise from abandonment of rail and elevator facilities. He hypothesized that the disruptive effects of abandonment

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[12]J. A. Brown and H. O. Olsen, A Study of the Growth of Selected Service Centres (Saskatoon: Department of Agricultural Economis, University of Saskatchewan, 1975, RR75-03), p. 39.

[13]Structural differentiation refers to the diversity of a community's economic base. Economic base refers to the number of retail and service outlets, population, secondary and tertiary manufacturing and family incomes.

vary inversely with the amount of community structural differentiation. Mosersky states that "the relationship between community and the railroad is hypothesized to be highly dependent if the community is primarily agricultural with low economic diversity."[14] His results indicate that abandonment of the grain handling operation has a smaller impact on the more diversified communities and a larger impact on smaller communities.

The report of the Grain Handling and Transportation Commission, commonly referred to as the "Hall Commission", was empowered under its terms of reference to study the social and community implications of railway abandonment. The Commission cites several factors which have led and continue to lead to a reduction in the economic importance of communities; such as rural electriciation, road improvements and school consolidation. Grain handling is not mentioned as a contributary factor. The report states that "The Commission was unable to locate any study which indicated that the viability of a community which was already declining would be saved by the retention of the railway."[15]

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[14]Kenneth A. Mosersky, "The Structural Determinants of Individual Perceptions to Social Changes in Western Canadian Communities," Canadian Journal of Agricultural Economics, Vol. 21, No. 1 (February, 1973), pp. 27-40.

[15]The Report of the Grain Handling and Transportation Commission, Hall Commission, Government of Canada, Ottawa, Canada, 1977, p. 82, Volume 1.

The Prairie Regional Studies in Economic Geography[16] provided background information relating to a description of the communities, a description of grain production areas, a description of the grain marketing and handling system and an analysis of changes that might be expected if some delivery points were closed. The system of community classification used by the Prairie Regional Studies is incorporated in this study.

A number of relevant points emerge from the studies mentioned above. Firstly, hamlets and villages are currently decreasing in size. This trend has been evident for the past ten to fifteen years. Secondly, larger communities have a better chance of growing or at least holding their own in the future. Whether a community grows appears to depend on its power to attract rural residents and farmers to use the commercial facilities, and not on whether it has a large grain handling operation. However, the size of a community does attract grain producers to some extent. Thirdly, the grain handling function is not a predominant element in promoting the economic viability of a community. Finally, the smaller the community the greater the chance that removal of the elevator could hamper the viability of its existence, but

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[16]Canada Department of Agriculture, Economics Branch, Prairie Regional Studies in Economic Geography (Ottawa: Canada Agriculture).

conversely, communities in this category, function for the most part, as a "corner store" catering to only a small part of the needs of rural inhabitants.

Recently, several studies have been undertaken at the University of Manitoba in order to investigate some of the economic implications of branch line and/or elevator rationalization. These studies have focused more specifically on the grain producers and railway and elevator companies. The closure of country grain elevators and its implications for the elevator industry were studied by Tangri, Zasada and Tyrchniewicz.[17] The effects elevator abandonment can have on the costs of transporting grain by farm trucks and commercial trucks was studied by Tyrchniewicz, Butler and Tangri[18] and Tyrchniewicz, Moore and Tangri[19] respectively. A simulation model for rationalizing the grain transportation and handling system in

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[17] Om P. Tangri, D. Zasada and Edward W. Tyrchniewicz, Country Grain Elevator Closures: Implications for Grain Elevator Companies, Centre for Transportation Studies, Research Report No. 10 (Winnipeg: University of Manitoba, January, 1973).

[18] Edward W. Tyrchniewicz, A. H. Butler and Om P. Tangri, The Cost of Transporting Grain by Farm Truck, Centre for Transportation Studies, Research Report No. 8 (Winnipeg: University of Manitoba, July, 1971).

[19] Edward W. Tyrchniewicz, G. W. Moore and O. P. Tangri, The Cost of Transporting Grain by Custom and Commercial Trucks, Centre for Transportation Studies, Research Report No. 16 (Winnipeg: University of Manitoba, August, 1974).

western Canada on a regional basis was developed by Tyrchniewicz and Tosterud.[20]

The present study is part of the analysis of the whole western grain handling and transportation system, with respect to rationalization. One important reason for the lack of emphasis in studying community impacts on rationalization is summarized by Stabler as follows, "the concern that has arisen is due more to uncertainty over the distribution of costs and benefits between farmers, railroads and the elevator companies than over the indirect impact removal would have on communities from which rail lines and/or elevator are withdrawn."[21]

It is hypothesized that the removal of elevator facilities will have little economic effect on most communities. The contention is that, if the grain handling operation ceases to operate, the economic effects on the size and viability of any but the smallest communities will be negligible.

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[20]E. W. Tyrchniewicz and R. J. Tosterud, "A Model for Rationalizing the Canadian Grain Transportation and Handling System on a Regional Basis," Canadian Journal of Agricultural Economics, Vol. 21, No. 4 (December, 1973).

[21]J. C. Stabler, Transportation and Prairie Communities, Canada, Canadian Transport Commission, Research Publication (Saskatoon: University of Saskatchewan, June, 1973).

OBJECTIVE OF STUDY

The general objective of this study is to investigate the possible effects branch line and/or elevator abandonment can have on the economic viability of rural prairie communities. The specific objectives are the following:

(i) to give an economic analysis of the present situation regarding the decline of small rural communities in a grain producing area;

(ii) to identify the economic factors which contribute most to growth and those which have little or no effect on growth of rural communities;

(iii) to consider some specific implications of rationalization of the grain handling and transportation system for rural communities.

GENERAL PROCEDURES

The general conceptual framework for analysis will be a modified central place theory originally developed by Christaller.[22] The original theory was utilized to explain the size, number and location of service centres in any agricultural area. The size, number and location of communities surrounding Brandon (see Table 1.3) is governed

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[22]Walter Christaller (trans.), Central Places in Southern Germany, by C. W. Baskin (New Jersey: Prentice-Hall Inc., Englewood Cliffs, 1966).

by population density and the nature of the agricultural resource base. According to an interpretation of Christaller's model, not only does the population of several sizes of typical settlements tend to bear a regular relation to each other, but also the distance separating any pair of settlements of like size tends to increase by a specific magnitude as one proceeds from a settlement of a given size to the settlement of the next higher size. In the light of this interpretation, the size and strength of a community surrounding Brandon is governed by its distance to the next competing community and the rural population density. The size and number of communities are primarily governed by the nature and range of goods or services. Goods and services are situated in a milieu which will cater to the greatest number of rural inhabitants.

Firstly, the hamlets, villages, towns and prairie farm cities will be analysed using a multiple regression technique to investigate the relationships, if any, that exist between the grain handling system and the growth or decline as service centres. Secondly, the correlation matrices (by-product of regression analysis) will be constructed to indicate the relationships that may contribute to the growth of service centres, and to show which variables, if any, are associated with the grain handling operation.

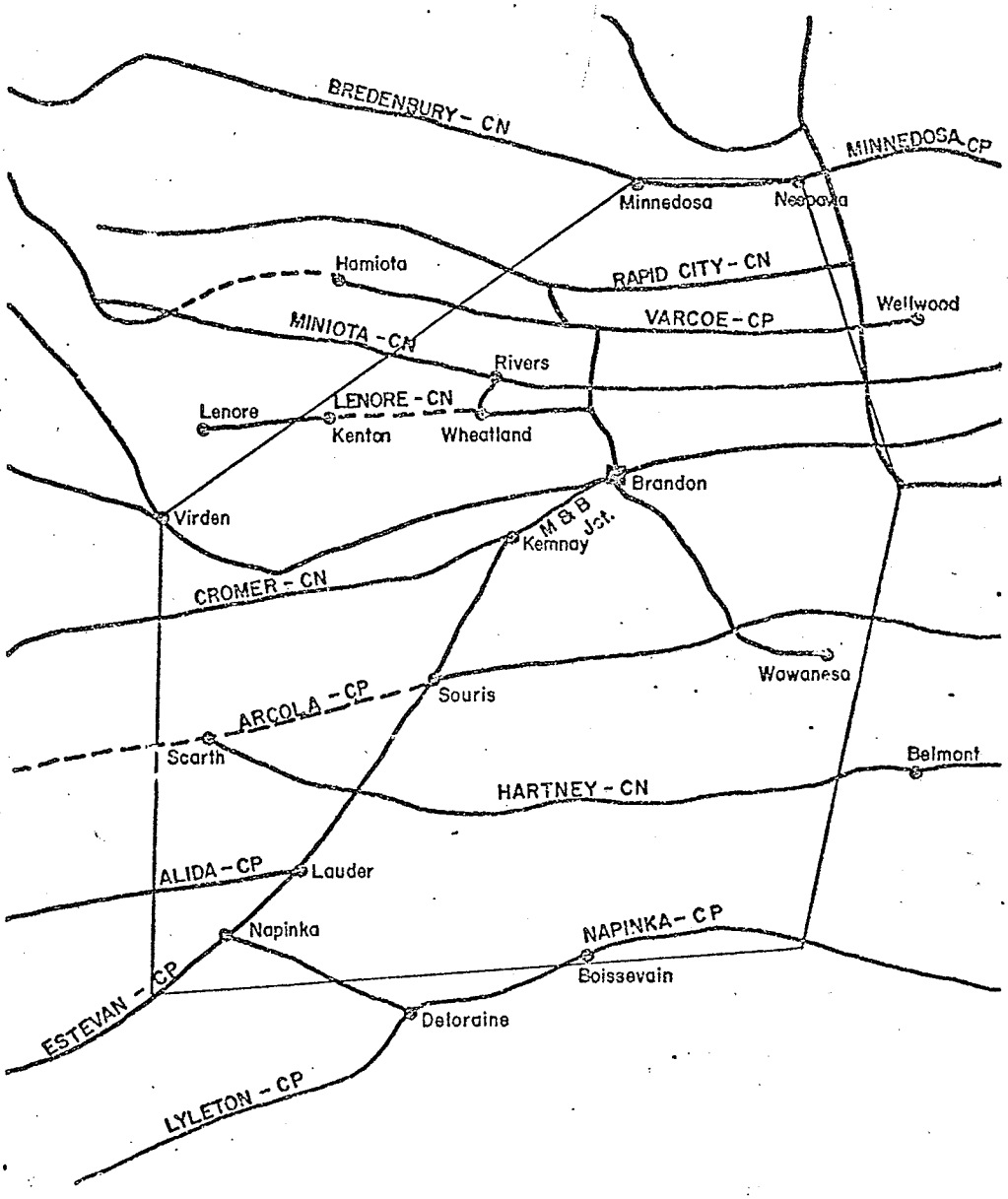
SCOPE OF STUDY

The area under study is the grain producing region surrounding the city of Brandon, shown on Figure 1.1. There are three reasons for choosing this area. First, to duplicate as closely as possible a trade centre hierarchy comparable to the one developed by Christaller, the Brandon area suited the purpose. Secondly, providing for a hierarchy of communities having one city at its centre and situated in a grain growing area, lent itself to choosing the Brandon area. Finally, another condition had to be met. The area under study had to have some branch lines that were subject to abandonment as well as some that were not.

It was indicated earlier that the major objective of this study was to investigate the effects rationalization has on communities. However, it would be extremely tedious to cover all settlements in the grain producing area that are located on low density lines. For this reason it appears logical to narrow the study to one specific region in Manitoba. The area chosen also coincides to some extent with two Regional Studies in Economic Geography No. 13 and No. 2, the Virden Region and Boissevain Region respectively.

Figure 1.1

MAP OF BRANDON STUDY AREA



PREVIEW OF THE ORGANIZATION OF THE FOLLOWING CHAPTERS

Chapter II consists primarily of a literature review and background material elaborating more specifically on the problem at hand. A brief description of the geographical area will be included.

Chapter III contains a formal elaboration of the conceptual framework and a general statement of the hypothesis.

Chapter IV provides, primarily, a description of the analytical procedures, and specification of the model. It also includes a brief summary of data collection and data problems.

Chapter V is a detailed account of the results from the multiple regression and correlation matrix analysis.

Finally, Chapter VI provides a general summary and conclusions of the study.

CHAPTER II

BACKGROUND TO THE PROBLEM

This chapter is comprised of a general overview of the prairie community system, and some related background information to the current problem at hand. A brief review of the historical setting forms the first part of this chapter. Secondly, we look at some relevant socio-economic aspects of rural prairie life. Thirdly, an elaboration of the contributions by Stabler, Brown and Olsen, Mosersky, Hodge and Zimmerman and the Hall Commission is made. Finally, a brief description of the geographic area is included.

HISTORICAL SETTING

Prairie communities have remained a distinctive economic component of rural prairie life. Since the epoque of westward expansion, communities have played a central place function. Early in western Canadian history, the role of central places was specifically oriented towards meeting the needs of homesteaders. This function has remained predominantly unchanged; but the change in the distribution and dispersion of rural dwellers is placing a heavy stress on the economic viability of small communities. In the report of the Royal Commission of

Agriculture and Rural Life, it was stated that "Early immigration and settlement policies which aimed at populating the prairies as quickly as possible were in part responsible for preventing the development of a stable population in Saskatchewan."[23] During the settlement period, homesteads were uniformly distributed as a space encompassing strategy, while little consideration for variations in topography, climate and soil was taken.

The grid-iron pattern of allocating and redistributing tracts of land in an equitable and speedy fashion proved to be expedient and politically justifiable.[24] At the time it was probably the "best" known method of accomodating the incoming settlers. Warkentin made note of this phenomenon and concluded that "together, survey systems and land settlement policies were potent instruments in controlling the arrangement of farmsteads, fields and woods and in encouraging dispersed and mutilated settlements.[25]

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[23]Report of the Royal Commission on Agriculture and Rural Life in Saskatchewan, 1956, The Queens Printer, Province of Saskatchewan, Regina, Volume 7, p. 123.

[24]H. E. Heresford, Early Surveys in Manitoba (Papers Read Before the Historical and Scientific Society of Manitoba, Series III, No. 9), Winnipeg, 1954, p. 12.

[25]John Warkentin, "Manitoba Settlement Patterns," Readings in Canadian Geography, ed. Robert Irving (Toronto: Holt, Rinehart and Winston, 1972), p. 56.

The type of rural settlement pattern that was produced by the survey system proved to be justifiable only until westward settlement was completed. First, it failed to take into consideration the variations in topography and geomorphology of rural Manitoba. Secondly, it failed to take into consideration the variations in soil fertility and texture. At the expense of the above mentioned considerations, the grid-iron survey system artificially provided an even dispersion of settlement across the prairies. In addition, the spatial network of rural communities had by 1930 reached an equilibrium with respect to the dispersion of homesteads.

Unfortunately, the advantages of the grid-iron structure in settling the great tracts of land resulted in several changes. Technological advances in farming practices and an improvement in the network of roads provided the impetus to farm consolidation. In addition, due to the inconsistencies in the quality of arable lands, consolidation of farmsteads became a predominant trend in order for farmers to maintain a viable operation. The out-migratory forces ranged from changing life style preferences and urban-pull factors to the lack of employment opportunities in retaining rural inhabitants, of which the farmer is the more important factor. People are continuously in search of alternatives for a better living. More often than not, their search leads them to large urban areas.

As farm size increases and time-distances continue to shrink, the out-migratory trend will continue to exert strong social and economic pressures on the remaining communities. Many rural communities built on a railroad and providing a grain handling service and other related farm services are currently experiencing declines in their populations. The remaining citizens feel that historically and to a large extent presently, the raison d'être of their settlement is still highly linked to the marketing of grains. In several communities the only remaining service is the elevator; other services have already been abandoned. Rural-push urban-pull may continue to influence the depopulation trends experienced in small communities; but if grain producers continue to market their grain in small communities, the economic viability of these communities is strengthened that much more. In reality, however, many grain producers in several communities are "abandoning" their nearest small local elevators in favor of larger more modern elevators in larger centres. In short, perhaps even in the event that the elevator remains in operation in small communities, it does not necessarily guarantee the survival of these settlements.

SOCIAL AND ECONOMIC ASPECTS OF THE SITUATION

Man is a social animal, banding with his fellows for mutual security, work and pleasure. What are some of the sociological implications of the current out-migration

trends? First, the remaining rural inhabitants are subject to living more and more in semi-isolation. Farmers as well as towns' people are becoming more and more dispersed. In general, man being the social creature he is, enjoys living in closely knitted areas for some of the following reasons: communication, gatherings such as church socials, curling or sports and related benefits. A greater number of rural inhabitants are discovering that what their villages offered them in the way of social goods is declining, causing them to seek commercial recreation in more developed growth centres.

The manner in which one sees this situation depends to a large extent on defining community viability in both its social and economic terms. Many communities which are currently facing heavy losses in the number of services and businesses are prospering socially. For example, the villages of Mariapolis, in the southwest portion of the province, and Ste. Agathe, 20 miles south of Winnipeg, have both built new recreational facilities even though their populations have decreased significantly. Conversely, some communities that may be economically viable often do not provide the social benefits that measure up to the stature of their economic strength. However, it appears that the economic viability is often related to some extent to the social viability. However, to make generalities would be a serious mistake.

The economic implications of out-migration affect both types of communities, those that are losing population and those that are experiencing growth. The declining centres appear to be often financially overburdened and the growth centres are experiencing some financial difficulties. Communities rely heavily on property taxes as a source of local revenue. Apart from conditional and unconditional grants (subsidy payments from the Provincial Government) under The Municipal Act,[26] the primary source of revenue is property and business taxes. The total revenue derived from property and business taxes generally diminishes as the local population decreases and, conversely, increases with growth in the population base of a community.

In the case of service centres experiencing a decline in population, the direct economic effects on the future viability are important. Fewer school children eventually mean the closing of the schools of a community. Such a process undoubtedly increases the financial burden of the remaining citizens, by having to provide extra busing to centrally located schools. Demise of a service centre not only encompasses a decline in population, but

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[26]Province of Manitoba, The Municipal Act, being Chapter C100-CAPM225 of the Revised Statutes of Manitoba, an Act Respecting Municipal Institutions, 1970 (Winnipeg, Manitoba: Queen's Printers, 1970).

also the closing down of businesses and service outlets. Under normal conditions, the loss of businesses can increase the tax burden of the community by reducing the business and/or property tax base. To sum up, population losses reduce the trade centre's tax base and its ability to provide adequate services and amenities for the remaining citizens. There is also concern of the loss to municipalities of property tax revenues resulting from elevator and branch line abandonment. However, the resource tax base depends on the size of the municipality and the financial situation. In short, fewer rural families and businesses in a municipality reduce the property tax base. However, the remaining people must be provided with a certain standard in road transportation. More roads need to be maintained for fewer people.

Apart from the added costs of retaining the public services to a comparable level with their counterparts in growth centres, the remaining citizens have larger distances that must be travelled to meet their shopping needs, which were often more than not previously met in their own communities.

The larger communities, which are experiencing growth, must continuously update and enlarge their public service facilities to meet the needs of a larger population. An implication of growth trends for most prairie regional centres is the expansion of new community services, ranging from schools and clinics to sewers,

water mains and streets. Especially expensive are the labor-intensive services such as education which occupy a majority of the municipality's budget and which necessarily face extreme rapid cost increases. The joint effect of continued new capital-intensive service needs, which are rapidly inflating as well, impose a continual expenditure drain on municipal resources.

AN ELABORATION OF PREVIOUS STUDIES AND THEIR POTENTIAL CONTRIBUTIONS

As was briefly mentioned in the introductory chapter, the main contributions to understanding the prairie community system were brought forward by Stabler, Hodge, Zimmerman and Moneo, Mosersky, and Brown and Olsen.

In studying the economic effects rationalization of the grain handling and transportation system may have on prairie communities, Stabler[27] discovered that removal of rail and elevator facilities would not alter what appears to be inevitable, although it might affect the timing. In a detailed study of 21 communities of south east Saskatchewan that have had their elevator and rail services removed, it was observed that "in terms of changes in population as well as variety and number of retail outlets, their performance was in most cases similar to but

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[27]Jack C. Stabler, Economic Effect of Rationalization of the Grain Handling and Transportation System on Prairie Communities (Saskatoon: Underwood, McLellan and Assoc. Limited, 1972).

slightly stronger than that of centres of the same class considered elsewhere in the study."[28] The study indicated that the loss was not particularly detrimental to the economic performance of the communities. This suggests that the trade centre role is not closely associated with the transport or grain delivery function.

Stabler's method of analysis was a conceptual framework based on the theory of central places.[29] The area chosen was comprised mainly of trade centre hierarchy of 105 incorporated centres in a grain producing area within which the City of Regina exerted a dominant influence. In his attempt to determine what factors are responsible for community change, Stabler grouped centres into three general categories. The categories or groups were classified as complete shopping centres, partial shopping centres and convenience centres.[30] In studying trade centres over a ten year period he discovered that the trade centre hierarchy had changed. The number of complete

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[28]Stabler, op. cit., p. 5.

[29]The original central place theory was developed by August Losch and Walter Christaller. Stabler uses their theories, but with some modifications.

[30]Stabler, op. cit., pp. (B-5)-(B-9). In comparison to the classification system used in this study, a complete shopping centre would be similar to a prairie farm city, a partial shopping centre would be a town and the convenience centres to a village.

shopping centres remained constant but the intermediate shopping centres declined while the small centres showed slight to moderate increases. It appeared that the levels in the hierarchy were becoming more distinct. Stabler attributes two reasons for the general changes:

a) due to declining rural population, the potential market demand was correspondingly decreased, and

b) a growing tendency on the part of rural dwellers to shop at regional trade centres.

The primary reason for the continuing existence of small service centres[31] is their providing a corner grocery store function. Stabler also identified that the service centres experiencing growth were in the full convenience shopping centre classification. All other centres experienced some decline in the number and variety of retail outlets. This decline according to Stabler is in part directly related to the size of the centre at the beginning of the period.

Hodge, in studying the relationships that may exist between the grain handling operation and the economic viability of a community, also investigated what factors are responsible for the growth or demise of service centres. He comes to the general conclusion that "grain collection does not constitute the majority of economic base

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[31]A small service centre is equivalent to the convenience centre classification.

activities of most communities."[32] He also indicates that the presence of schools, hospitals and a good road network contribute most to a town's development.

In order to discover various sets of relationships existing amongst variables characterizing service centres, Hodge used a factor analysis technique. A total of 40 variables[33] were dealt with to study the possible interconnections. A series of clusters on the original data was then used to bring data into a more manageable form. To investigate the importance of the grain shipments and the relationships to the 40 listed variables, a multiple regression analytical technique was utilized. Table 2.1 shows Hodge's results. The table is a correlation matrix of six variables. The value of grain shipped and percentage of grain value show small correlation coefficients of the performance variables of centres. For example, the correlation coefficient between value of grain shipped and percentage change in population is .111; and value of grain shipped and percentage change in population 1961-1966 is .072. Correlation coefficients between value of grain shipped and two performance variables (percent change in

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[32]Gerald Hodge, "Grain, Trains and Towns," Transportation Research Forum, Ninth Annual Meeting, ed. G. C. Vietsch (Oxford: The Richard B. Cross Company, 1968), p. 301.

[33]Ibid., p. 302. Variables range from demographic, social and economic in nature.

Table 2.1

CORRELATION BETWEEN PERFORMANCE VARIABLES FOR INCORPORATED CENTRES, SASKATCHEWAN

	% Population Change 1951-1961	% Population Change 1961-1966	% Change in Retail Firms, 1951-1961	Average Family Earnings, 1961	Value of Grain Shipped, 1961-1962	% Change in Grain Value, 1951-1961
1) % Population Change 1951-1961	1.000					
2) % Population Change, 1961-1966	.114	1.000				
3) % Change in Retail Firms, 1951-1961	.437	.176	1.000			
4) Average Family Earnings, 1961	.238	.134	.246	1.000		
5) Value of Grain Shipped, 1961-1962	.111	.072	.173	.183	1.000	
6) % Change in Grain Value, 1951-1961	.156	-.116	.069	.151	.327	1.000

SOURCE:

Gerald Hodge, "Grain, Trains, and Towns," Transportation Research Forum, Ninth Annual Meeting, ed. G. C. Vietsch (Oxford: The Richard B. Cross Company, 1968), p. 309.

retail firms and average family earnings 1961) are .173 and .183 respectively.

The two analytical approaches used to examine the relationship between the amount of grain shipped and the 40 economic variables demonstrate that no strong correlations exist amongst the performance variables[34] of incorporated centres.

In investigating the prairie community system, Zimmerman and Moneo studied the proposition of the inevitable disappearance of the small trade centres and the almost total concentration of rural dwellers in large towns. The authors discovered that rural depopulation has greatly strengthened the existence of regional trade centres at the expense of small local communities. However, one of the general conclusions drawn was that there is a tendency for the persistence of small communities. The survival of small communities is in general due to the social needs of the community members. Stabler also drew a similar conclusion by indicating that the small convenience centres will continue to provide a "corner grocery store" function vital to the local inhabitants. Zimmerman and Moneo then go on to cite that good road accessibility, the variety of services offered in a community, and public

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[34]The performance variables are the following: population, the size, number and type of retail firms and average family earnings.

and social services (schools and hospitals) are very important variables in attempting to recognize the development of certain service centres.

Mosersky, in his study on rural communities and the possible effects branch line abandonment might have, concluded that the severity of rail and/or elevator abandonment does vary inversely with community structural differentiation. He analyzed 160 communities located on low density branch lines that are candidates for abandonment. The structural variables depicting the viability of any community were the following: population size, proportion of work force (middle income category), proportion of labor force in managerial and professional occupations, proportion of labor force in agriculture, proportion of labor force in manufacturing, and service industries, heterogeneity of the religious composition of population and proportion of population of British origin. Using a factor analysis technique, he separated communities into 2 categories: high differentiation and low differentiation communities. Using a factor analysis method, he discovered that the disruptive effects of abandonment vary inversely with the amount of community structural differentiation.

Recently, a study on selected service centres conducted by Brown and Olsen attempted to investigate what factors or events have contributed most to the growth or decline of communities. Using a multiple regression technique to show which variables contributed most to

growth, they discovered that "growth centres had grown at the expense of smaller centres, due to their ability to provide a wider range of services."[35] The success of a service centre was most attributable to school and hospital facilities, good road accessibility and senior citizen homes.

The simple regression analysis indicated that a significantly positive relationship existed between 1971 population of a centre and the following variables: variety of services, road accessibility, population in 1951 and various public services. (Stabler also discovered that growth or decline was related to the size of the centre at the beginning of the period.) In the case study undertaken, no specific mention was made of the contributions the grain handling operation may have on rural service centres.

The Grain Handling and Transportation Commission investigated the social and economic implications of railway abandonment. The Commission cites several factors which have and continue to contribute to the reduction in the size and number of prairie communities. Rural electrification and refrigeration have had a strong economic impact on the viability of several types of community services. The improved road network, dependable cars and

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[35]Brown and Olsen, op. cit., p. 86.

trucks have facilitated the movement of goods and services over greater distances. Such developments as school consolidation, regional health centres and a host of other reasons all contributed to the growth of certain communities and the demise of others. Railways and elevators are not mentioned.

The report also states that "our system of communities was also over-built in the light of technological development, and that all could not survive under conditions of larger farm units, mechanization and the accompanying decreased in rural population. The evolvement of fewer centres rendering a larger number of services has taken place only because several small centres have decreased in size or disappeared altogether."[36]

From the various studies discussed above, what general conclusions are relevant to the topic at hand? Firstly, Stabler and Hodge come to a similar conclusion that the relationship between the economic viability of a community and the grain handling operation is negligible. Secondly, Hodge, Zimmerman and Moneo, Brown and Olsen indicate that such variables as schools, hospitals, senior citizen homes and good road accessibility are important factors influencing the growth of service centres.

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[36]The Report of the Grain Handling and Transportation Commission, Hall Commission, Government of Canada, Ottawa, 1977, p. 80, Vol. 1.

Thirdly, Mosersky, Stabler and Hodge independently indicate that the diversity of services is an important element in a community's attractiveness as a centre. One element that all of the above studies have in common is the fact that the grain handling facilities do not contribute to the economic strength of the community as was once believed to be the case. This thesis will attempt to investigate the proposition that the grain handling operating has little to do with the economic viability of a community. In short, the purpose of this project will be to add to the already existing body of knowledge by looking specifically at Manitoba.

BRIEF DESCRIPTION OF GEOGRAPHIC AREA UNDER STUDY

Figure 1.1 shows the southwest corner of the province of Manitoba. The predominant livelihood of most agricultural enterprises is through the cultivation of field crops and cereals. Due to the quality and topography of the soils, it neither caters to large animal husbandries nor to specialized forage crops as is found in the Red River Valley. It is often described as a major grain producing area of Manitoba.

The area under study comprises a central place hierarchy with Brandon as the urban area surrounded by 6 prairie farm cities, 6 towns, 16 villages and 45 hamlets. All the communities are located on a rail line, of which 34 are specifically located on low density branch lines

Table 2.2

CLASSIFICATION OF COMMUNITIES
IN THE BRANDON STUDY AREA

Hamlets (3-10 Services)	Villages (11-35 Services)	Towns (36-75 Services)	Prairie Farm City (75 and more Services)
Cordova*	Oak River	Rivers*	Minnedosa
Franklin	Rapid City*	Hartney	Neepawa
Rufford*	Kenton	Boissevain	Virden
Mentmore*	Pipestone*	Deloraine	Melita
Oberon*	Waskada*	Souris	Carberry
Brookdale	Napinka	Glenboro	Killarney
Moorepark*	Belmont*		
Pettapiece*	Oak Lake		
Floors*	Griswold		
Smart*	Alexander		
Justice*	Minto*		
Forrest*	Dunrea*		
Ingelow	Ninette*		
Fairview	Wawanesa*		
Lenore*	Margaret*		
Harding*	Reston*		
Bradwardine*			
Pindennis*			
Douglas			
Ninga			
Rhodes			
Lauder			
Regent+			
Fairfax*			
Underhill*			
Argue*			
Nesbitt			
Broomhill*			
Gregg			
Carroll			
Treesbank			
Stockton			
Elgin*			
Menteith*			
Kemnay			

(Continued)

Table 2.2 (continued)

Hamlets (3-10 Services)	Villages (11-35 Services)	Towns (36-75 Services)	Prairie Farm City 75 and more Services)
Dand+			
Hathaway+			
Wellwood*			
Medora			
Belleview*			
Elva			
Holmfield			
Hilton+			
Carnagie*			
Largs			
Croll+			

* Elevator points on low density branch lines.

\+ Hamlets on rail lines no longer in use to be referred to C.T.C. for decision.

Table 2.3

NUMBER, GRAIN HANDLED AND CAPACITY OF LICENCED ELEVATORS
BY GRAIN DELIVERY POINT
1966-67 AND 1974-75

Delivery Point	Number of Elevators		Storage Capacity		Grain Handled	
	1966-67	1974-75	1966-67	1974-75	1966-67	1974-75
	Number		-000 bushels		—bushels—	
Hamlets						
Belleview	1	closed	20	-	91,355	-
Bradwardine	1	1	58	58	216,545	312,652
Brookdale	2	2	178	178	526,828	615,545
Broomhill	1	closed	24	-	107,190	-
Carroll	1	closed	90	-	87,863	-
Cordova	1	closed	49	-	122,978	-
Croll	1	1	78	78	103,223	12,976
Dand	1	1	57	57	140,294	64,789
Douglas	1	1	36	102	194,722	213,412
Elva (not licenced)	closed	closed	-	-	88,567	-
Fairfax	3	3	240	205	483,949	578,345
Fairview	1	1	93	85	270,115	64,028
Floors	1	1	40	40	105,477	182,137
Forrest	2	1	136	108	276,188	305,861
Franklin	2	2	171	171	269,698	308,350
Gregg	1	1	90	90	189,613	180,029
Harding	1	closed	29	-	132,870	-
Hathaway	1	closed	27	-	106,859	-
Holmfield	1	1	50	50	186,403	5,333
Ingelow	1	1	52	52	107,635	-
Justice	1	1	100	100	171,788	170,670
Lauder	1	1	94	50	194,139	168,830
Leighton (not licenced)	1	closed	50	-	184,321	-
Lenore	1	1	82	82	289,405	399,945
Menteith	1	1	78	78	180,389	259,667
Mentmore	1	1	88	88	192,018	304,592
Moorepark	2	2	79	79	195,646	375,415
Nesbitt	2	2	212	212	604,209	594,518
Oberon	1	1	66	66	147,526	-
Regent	1	1	88	60	231,411	51,346
Rounthwaite	2	1	132	84	466,052	529,543
Rufford	1	closed	49	-	78,349	-
Smart	1	1	66	66	207,225	284,342
Treesbank	1	closed	33	-	65,968	-
Wellwood	2	1	115	90	158,452	78,197
Pendennis	closed	closed	-	-	-	-
Ninga	2	2	243	217	393,111	355,522
Rhodes	closed	closed	-	-	50,218	-
Underhill	closed	closed	-	-	-	-
Argue	closed	closed	-	-	-	-
Stockton	closed	closed	-	-	-	-
Hilton	closed	closed	-	-	-	-
Carnagie	closed	closed	-	-	-	-
Langs	closed	closed	-	-	-	-
Pettapiece	1	closed	36	-	-	-
Elgin	3	3	267	267	556,205	598,200
Medora	2	2	308	308	663,233	652,092
Villages						
Alexander	2	2	191	191	450,479	530,784
Belmont	2	1	185	109	403,840	397,879
Dunrea	2	2	193	195	445,014	411,383
Griswold	2	2	153	153	379,533	262,823
Kenton	1	3	82	133	286,822	422,624
Margaret	2	2	125	114	296,265	216,598
Minto	3	3	296	273	484,692	457,656
Napinka	2	2	120	85	216,364	148,931
Oak Lake	2	2	105	105	289,269	259,374
Oak River	3	3	170	170	322,128	315,129
Pipestone	2	2	116	116	346,983	366,440
Rapid City	2	2	126	126	398,181	553,670
Reston	2	2	189	189	605,982	550,334
Waskada	3	3	274	274	578,105	501,573
Ninette	1	1	44	46	158,851	116,620
Wawanesa	1	1	95	95	158,452	307,000

(Continued)

Table 2.3 (continued)

Delivery Point	Number of Elevators		Storage Capacity		Grain Handled	
	1966-67	1974-75	1966-67	1974-75	1966-67	1974-75
	Number		-000 bushels		—bushels—	
Towns						
Boissevain	4	5	560	597	1,293,572	1,155,333
Deloraine	4	4	375	375	856,520	1,366,261
Hartney	3	4	217	242	521,169	566,110
Glenboro	2	2	157	132	536,570	461,973
Rivers	2	2	162	162	420,825	573,131
Souris	3	3	460	440	780,803	721,225
Prairie Farm City						
Carberry	1	1	56	56	205,132	178,785
Killarney	5	5	619	685	1,335,994	1,392,415
Minnedosa	2	4	144	367	541,245	792,894
Melita	3	3	301	409	750,589	691,730
Neepawa	2	2	208	208	447,578	671,253
Virden	2	2	150	150	380,909	545,796

SOURCE:
Statistics Division, Summary of Country Elevator Receipts at Individual Prairie Points, Canadian Grain Commission.

that were investigated by the Canadian Transport Commission and by the Hall Commission.

As indicated earlier, the predominant livelihood of this region is from the cultivation of field crops and cereals. Grain production in the Brandon study area is primarily devoted to wheat, barley and oats. Of the seventy-four grain delivery points, the land use of farm acreage by delivery point for the years 1974-1975 is the following: wheat approximately 17.4 percent of total acreage, barley approximately 8.7 percent of total acreage, oats approximately 9.7 percent of total, summer fallow 26.9 percent of total acreage, forage crops 4.2 percent, others 6.5 percent, and unimproved land having close to 26.6 percent.[37]

From the summary on Table 2.3, the storage capacity and number of grain delivery points, the following points of interest are noted. First, eleven grain delivery points which were in operation in 1966 are closed. Of the eleven points that have ceased handling grain, all are located in hamlets. Secondly, only in a few towns and prairie farm cities has the grain handling capacity increased, noteably Minnedosa, Killarney and Melita.

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[37]Canadian Wheat Board, Land Use of Farm Acreage by Delivery Point, 1974-1975, Winnipeg, Manitoba, 1975.

PRELIMINARY STUDY OF THE GROWTH OF RURAL COMMUNITIES

In analyzing the importance of the economic effects the grain handling operation has on rural communities, a preliminary study of the growth of communities was undertaken to investigate trends. This preliminary study demonstrated that hamlets, villages, towns and prairie farm cities show distinctive trends in their growth or decline. In examining all the hamlets in the study area, it was shown that most reached a peak of importance[38] as a community between the years 1948 to 1951. Figure 2.1 graphically represents the growth trend pattern of hamlets, villages, towns and prairie farm cities in the Brandon study area. The downward trend from 1951 to 1974 demonstrates the decline in the number of services offered by hamlets. A total of 46 hamlets were used in the preliminary study. The total number of services for all hamlets were added and averaged over the period 1945 to 1974.

Villages behaved in a similar fashion to hamlets except that the timing was different. For villages a peak in population and number of services was reached between 1954 and 1957, as shown on Figure 2.1. The total number of

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[38]Importance refers to a point in time when the total number of services is the highest.

services for the 16 villages in the study area are aggregated and averaged out for the period 1945 to 1974.

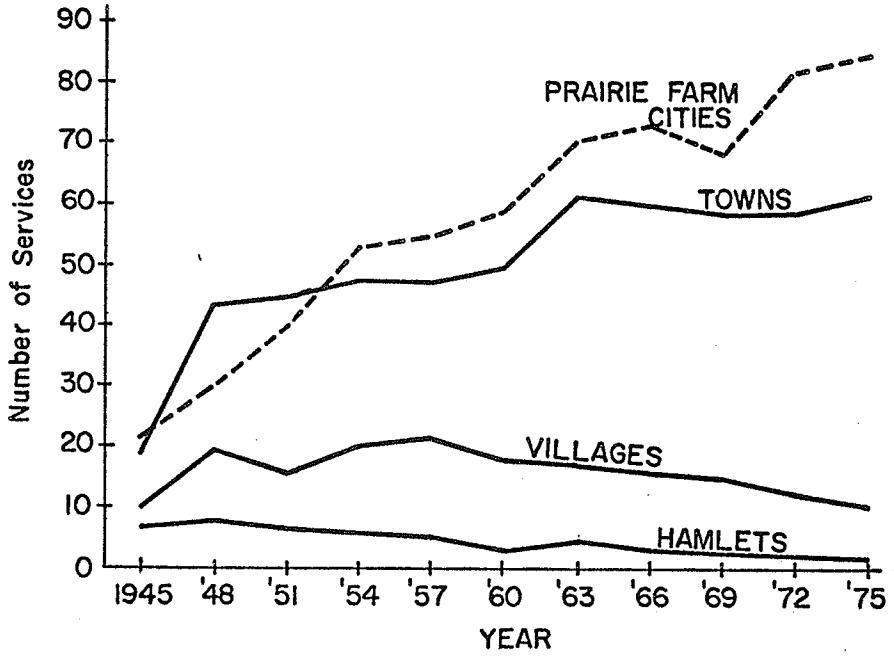
The 6 towns in the study area as depicted in Figure 2.1, reaching a peak in 1963 and have for the past 10 years been able to retain the same number of services. The trend appears to indicate that a plateau has been reached in the growth trend of towns.

The final category, prairie farm cities, shown in Figure 2.1, are experiencing continuous growth in population and total number of services over the period 1945 to 1974. The trend indicates that all prairie farm cities should continue to grow in the future. One important point is the rate of increases in the total number of services for towns and prairie farm cities. For most of the towns in the Brandon study area, a significant tapering off in their growth is apparent. Prairie farm cities have had significant increases in the number of services, but this increase is also slowing down. In short, all major towns and regional growth centres are increasing but at a decreasing rate.

In analyzing growth trends in all the four categories of communities, it appears fairly conclusive that irrespective of what the strength of the agricultural productivity of a community may happen to be, the potential of a community is governed by its uniqueness in demonstrating the power of functioning as a central place. Uniqueness is best defined in the diversity of services

Figure 2.1

AVERAGE NUMBER OF SERVICES FOR HAMLETS, VILLAGES, TOWNS AND PRAIRIE FARM CITIES IN THE BRANDON AREA (1945-1975)



SOURCE:

Manitoba rural telephone directories for the period 1945 to 1975.

offered by a central place. In short, communities that are centrally located with respect to others, given a favorable spatial demand structure, will generate a livelihood that may not occur in other communities.

CHAPTER III

A CONCEPTUAL MODEL FOR MEASURING THE ECONOMIC EFFECTS OF RATIONALIZATION ON COMMUNITIES

INTRODUCTION

The purpose of this chapter is to present a model and framework for dealing with communities and the rationalization of the grain handling system. Using central place theory and correlation analysis, the objective of the conceptual model is to evaluate to what extent the size, number and location of communities are influenced by the grain handling operation. By constructing correlation matrices on the performance variables and the grain operation of a community, possible relationships can then be analyzed.

The basic framework is provided by the "Christaller central place model."[39] This model is utilized because it provides a conceptual stage of development and describes a basic logic of the mechanics of locational analysis.

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[39] The model developed by Walter Christaller was to explain the size, number and location of communities in rural southern Germany.

THE CHRISTALLER MODEL

To explain the size, number and location of service centres in an agricultural area, central place theory[40] is most widely used. According to this theory, the role of a central place is to provide a milieu where goods and services are provided. The major reasons why the functioning of a central place is possible, are due primarily to the threshold demand and range of a good.[41] According to Christaller, the size, number and location of centres is governed by the nature of a good. Each good is characterized by a demand range. Christaller states that "the upper limit of this range, spatially the outer limit, is determined by the distance from a central place beyond which the particular good cannot be purchased from this central place. The lower limit of the range, viewed spatially from the central place as the inner limit, is determined by the minimum sales of a central good in order to make the offering pay."[42] The lower bound indicates

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[40] A summary of recent theoretical and empirical work in central place theory is found in B. J. L. Berry, Geography of Market Centres and Retail Distribution (Englewood Cliffs, N.J.: Prentice-Hall, 1967).

[41] The threshold demand is defined by Stabler in terms of "the minimum level of population and/or income required to support a particular activity." Range refers to "the maximum area that the activity in question can serve from a particular place."

[42] Christaller, op. cit., p. 39.

the minimum rate of return that will keep any entrepreneur in business and the upper end of the range indicates a rate of return exhibiting the likelihood for entrance of similar enterprises. Each type of good or service will seek a locational equilibrium in a centre in which the associated trading area contains a certain minimum level of demand. Restated in terms of supply and demand, the existence of demand for services in an area exerts economic pressure to service that demand--in other words, to locate central place services in such a manner that they will be accessible to residents of the entire area under the umbrella of the minimum transport cost criterion.

The trading area of a central place is of a circular form. However, to meet the "blanketing condition", the trading area circles must overlap thereby forming a hexagonal pattern. The pattern and location of different classes of centres (city, prairie farm cities, towns, villages and hamlets) is governed by the minimum distance criterion and the spatial demand range. The larger the central place, the greater is the likelihood that it will accommodate higher ordered goods; and conversely, the lower the order of the demand range for a good, the better the chance it can exist in smaller central places.[43] The

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[43] Each order of central places carries on the activities of all lower ordered central places plus some further activities not found in such places.

exact location of a good to be purchased is governed by the order system of classification. The basic goods can be offered in most central places, while higher ordered goods can only be offered in specific centres in order to be guaranteed a minimum demand potential.[44] For example, a grocery store pools its demand potential from most residents; therefore each community can support at least one general store. Conversely, fashion clothing stores cannot sustain themselves in small central places, but must locate in larger centres to increase the range of the trading area.

Figure 3.1 is a theoretical hierarchical central place structure. The theoretical distribution of service centres has the following functional classification: 1 city, 6 prairie farm cities, 6 towns, 24 villages and 54 hamlets.

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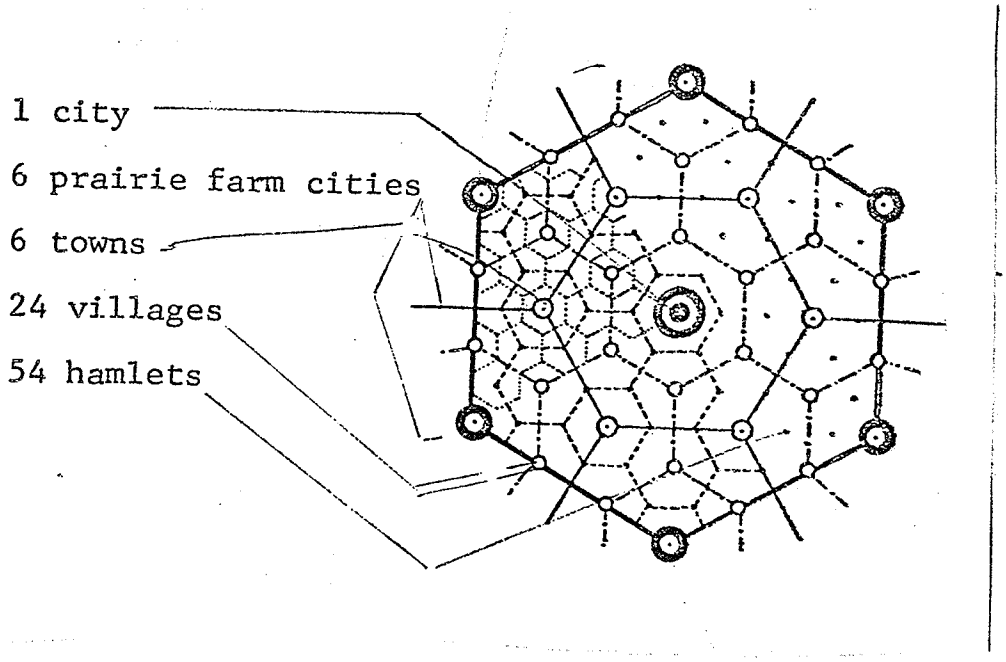
[44]The size of a trade area for a specific product depend on three basic factors: transfer costs, market density and agglomeration economies. Obviously, each of these conditions varies from one activity to another. Accordingly, we might expect that each additional product we introduce will have a different appropriate size of market area and spacing of supply centres. The appropriate area will be small and the appropriate number of centres large for products for which there is little economy in large scale production, or for which the density of market demand is high. Where the contrary conditions hold, we should expect production to be concentrated in a few widely spatial centres each serving a larger area.

Figure 3.1

THEORETICAL CENTRAL PLACE HIERARCHY



The spatial characteristics of the central place hierarchy are governed by the density of population and transportation costs. Each system of central places varies in the distance that separates the central places. A central place system situated in a densely populated area will be different from the one located in a sparsely populated area. The major difference lies in the distance separating central places. In short, the number of centres of each size is largely a function of total population and income, while the spacing of centres is determined by population density and accessibility. Christaller, in studying the size relationship amongst communities discovered that any pair of settlements of like size tend to

increase by the $\sqrt{3}$ as one proceeds from a settlement of a given size to the settlement of the next higher size. Thus market hamlets are found to be spaced roughly 7 kilometers apart, villages 12, towns 21, district cities (prairie farm cities) 36 and cities 62 kilometers. In the Brandon area, due to lower population density than the area studied by Christaller, it would be fair to conceptualize that the distance separating similar ordered settlements would be greater.

MODIFICATIONS OF THE CHRISTALLER MODEL

The theory of central place hierarchy is a statement of how the goal of exchanging goods at the least effort (distance travelled and costs of services) tends to produce a hierarchical regularity in the size and spacing of places. The major conditions under which a hierachical distribution of central places can be achieved depends on the following assumptions:- 1) a uniform plane of constant population density and purchasing power, 2) transport costs varying linearly with distance, and 3) no attenuation of demand with distance. A fourth condition implicitly implied by Christaller is that the economic model is a purely and perfectly competitive one.

The crucial test of central place theory is if it can answer some of the following questions. Do entrepreneurs seek to serve the available purchasing power of an area and carve out a monopolistic service area? Do

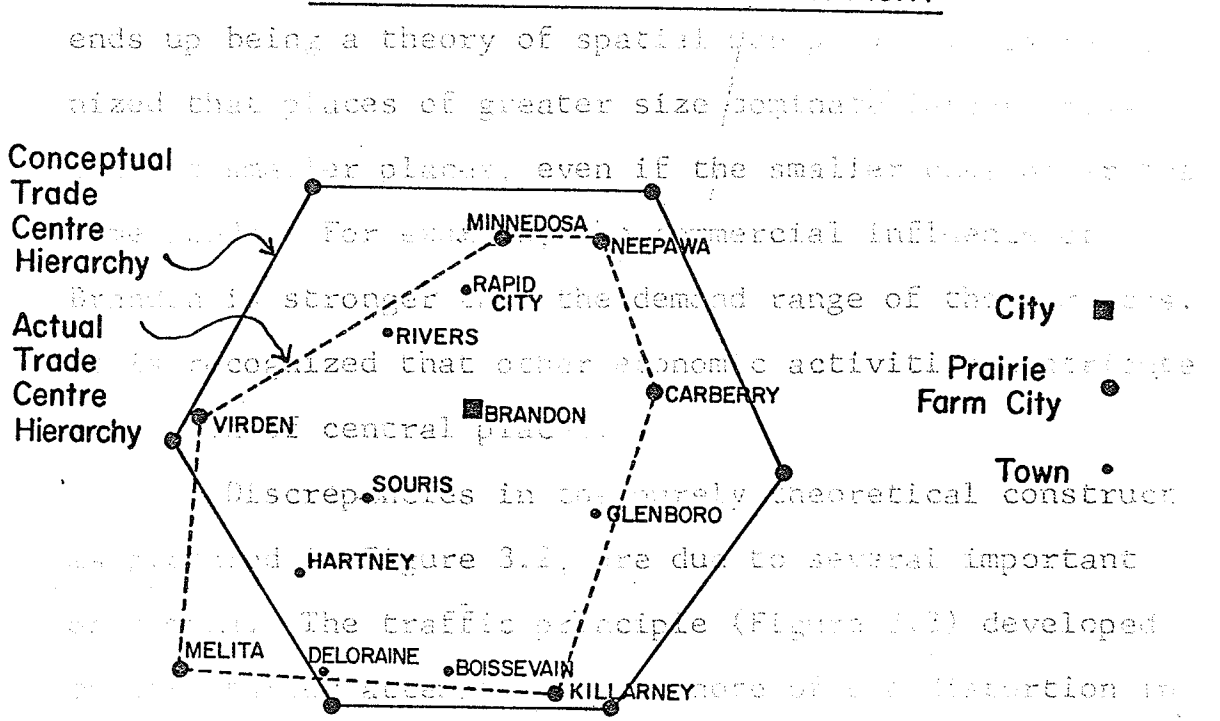
places with similar activities in similar physical and cultural environments tend to be regularly spaced? Do individuals tend to minimize the distance travelled to satisfy their desires? Does one individual have available and use a hierarchy of service centres; does he go to different places for different types of goods and services? The fact that places of different sizes exist is explicit evidence of a hierarchy, however, a clear hierarchical division cannot be expected for two major reasons: the density and relative purchasing power of surrounding population varies and entrepreneurs often make mistakes.

The fact that pure central place landscapes cannot be observed; this has lead to several modifications. The assumption that an area is a uniform plane is relaxed to permit physical and cultural variations such as the Carberry desert area (lower population density). The assumption of simultaneous development over limitless space is relaxed. The assumption that people will always make an optimal response and have perfect information is relaxed. The implicit assumption of a perfectly competitive model must be qualified. Competition tends to bring about a spacing in order to yield only minimal acceptable profits. However, each centre has a competitive advantage in a given piece of territory because of the factor of distance. This spatial monopoly is limited by competition. If for example, one centre raises prices, its cost advantage within its spatial monopoly or "captive market" is

impart eliminated, and neighbouring centres can capture portions of its market. Central place theory starts off using a competitive model in a spaceless framework, and ends up being a theory of spatial monopoly. It is recognized that places of greater size dominate larger areas than do smaller places, even if the smaller ones offer the same goods. For example, the commercial influence of Brandon is stronger than the demand range of the services. It is recognized that other economic activities contribute to growth of central places.

Discrepancies in the purely theoretical construct as pictured in Figure 3.2, are due to several important phenomena. The traffic principle (Figure 3.3) developed by Christaller attempts to take note of one distortion in the theoretical central place system. Given the importance of certain traffic routes, central places are distributed in such a manner that the larger more important centres lie along the traffic route. A traffic route can either be a river, road or railroad. Another distortion in the central place system developed by Christaller is the separation principle. This principle emphasizes the fact that some communities are separate because of the cultural and socio-political aspects of their community life. Another major distortion is the variations in the physical quality of space and in population density. Such distortions have required a modification of classical central place theory

Figure 3.2


BRANDON TRADE CENTRE HIERARCHY
Conceptual Trade Centre Hierarchy
Actual Trade Centre Hierarchy
MINNEDOSA
NEEPAWA
RAPID CITY
RIVERS
VIRDEN
BRANDON
CARBERRY
SOURIS
GLENBORO
HARTNEY
MELITA
DELORAINE
BOISSEVAIN
KILLARNEY
City
Prairie Farm City
Town

to recognize that the size of hexagonal market areas vary, hence the very reasons for distortion.

Given the boom of the railway era, coupled with mass immigration and the growth of the grain farming industry; the structure, size and location of central places had reached a spatial equilibrium by 1930. After the Great Depression, rural out-migration began, and is becoming a primary concern of western provincial governments. The hierarchical central place system and the corresponding pyramidal classification of services experienced heavy changes. Certain service outlets of higher order, which were originally viable enterprises due to population density and time-distance considerations, began to experience losses in sales. The only alternatives open to higher ordered services in order to maintain a threshold demand above a minimum level were the following:

a) diversify existing operation, or

b) establish enterprise in a higher ordered central place to take advantage of the centrality by ensuring that the sum of distances which clients must travel is a minimum.

From several analyses[45] already conducted in Manitoba the following major changes can be noted:

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[45]Analysis of the trade centre system in Manitoba and the subsequent classification of communities has been undertaken in specific areas by the Economics Branch, Agriculture Canada; Prairie Regional Studies in Economic Geography No. 2, No. 6, No. 8 and No. 13. Some brief

1) larger central places have experienced larger increases in the diversity of services,
2) most villages and hamlets have had significant decreases in population,
3) only communities with 1,000 or more people are projected to continue increasing in population,
4) only some towns and prairie farm cities had experienced increases in the total number of services, and
5) there appears to be a close correlation between population and number of services and retail outlets.

It appears that the percentage composition of central places has changed, even though the total number of communities has remained constant. The number of hamlets and villages is increasing at the expense of some towns and major prairie farm cities. The number of centres at both extremes of the retail service hierarchy increased relative to centres in the middle range of the hierarchy. This evolutionary phenomenon in the central

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analysis of the evolutionary pattern of rural communities is provided in the Manitoba Community Reports 1966 to 1975 inclusively, prepared by the Department of Industry and Commerce, Winnipeg, Manitoba. A report called "Population Projections for Manitoba by Region and Town Size--Some Alternatives 1971-1900" by Maki, Framingham and Sandell, Department of Agricultural Economics, University of Manitoba, 1973, attempted to investigate which communities are projected to increase and which are not.

place hierarchy was found to be the case in Saskatchewan.[46] From the brief studies on the Manitoba situation, the chronological pattern of central place hierarchy appears to be similar to Saskatchewan. The number of prairie farm cities has remained constant over the past thirty years. Towns and villages have decreased in number, while hamlets have increased significantly. Christaller summarizes the situation by stating that "with a general decrease in population in a region the weaker auxiliary central places die away, but the importance of other central places does not increase proportionately to the added population, but rather less than proportionately nonetheless under certain circumstances this importance might even be intensified because of the increased demand of central goods which have been released following the death of an auxiliary central place."[47]

Another factor that has drastically changed the hierarchy of central places in Manitoba has been the technological advances in personal and public transportation. The time-distance and economic-distances have been significantly reduced. This has led to an increase

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[46] J. C. Stabler, Economic Effects of Rationalization of Grain Handling and Transportation on Prairie Communities (Saskatoon: Underwood, McLellan and Associates Ltd., 1972), pp. B-9, B-8.

[47] Christaller, op. cit., p. 89.

in the mobility of rural dwellers. Population density in the rural areas has decreased, and subsequently, higher ordered goods which were previously attainable in smaller centres must now be purchased in regional centres. In addition, it is becoming increasingly apparent that the total gross sales of lower ordered retail outlets,[48] such as grocery stores, are increasing in the larger regional centres. The reasoning is the following: if a special trip is to be made to purchase higher ordered goods, why not make it a complete shopping day and purchase all the goods that are needed. Due to volume selling by most prairie farm city businesses, and by the very nature of their centrality, the retail prices of many goods are relatively lower than similar goods in smaller central places. The grocery store function in the small villages, hamlets and several towns is decreasing at the expense of high volume sales at discounted prices in larger centres. This would in part explain the ever increasing number of rural people that shop in urbanized areas. As a result, rural residents can maximize their income outlays by purchasing more of their goods and services in larger regional shopping centres.

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[48]The Manitoba Community Reports prepared by the Department of Industry and Commerce, Province of Manitoba indicate total sales for each incorporated community for the years 1966-1975 inclusively.

LIMITATIONS OF CENTRAL PLACE THEORY

As was indicated earlier, Christaller's model describes a bsic logic of the mechanics of locational analysis. However, viewing central place development as a gradual process in time as well as in space introduces two main limitations. Changes occur in the nature and price of goods and services, in population and in purchasing power, and in the quality and costs of transportation; that is, the parameters determining threshold range and profitability change. Central place theory is a stock concept (static) as opposed to a flow concept which is dynamic. Central place theory developed by Christaller is static and abstracts from time and if adjustments are made, they are assumed to be instantaneous. In short, most static model, including central place, is concerned only with the equilibrium values and equilibrium values are instantaneous. The second major limitation is the possibility that the entire central place system develops gradually as the settlement pattern is distorted by exogeneous factors.

Central place models, including Christaller's model, are static or, at best, comparative static. The model used in this study can deal with changes from one equilibrium (time period) to another equilibrium and such a change is instantaneous. In addition, comparative statics describes changes within the content of a static framework and does not trace changes in parameters.

THE HYPOTHESIS

It is the hypothesis of this study that the rationalization of the grain handling and transportation network will have only minor social and economic effects on most rural communities. A careful review of the historical development of Manitoban central places confirms the lack of regular hexagonal patterns of centres. In point of fact, the spatial characteristic follows to some extent the "traffic principle" developed by Christaller. The characteristic pattern is a linear one that was fostered by the extensive railway building the province experienced in its settlement period of 1900 to 1930. Figure 3.3 demonstrates the linear settlement pattern and how it coincides to some extent with the branch lines. This fairly regular spacing of centres along the rail lines arose with the establishment of trade centres at grain collection points.

The location of centres is distorted to some extent from the symmetrical pattern developed by Christaller; and the influence of the rail transport network on the location and size of service centres is for the most part responsible for this deviation. The "separation principle" can also be used to explain some of the distortions in the theoretical spatial central place hierarchy, but the major reason for the lack of symmetry is due to the geomorphological aspects of the area.

Figure 3.3

TRAFFIC PRINCIPLE

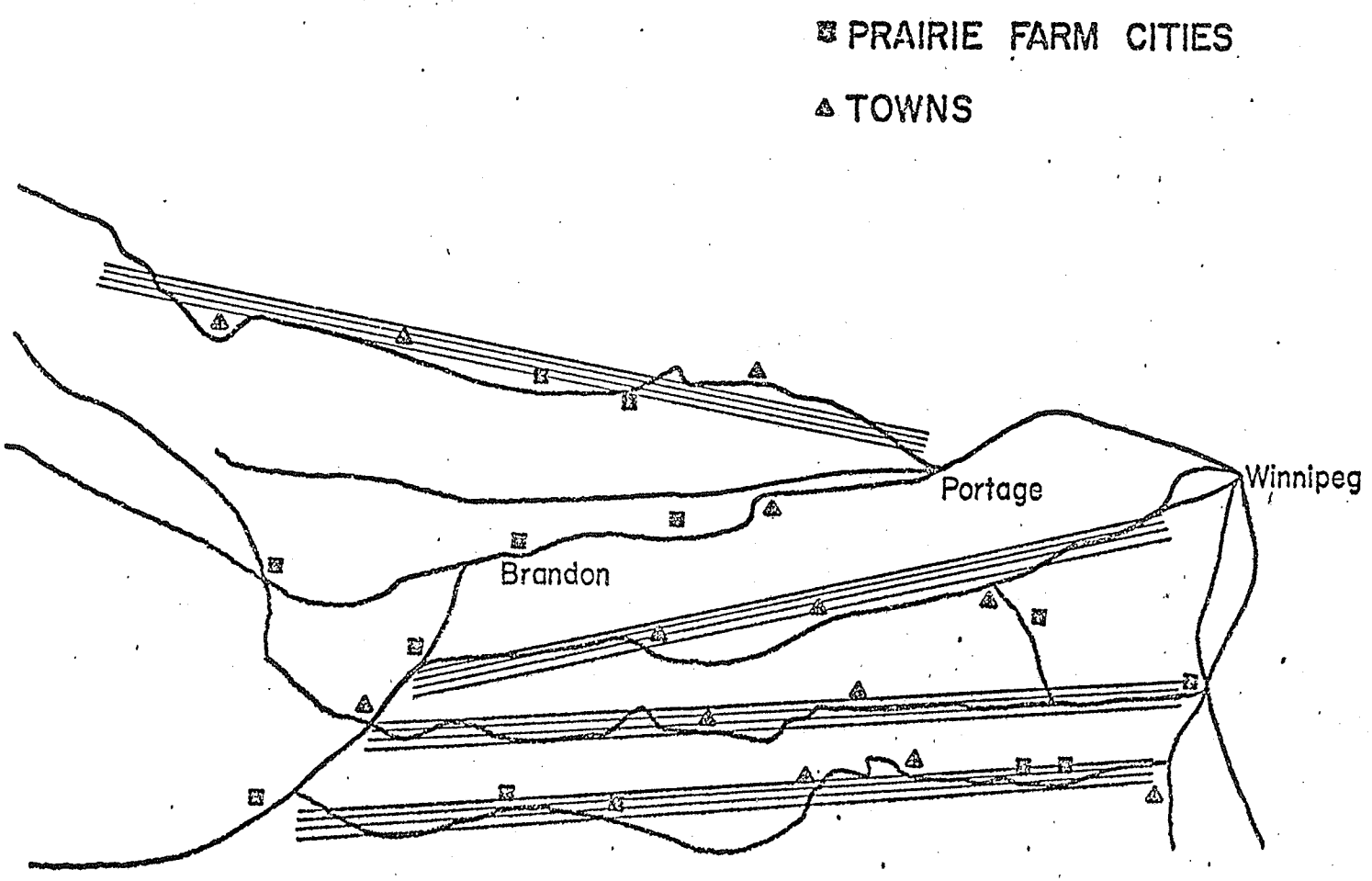

Figure 3.2 demonstrates the deviation in the Brandon trade centre hierarchy from the theoretical central place hierarchy.

If some rail lines are abandoned, the net economic effect can be small, due primarily to the fact that communities of today are less dependent upon the railroad as a means of providing important linkages. In other words, in an era of a speedy road transportation and shifting shopping preference patterns the dominance of regional prairie farm cities will continue to increase. If certain rail lines are abandoned it will have a negligible effect on many communities that has not already taken place by the changes in the rural marketing system.

CHAPTER IV

EMPIRICAL PROCEDURES

BRIEF DESCRIPTION OF ANALYTICAL PROCEDURE

To understand the relationship that exists between communities and to what extent the grain handling function directly or indirectly contributes to the economic viability of communities, a multiple regression analysis is used. In addition, correlation matrices, (by-product of regression) will be useful in showing which relationships are present amongst the explanatory variables.

Three specific models are used in arriving at explaining what relationships exist amongst the explanatory variables. Model 1 is used to study the relationships existing between the performance variables and the grain handling operation. Model 2 is used to study the relationships between the agriculturally based services and the grain handling operation. Model 3 is used to verify if the distance separating communities is a good explanatory variable in understanding the hierarchical distribution of communities surrounding Brandon.

SPECIFICATION OF THE MODEL

To analyse the economic effects the grain handling operation can have on a rural community, data that are

indicative of the grain handling operation and the economic viability of service centres were collected. The most widely used indicator of a community's size is its population. Total number of services and the diversification of retail outlets are also used as measures of community size and strength. Because population statistics are more attainable and simpler to understand, it will be used as the proxy dependent variable in the analysis. The total number of services and the diversity of services are two explanatory variables that show the structure and diversification of a community. The measurement of the community's grain handling capacity is the total amount of grain[49] (in bushels) received by the elevator. In order to measure the trend of grain handled in a community, a ten year average of grain shipped into a country elevator point is used. Another variable that is examined is the number of permit holders registered to ship grains to various country elevator points.

The general model used in studying the relationships will be a multiple regression analysis and correlation matrix approach. The general model will consist of three separate sub-models.

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[49]Grains include wheat, oats, barley, flax, rapeseed and rye.

Model #1

This model consists of the following equation:

$$Y_1 = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + e$$

where:

Y_1 = population of the community

x_1 = total number of services offered in a community, including recreational facilities and post offices

x_2 = diversity of services (a total of the different type of services)

x_3 = total amount of grain shipped into a community, measured in bushels

x_4 = a ten year average of grain received by a community (last nine years plus the year in question)

x_5 = number of permit holders that are delivering grain to a community

e = random variation

From the studies undertaken by Hodge for the province of Saskatchewan, and in the case of Manitoba, certain variables will have definite sign and magnitude. In the case of x_1 it is expected that the sign of the coefficient will be positive and of strong magnitude. The population of a community is probably positively correlated to the diversity of services (x_2). On a priori grounds we would expect the sign of the coefficient between y_1 and x_3 to be negative or zero, since under normal conditions the grain handling capacity of a community is unrelated to the

population. The number of permit holders (x_5) will have little or no correlation to the population and total number of services.

Model #1 is a single equation regression model consisting of two parts: a time series analysis for each community and a time series for each category of community (aggregated). A time series analysis will be conducted on each community in the study area for the period 1945-1975. The years to be used in the analysis are 1945, 1948, 1951, 1954, 1957, 1960, 1963, 1966, 1969, 1972 and 1975.

The grouping of each category of community is conducted by the addition of each variable for all communities and dividing by the number of communities to arrive at an average for each year in question.[50]

Model #2

Of the total quantity and variety of services offered in a central place, a certain number of these are believed to be strongly associated with grain production. For example, farm implement and bulk fuel dealers, general garages, lumber yards and hardware stores should intuitively be directly associated to a large extent with the total quantity of grain marketed through a community. To

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[50]For further reference to the grouping of observations (aggregation) see A. Koutsoyiannis, Theory of Econometrics, London, The MacMillan Press Ltd., 1973, pp. 276-283.

investigate more closely what relationships exist between agriculturally based services and the grain handling operation of a community, a regression analysis and correlation matrices will be constructed. The regression equation is:

$$Y_1 = c + a_1z_1 + a_2z_2 + a_3z_3 + a_4z_4 + a_5z_5 + e$$

where:

Y_1 = population of a community

c = constant

z_1 = number of farm implement and bulk fuel dealers

z_2 = number of hardware, lumber yards and garages

z_3 = total amount of grain shipped into a community

z_4 = ten year average of grain shipped into a community

z_5 = a ratio of grain producing related services to the total number of services offered in a community, $(z_1 + z_2)/x_1$

e = random variation

The reason for lumping farm equipment and bulk fuel dealers together is due to the nature of the service with respect to grain farming; as opposed to other variable (z_2). Fuel and equipment constitute a major portion of the total farm input costs in a grain farming enterprise. Z_2, the number of hardware stores, lumber yards and garages is not as closely linked to farming. Hardware stores, garages and lumber yards are not as dependent upon a grain farming

base as fuel, equipment and fertilizers. The relationship between z_2 and Y_1 is expected to be positive which the relationship between Y_1 and z_3 should be zero or slightly positive.

As in the case of Model #1, Model #2 will be estimated for each community in the study area on a time series basis. The model will then be estimated for the four categories of communities.

Model #3

If the economic base and the grain marketing capacity of a community have little to do with the performance variables,[51] what governs the hierarchical distribution and size of central places? The alternative hypothesis is that distance governs the distribution and size of central places. Several variables can be used to explain the size, location and spacing of communities of which the following are the most relevant: population of community, diversity of services and distances between communities. From the analysis conducted by Stabler, the population of a community and the diversity of its services were highly correlated. Using this information, a regression equation using diversity of services as the dependent variable and distance as the independent variable

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[51]The performance variables are the following: population, number of retail firms, and diversity of services.

was used. The regression equation is:

$$X_2 = a + c_2 x_6 + e$$

where:

X_2 = diversity of services of a community

a = constant

x_6 = distance between a central place and next nearest higher ordered central place (distance measured in miles using provincial trunk and provincial highways)

e = random variation

There are two reasons for choosing the diversity of services as the dependent variable: first, the diversification of services is an excellent indicator of a community's power to attract people; and secondly, the diversity of the types of services is a better indicator than population of the economic viability of a community. In short, central places having a wider range of services are commercially in a better position than a central place having several services but of the same type. A cross-sectional study of each year in question was conducted for all the communities in the Brandon study area. Regression was conducted on the following years: 1945, 1948, 1951, 1954, 1957, 1960, 1963, 1966, 1972 and 1975. For each year in question, a single regression analysis was run using the diversity of services as the dependent variable and distance to the next nearest higher ordered community as the independent variable for each community in that

particular year. A total of eleven regression equations were derived from the cross-sectional data for the eleven years in question.

A multiple regression model is based on certain assumptions, some of which refer to the distribution of the random variable e, some to the relationships between e and the explanatory variables and finally some refer to the relationship between the explanatory variables themselves. Apart from the six basic stochastic assumptions, other assumptions must be mentioned. For instance, the relationship must be correctly specified. All important regressors must be explicitly included in the model. In addition, the relationship must be correctly identified. It is assumed that the relationship whose coefficients we want to estimate has a unique mathematical form, that it does not contain the same variables as any other equation related to the one being investigated. Finally all macro-variables must be correctly aggregated and the explanatory variables must not be perfectly linearly correlated.

Given the set of assumptions and meeting the assumption of identification, a single equation model is the best linear unbiased estimator of the parameters. For this reason, a single equation multiple regression technique was used.

PROBLEMS OF AGGREGATION

In dividing the communities into their respective categories, one can then study the differences and similarities that exist among the four groups. Once the detailed analysis has been conducted for each community, the problem of aggregation narrows down to one of summation and averaging.

The basic problems can be divided into four types: geographical, demographic, economic and social.

In the aggregation of the communities in the study area, the central places are dispersed over a large enough area to encompass a wide range of service orientated functions. In other words, with averaging, most of the communities become lumped into a category, and geographic-topographic differences are not taken into consideration.

Some communities have a larger percentage of its citizens at a retirement age than do others. Conversely, some communities cater to a younger age group due to the very nature of their economic base; for example, those having a high school. In addition, many communities show distinctive demographic characteristics apart from the so-called average settlement. For example, Ninette is reported to have had a population of 630 in 1970 of which 400 were patients at the Manitoba Sanitorium for Tuberculosis; and Wawanesa had over 200 people engaged in the administrative duties of Wawanesa Insurance Corporation.

For these reasons, aggregation will impart an "aggregation bias"[52] in the estimates of the coefficients.

Due to the nature of soil qualities and the climatic variations, certain agricultural areas are more productive than others. In short, the agriculturally based economy can vary from one community in one locality of the study area to another similar sized community in another locality. Differences in the economic potential of the agriculturally based enterprises surrounding a service centre can affect that centre's total structure and size. For this reason, aggregation may impart some bias.

SUMMARY OF DATA COLLECTION

The principal sources of data are the following:

1. Manitoba Community Reports 1966-1975, Province of Manitoba;
2. Manitoba Rural Telephone Directories 1945-1975, Manitoba Telephone System;
3. The Canadian Wheat Board Summary of Seeded Acreage reported on permit holder booklets 1945-1975, Canadian Wheat Board;

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[52] Aggregation bias is defined as possible sources of error in estimating the aggregative variables of the model. Sources of aggregation create various complication such as the grouping of communities into specific categories.

4. Summary of primary elevator receipts at individual prairie points 1944-45 to 1974-75, Economics and Statistics Division, Canadian Grain Commission; and
5. Prairie Regional Studies in Economic Geography No. 13, No. 6, No. 8 and No. 2, Economics Branch, Agriculture Canada.

The purpose of the rural telephone directory was to extract information concerning the number and diversity of services offered in each community in the study area. The types of services were broken down into 41 groups:[53] churches, restaurants, general stores, trade contractors, gas service stations, barber and beauty shops, auto repair services, schools, bulk fuel dealers, farm implement dealers, hotels or motels, repair services, food stores, building contractors, banks and credit unions, motor vehicle dealers, hardware stores, lumber yards, clothing and shoe stores, doctors, lawyers, accountants, drug stores, hospitals and clinics, real estate agents, laundries and dry cleaners, theatres, hay-feed or seed stores, jewellers, household furniture, undertakers, dentists, public libraries, veterinarians, department

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[53]The basis for the number of services chosen is the fact that the total number of types of services offered in a prairie community excluding secondary manufacturing is 41. The Prairie Regional Studies in Economic Geography used a service classification of 39. Stabler, in his study "Economic Effects of Rationalization of Grain Handling and Transportation System on Prairie Communities," used a classification of 40.

stores, florists, technical college, elevators, municipal offices, recreational facilities and senior citizen homes. The basic method of computation was to enumerate the type and quantity of different services of each community by carefully reviewing the list of telephone subscribers. In addition, a cross check was conducted to alleviate the possibility of errors in double counting.

The purpose of the annual reports of the Canadian Grain Commission was to gather data on the total amount of grain shipped into a community and the ten year average of total bushels of grain shipped. The grains consist of wheat, barley, oats, rye, flax and rapeseed. The Canadian Wheat Board annual report on seeded acreage from various country elevator points furnished information on the registered permit holders delivering cereal grains to licensed country elevators.

The statistics on population for the eighty communities were gathered from the Dominion Bureau of Statistics Canada 1936, 1941, 1946, 1951, 1956, 1961, 1966 and 1971. Population figures for non-census years were interpolated by constructing a linear regression line for each community.[54]

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[54]See Appendix E for the simple linear regression equations for each community in the study.

PROBLEMS OF DATA COLLECTION

Problems in data collection were encountered in two specific areas in the study: population and number of services.

In relation to population statistics of various communities, data were only available in specific census years. However, in the time series analysis, the years chosen were the following: 1945, 1948, 1951, 1954, 1957, 1960, 1963, 1966, 1969, 1972 and 1975. Linear regression analysis was conducted for each community and for the years that census data was missing; and interpolation was conducted to have a population figure for each year of the time series analysis.

Collection of data on the type and quantity of services and retail outlets in the communities under study, posed several problems. The entire method of collecting data of service and retail outlets was based on the assumption that most businesses have a telephone number. Since the data was collected for the period 1945 to 1975, the assumption is realistic, since most businesses had a phone by 1945. In calculating the total number of services, the number of elevators was included but a certain number of recreational facilities were not included. The primary reason for the omission of some recreational facilities is the fact that not all recreational facilities have a business phone or a year around phone number, due, in part,

to their seasonality or specific cultural programs. In general, all permanent recreational services such as social clubs, theatres, associations were included in the study.

Other types of possible errors in the collection of data are the following: errors in duplication of phone numbers, failure to remain consistent in the criteria used to evaluate businesses, and no method of discovering whether certain establishments handle only what is advertised in the telephone directory. The method utilized to control errors in data collection was to cross-check each community twice, thereby ending up with correct and consistent data. The cross-check was conducted by a different person and results were then compared to test correctness and consistency of data collected.

CHAPTER V

EMPIRICAL RESULTS OF REGRESSION AND CORRELATION ANALYSIS

Correlation analysis was conducted using three sub-models: Model 1, the study of the relationships between the community performance variables[55] and the grain handling operation; Model 2, the study of the specific relationship between the grain handling operation and the agriculturally based services; and Model 3, the study of relationships between distance and the performance variables of a community.

CORRELATION ANALYSIS MODEL 1

Regression analysis using Model 1 was conducted on two levels; firstly on each community in the study area, and secondly on the four categories of communities (aggregated and averaged out). Appendix A, B, C and D contains the detailed correlation matrix for each community in the study area.

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[55] Performance variables of a community are population, diversity of services and/or total number of services.

Correlation Analysis Model 1 for each Hamlet

A detailed time series analysis and correlation matrix for each hamlet is provided in Appendix A. However, instead of studying each community separately, Table 5.1 provides a resume of the correlation matrices for all hamlets. The table is a compilation of correlation matrices for each hamlet in the study area. The main purpose of Table 5.1 is to provide a summary of Appendix A. The mean correlation coefficient is the averaged correlation coefficient for each variable; and the mean standard error is the mean standard deviation for each variable. Tables 5.2, 5.3 and 5.4 are the correlation matrix tables for villages, towns and prairie farm cities respectively.

Table 5.1 is the result of the correlation matrix tables for each hamlet in Appendix A, averaged out. In looking at Table 5.1, negative mean correlation coefficients of -.299, -.398 and -.150 are demonstrable between the amount of grain shipped into a hamlet and the three performance variables, population, total number of services and diversity of services, respectively. The sign and magnitude of these mean correlation coefficients indicate that the size of most hamlets is inversely related with the total amount of grain marketed.[56] At a

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[56] Tests of statistical significance for the correlation coefficients are provided in Appendix A for hamlets, Appendix B for villages, Appendix C for towns and Appendix D for prairie farm cities.

5 percent level of significance, several hamlets display statistically significant negative relationships between population and grain marketed. In short, for most hamlets, the population, total services and diversity of services decreased while the actual quantities of grain marketed continued to increase for the period 1945 to 1975. The major reasons for this inverse relationship are that smaller communities are losing at the expense of larger communities and that farmers are using elevator facilities in larger communities.

The mean correlation coefficients of -.461 and -.511 between X_3 and X_5 and X_4 and X_5 on Table 5.1 indicates that even in the face of continued increases in volumes of grain marketed through hamlets, the number of permit holders has decreased. Taking into consideration the fact that the average farmer is delivering more grain, the sign and magnitude demonstrate that the actual number of farmers using the elevator facilities has decreased. As Mosersky stated in studying the relationship between population and size of grain delivery points, that "taking into account the decline in elevators and producers during the time period (1965-66 to 1971-72), the larger the communities are, their either gaining or holding their own in the number of producers at the expense of the smaller

Table 5.1

CORRELATION MATRIX FOR ALL HAMLETS (AVERAGED)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Amt. Grain Shipped (X_3)	10 Yr. Average Grain Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	M.C.C.[a] .645 M.S.E.[b] .072	1.0				
X_2	M.C.C. .635 M.S.E. .831	M.C.C. .920 M.S.E. .020	1.0			
X_3	M.C.C. - .299 M.S.E. 2.255	M.C.C. - .398 M.S.E. .820	M.C.C. - .150 M.S.E. 1.264	1.0		
X_4	M.C.C. - .430 M.S.E. 1.564	M.C.C. - .196 M.S.E. 1.975	M.C.C. - .084 M.S.E. 1.361	M.C.C. .652 M.S.E. .511	1.0	
X_5	M.C.C. .648 M.S.E. .391	M.C.C. .559 M.S.E. .517	M.C.C. .491 M.S.E. .960	M.C.C. - .461 M.S.E. 1.614	M.C.C. - .511 M.S.E. 1.416	1.0

a Mean correlation coefficient

b Mean standard error

communities."[57] Table 5.4 shows a mean correlation coefficient of .808 between number of permit holders and amount of grain shipped into the prairie farm city; which supports Mosersky's general findings. Mosersky goes on further to indicate that communities that are increasing in population have a better chance of attracting permit holders than communities that are losing their people which is the case in all the hamlets under study.

Correlation Analysis Model 1 for Villages

Table 5.2 is the correlation matrix for all villages averaged out from Appendix B. Table 5.2 is simply used to recap the results from Appendix B. In general, the similarity between the mean correlation coefficients of several variable for hamlets and villages is important. For example, the mean correlation coefficients between the performance variables and the amount of grain shipped are negative for both hamlets and villages. The mean correlation coefficients between Y_1 and X_3 and Y_1 and X_4 for villages are -.299 and -.430. In comparison, hamlets show similar correlation coefficients of -.458 and -.454. The negative mean correlation coefficients between total number of services and amount of

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[57] J. A. Mosersky, The Relationship Between the Population of Producers and Size of Grain Delivery Points in the Prairie Provinces 1966-1971 (Ottawa: Economics and Social Branch, Canadian Transport Commission, Regional Impact Analysis Group, 1972), p. 49.

Table 5.2

CORRELATION MATRIX FOR ALL VILLAGES (AVERAGED)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Amt. Grain Shipped (X_3)	10 Yr. Average Grain Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	M.C.C.[a] .628 M.S.E.[b] .460	1.0				
X_2	M.C.C. .604 M.S.E. .401	M.C.C. .805 M.S.E. .238	1.0			
X_3	M.C.C. - .458 M.S.E. 1.351	M.C.C. - .317 M.S.E. .842	M.C.C. - .242 M.S.E. .854	1.0		
X_4	M.C.C. - .454 M.S.E. 1.334	M.C.C. - .320 M.S.E. 1.189	M.C.C. - .197 M.S.E. .598	M.C.C. .803 M.S.E. .319	1.0	
X_5	M.C.C. .714 M.S.E. .914	M.C.C. .470 M.S.E. .864	M.C.C. .135 M.S.E. 1.721	M.C.C. - .322 M.S.E. 1.083	M.C.C. - .366 M.S.E. 1.113	1.0

a Mean correlation coefficient

b Mean standard error

grain shipped and ten year average of grain shipped of -.317 and -.320 indicate that as the economic performance of the village continues to decline the volume of grain handled continues to increase. The negative mean correlation coefficients of -.322 and -.366 between X_5 and X_3, and X_5 and X_4 indicate that villages have losses in the number of producers delivering grains to their elevator points. However, the magnitude of the mean correlation coefficients for villages is not as statistically significant as in the case of hamlets.

Correlation Analysis Model 1 for Towns

Table 5.3, the correlation matrix (averaged) is compiled from Appendix C. In the case of towns, the relationships between the grain handling operating and the performance variables indicate that only a weak association is discernible between the amount of grain shipped to the town and the economic viability of the community. For example, a mean correlation coefficient of .345 between Y_1 and X_3 indicates a weak association. Mean correlation coefficients of -.145, .100 and .158 between the number of permit holders delivering grains to towns and the performance variables of a town (Y_1, X_1 and X_2) demonstrate that the relationships are weak.

Correlation Analysis Model 1 for Prairie Farm Cities

Table 5.4 is the correlation matrix table averaged out from Appendix D for the six prairie farm cities in the

Table 5.3

CORRELATION MATRIX FOR ALL TOWNS (AVERAGED)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Amt. Grain Shipped (X_3)	10 Yr. Average Grain Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	M.C.C. .773 M.S.E. .749	1.0				
X_2	M.C.C. .811 M.S.E. .817	M.C.C. .943 M.S.E. 1.009	1.0			
X_3	M.C.C. .345 M.S.E. .056	M.C.C. .499 M.S.E. .322	M.C.C. .447 M.S.E. .046	1.0		
X_4	M.C.C. .259 M.S.E. .136	M.C.C. .301 M.S.E. .619	M.C.C. .436 M.S.E. .084	M.C.C. .917 M.S.E. .204	1.0	
X_5	M.C.C. - .145 M.S.E. 1.146	M.C.C. .100 M.S.E. .196	M.C.C. .158 M.S.E. 1.914	M.C.C. .107 M.S.E. .619	M.C.C. - .109 M.S.E. .910	1.0

Table 5.4

CORRELATION MATRIX FOR ALL PRAIRIE FARM CITIES (AVERAGED)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Amt. Grain Shipped (X_3)	10 Yr. Average Grain Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	M.C.C. .865 M.S.E. .784	1.0				
X_2	M.C.C. .836 M.S.E. .741	M.C.C. .926 M.S.E. .023	1.0			
X_3	M.C.C. .553 M.S.E. .216	M.C.C. .624 M.S.E. .719	M.C.C. .664 M.S.E. .380	1.0		
X_4	M.C.C. .519 M.S.E. .064	M.C.C. .520 M.S.E. .315	M.C.C. .545 M.S.E. .317	M.C.C. .860 M.S.E. .554	1.0	
X_5	M.C.C. .709 M.S.E. .184	M.C.C. .656 M.S.E. .018	M.C.C. .658 M.S.E. .196	M.C.C. .808 M.S.E. .710	M.C.C. .700 M.S.E. .474	1.0

study area. The first piece of interesting information is the mean correlation coefficients between the economic variables X_1 and X_2 and the amount of grain handled through the community. Mean correlation coefficients of .553 between Y_1 and X_3, of .624 between X_1 and X_3, of .519 between Y_1 and X_4 and of .520 between X_1 and X_4 indicate that weak relationships exist. Since most prairie farm cities have continued to increase in their size and importance, the amount of grain handled has not significantly increased in the same magnitude. Several important pieces of information are provided in the results on Tables 5.4. First, the mean correlation coefficient between amount of grain handled and the number of permit holders of .808 is significant; additionally, the mean correlation coefficients of .709 and .656 between Y_1 and X_5 and X_1 and X_5 substantiate Mosersky's findings. In short, larger communities have a good chance of holding or increasing the number of shippers using the elevator facilities.

Regression Analysis Model 1 for Hamlets (Aggregated)

Instead of studying each hamlet separately, the data from the communities that enter into the category of hamlets were grouped and averaged. Table 5.5 shows the results of the time series study on the lowest hierarchical order of communities (hamlets) for the period 1945 to 1975. Table 5.5 demonstrates that the dependent variable (population) can be explained to a large extent by the two

Table 5.5

REGRESSION EQUATION - HAMLETS
AGGREGATED (1945-1975)
MODEL 1

Estimated Equation[a]

$$Y_1 = 74.562 + 2.842X_1^{*} + 9.880X_2^{**} - .0007X_3^{*}$$

$$(3.48) \quad (1.49) \quad (2.78) \quad (.0003)$$

$$- .0001X_4 - .123X_5$$

$$(.0009) \quad (.382)$$

where:

$R^2 = .971$ (coefficient of determination)

Standard error of estimate 3.48

a Figures in parentheses are standard errors of the estimate.

* Statistically significant at 5 percent, using a student t test. The critical value of t is + or - 1.812.

** Statistically significant at 1 percent, using a student t test. The critical value of t is $\pm$ 2.764.

† Statistically significant at 10 percent, using a student t test. The critical value of t is $\pm$ 1.372.

independent variables X_1 and X_2. Using a step up method, the variables giving the greatest in reduction the sum of squares of Y_1 was selected. Table 5.6 is the correlation matrix table for hamlets (aggregated). From Table 5.6, significant relationship between (X_5) permit holders and population Y_1 and total services (X_1) is illustrated. This association is only related in the sense that both population and number of permit holders are decreasing simultaneously. No causality is implied.

Regression Analysis Model 1 for Villages (Aggregated)

From the tests on the significance of parameter estimates, total number of services and the diversity of services contribute to a large extent in explaining the dependent variable, population. Table 5.7 illustrates that X_5 also is statistically significant. As the population of villages decreases, the number of permit holders delivering grain increases. As was mentioned with regards to Table 5.1, the association between the community performance variables and the grain operation is significantly negative. For example, in Table 5.6, a correlation coefficient of -.800 between population and amount of grain shipped shows that as the hamlets decrease in their economic importance, elevators continue to receive greater amounts of grain.

Table 5.8 is the correlation matrix chart for villages (aggregated). The sign and magnitude of several

Table 5.6

CORRELATION MATRIX - HAMLETS
AGGREGATED (1945-1975)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Total Grain Shipped (X_3)	10 Year Average Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	.882(a)	1.0				
X_2	.953(a)	.884(a)	1.0			
X_3	-.800(a)	-.615	- .661	1.0		
X_4	-.275	-.088	- .115	.698	1.0	
X_5	.920(a)	.951(a)	.911(a)	-.720(a)	- .187	1.0

(a) Using a student t test,

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}},$$

the following simple correlation coefficients were significant at the 5 percent level.

Table 5.7

REGRESSION EQUATION - VILLAGES
AGGREGATED (1945-1975)
MODEL 1

Estimated Equation[a]

$$Y_1 = 116.108 - 4.597X_1^{**} + 12.873X_2^{**}$$
$$(.281) \qquad (3.525)$$
$$- .00008X_3^{*} - .00008X_4 + 1.583X_5^{*}$$
$$(.00004) \quad (.00009) \quad (.418)$$

where:

R^2 = .976 (coefficient of determination)

Standard error of the estimate 4.366

a Figures in parentheses are standard errors of the parameter estimates.

* Statistically significant at 5 percent level, using student t test. The critical value of t is $\pm$ 1.753.

** Statistically significant at 1 percent level, using student t test. The critical value of t is $\pm$ 2.602.

coefficients are similar to the ones observed in the case of hamlets. In short, whether the volume of grain handled increases or decreases, it has no relationship with the growth of the community. Statistically significant negative correlation of -.786 and -.769 between X_3, X_4 and X_5 indicates that the number of permit holders delivering grains to villages is decreasing while the actual volume of grains delivered increases.

Regression Analysis Model 1 for Towns (Aggregated)

Table 5.9 shows the results of correlation analysis conducted on the six towns in the study area from 1945 to 1975. The first major difference between the towns and smaller communities is shown in the lack of negative coefficients between the performance variables and the volume of grain handled by the communities. Figure 4.3 indicates a continuous growth trend in the performance variables with some tapering off in the last several years. For most towns the growth trend has completely stopped. Positive coefficients of .834 and .669 between X_1, X_2 and X_3 respectively, demonstrates that a relationship is apparent between performance variables and grain shipped into towns. A positive relationship of .748 between total number of services and the ten year average of grain shipped does imply some, albeit a weak association between the growth trend of a town and the increased volumes of grain shipped. Another major difference between towns and smaller

Table 5.8

CORRELATION MATRIX - VILLAGES
AGGREGATED (1945-1975)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Total Grain Shipped (X_3)	10 Year Average Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	.755(a)	1.0				
X_2	.654	.937(a)	1.0			
X_3	- .770(a)	- .335	- .132	1.0		
X_4	- .724	- .270	- .089	.934(a)	1.0	
X_5	.806(a)	.410	.197	-.786(a)	-.769(a)	1.0

(a) Using a student t test,

$$t = r\sqrt{n-2}/\sqrt{1-r^2},$$

the following simple correlation coefficients are significant at the 5 percent level.

Table 5.9

CORRELATION MATRIX - TOWNS
AGGREGATED (1945-1975)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Total Grain Shipped (X_3)	10 Year Average Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	.901(a)	1.0				
X_2	.892(a)	.958(a)	1.0			
X_3	.500	.834(a)	.669	1.0		
X_4	.535	.748(a)	.704	.984(a)	1.0	
X_5	.921(a)	.956(a)	.866(a)	.754(a)	.758(a)	1.0

(a) Using a student t test,

$$t = r\sqrt{n-2}\,/\sqrt{1-r^2},$$

the following simple correlation coefficients are significant at the 5 percent level.

communities is demonstrated by the sign and magnitude of the coefficients Y_1 and X_5, and X_1 and X_5 shown by .921 and .956 respectively. In short, these values indicate a significant relationship between the number of permit holders shipping grain to towns and the growth of towns. Mosersky's general conclusion with respect to the size of a service centre and the capabilities of retaining or even increasing grain producers delivering, is substantiated by the correlation coefficients on Tables 5.9 and 5.11.

The results of the time series study for Towns aggregated for the period 1945 to 1975 is shown by Table 5.10. Tests on the statistical significance of parameter estimates showed that total number of services and the diversity of services contribute in explaining the dependent variable, population. In addition, X_5 (number of permit holders) is also related to the growth of towns. The number of permit holders delivering grain to towns has increased over the past several years, and similarly, the population of towns has increased slowly.

Regression Analysis Model 1 for Prairie Farm Cities (Aggregated)

Table 5.11 is the correlation matrix table for the six prairie farm cities aggregated from 1945 to 1975. Several interesting observations can be cited from this table. First, the similarities in the sign and magnitude of most coefficients between towns and prairie farm cities are strong. Secondly, even in the face of growth on the

Table 5.10

REGRESSION EQUATION - TOWNS
AGGREGATED (1945-1975)
MODEL 1

Estimated Equation[a]

$$Y_1 = -288.609 - \underset{(.959)}{7.762X_1}^{*} + \underset{(1.260)}{20.725X_2}^{*} - \underset{(.0003)}{.002X_3}^{**} + \underset{(.0007)}{.002X_4}^{*} + \underset{(3.95)}{8.753X_5}^{+}$$

where:

R^2 = .945 (coefficient of determination)

Standard error of the estimate 37.68

a Figures in parentheses are standard errors of the parameter estimates.

* Statistically significant at 5 percent level, using student t test. The critical value of t is $\pm$ 2.015.

** Statistically significant at 1 percent level, using student t test. The critical value of t is $\pm$ 3.365.

+ Statistically significant at 10 percent level, using a student t test. The critical value of t is $\pm$ 1.476.

Table 5.11

CORRELATION MATRIX - PRAIRIE FARM CITIES
AGGREGATED (1945-1975)
MODEL 1

	Population (Y_1)	Total Services (X_1)	Diversity (X_2)	Total Grain Shipped (X_3)	10 Year Average Shipped (X_4)	Permit Holders (X_5)
Y_1	1.0					
X_1	.946(a)	1.0				
X_2	.905(a)	.945(a)	1.0			
X_3	.699	.653	.705	1.0		
X_4	.609	.710	.662	.949(a)	1.0	
X_5	.838(a)	.946(a)	.929(a)	.831(a)	.748(a)	1.0

(a) Using a student t test,

$$t = r\sqrt{n-2} \,/\sqrt{1-r^2},$$

the following simple correlation coefficients are significant at the 5 percent level.

part of prairie farm city performance variables and grain handled, the association is not significant. For example, correlation coefficients of .699, .653, .609 and .710 demonstrate that some positive relationships exist but they are not significant. Thirdly, the strong relationship between prairie farm city performance variables and the number of farmers delivering grain indicates that even while the number of permit holders is decreasing, the community has managed to attract grain deliverers to use prairie farm city elevator facilities. Table 5.12 shows the results of a time-series study on the six prairie farm cities over a period 1945 to 1975. From the tests of significance of parameter estimates, the total number of services (X_1) and the diversity of services (X_2) contribute to explaining the dependent variable population. On the other hand, the amount of grain shipped into prairie farm cities (X_3) is not statistically significant, and does not help in explaining the performance variables for prairie farm cities.

CORRELATION ANALYSIS MODEL 2

Regression equations and correlation matrices using Model 2 were constructed on each category of communities: hamlets, villages, towns and prairie farm cities. Instead of using performance variables of a community as the indicator of importance, specific services that are closely

Table 5.12

REGRESSION EQUATION - PRAIRIE FARM CITIES
AGGREGATED (1945-1975)
MODEL 1

Estimated Equation[a]

$$Y = 1531.859 + \underset{(4.71)}{16.570X_1}^{*} + \underset{(12.31)}{31.628X_2}^{**} + \underset{(.0004)}{.0004X_3} + \underset{(.0006)}{.003X_4}^{**} + \underset{(6.54)}{13.422X_5}^{\dagger}$$

where:

R^2 = .958 (coefficient of determination)

Standard error of the estimate 87.109

a Figures in parentheses are standard errors of the parameter estimates.

* Statistically significant at 5 percent level, using student t test. The critical value of t is $\pm$ 2.015.

** Statistically significant at 1 percent level, using student t test. The critical value of t is $\pm$ 3.365.

$\dagger$ Statistically significant at 10 percent level, using student t test. The critical value of t is $\pm$ 1.476.

related to the grain industry are used. The general reasoning behind the usage of Model 2 was to add clarification to the relationships that might exist between the grain handling operation and several important agriculturally based services.

Correlation Analysis Model 2 for Hamlets (Aggregated)

Table 5.13 is the correlation matrix table for hamlets for the period 1945 to 1975. As was indicated on Figure 4.1, the number of services of hamlets has continuously decreased over the period 1945 to 1975. A statistically significant positive coefficient of .770 between population (Y_1) and hardware, garage and lumber yards (Z_2) demonstrates this trend. Negative correlation of -.329, -.605, -.064 and -.329 between the variables Z_1 and Z_3, Z_2 and Z_3, Z_3 and Z_4, Z_2 and Z_4 indicate that agriculturally based services and the volume of grain handled by hamlets have a negative relationship. The explanatory variable Z_5, a ratio of agriculturally based services divided by total number of services is used to explain the importance of farm based services with respect to the volume of grain handled. For example, a correlation coefficient of -.678 between amount of grain shipped into hamlets and the ratio of $Z_1 + Z_2/X_1$ demonstrates that the grain handling operation is not related to farm based services. Even though a community may be losing its services and retail outlets, it might be able to at least

Table 5.13

CORRELATION MATRIX - HAMLETS
(AGGREGATED) 1945-1975
AGRICULTURALLY BASED SERVICES
MODEL 2

	Population (Y_1)	Fuel and Implement Dealers (Z_1)	Hardware Garages, Lumber Yards (Z_2)	Amount Grain Shipped (Z_3)	10 Year Average (Z_4)	Ratio Z_1+Z_2/X_1 (Z_5)
Y_1	1.0					
Z_1	.071	1.0				
Z_2	.770(a)	.055	1.0			
Z_3	- .800(a)	-.329	- .605	1.0		
Z_4	- .293	-.064	- .329	.709	1.0	
Z_5	.826(a)	.118	.705	- .678	- .015	1.0

(a) Using a student t test,

$$t = r\sqrt{n-2}\ /\sqrt{1-r^2},$$

the following simple correlation coefficients are significant at a 5 percent level.

retain those services most associated with the grain handling operation. In fact, a coefficient of -.678 indicates that hamlets are losing their farm based services even though the volumes of grain handled has increased.

Correlation Analysis Model 2 for Villages (Aggregated)

Table 5.14, a correlation matrix table from the regression analysis run on the villages in the study area, demonstrates very similar relationships as in the case of hamlets. Firstly, negative coefficients of .432 and .263 between Z_1, Z_3 and Z_4 respectively, indicate that the number of fuel and implement dealers has decreased in the face of continued increases in the amount of grain handled. Secondly, significant coefficients of -.850 and -.878 between Z_2, Z_3 and Z_4 respectively, show that a definite inverse relationship exist between agriculturally based services and the grain handling operation. In short, grain producers who continue to deliver to villages and hamlets are purchasing their farm supplies in larger growth service centres. Thirdly, coefficients of -.746 and -.734 between Z_3 and Z_5, and Z_4 and Z_5 respectively indicate the extent to which farm based services are related to the amount of grain shipped into villages. For most villages, the number of agriculturally based services as a percentage of services offered in a community has decreased while the grain handling operation has increased.

Table 5.14

CORRELATION MATRIX - VILLAGES
(AGGREGATED) 1945-1975
AGRICULTURALLY BASED SERVICES
MODEL 2

	Population (Y_1)	Fuel and Implement Dealers (Z_1)	Hardware Garages, Lumber Yards (Z_2)	Amount Grain Shipped (Z_3)	10 Year Average Grain Shipped (Z_4)	Ratio Z_1+Z_2/X_1 (Z_5)
Y_1	1.0					
Z_1	.748(a)	1.0				
Z_2	.606	.112	1.0			
Z_3	- .770(a)	- .432	- .850(a)	1.0		
Z_4	- .724(a)	- .263	- .878(a)	.934(a)	1.0	
Z_5	.479	.086	.868(a)	- .746(a)	-.734(a)	1.0

(a) Using a student t test,

$$t = r\sqrt{n-2}/\sqrt{1-r^2},$$

the following simple correlation coefficients are significant at a 5 percent level.

Correlation Analysis Model 2 for Towns (Aggregated)

Towns in the study area for the period 1945 to 1975 on Table 5.15, demonstrate different trends from that of villages and hamlets. First, significantly positive coefficients of .818 and .881 between Z_1, Z_2 and Z_3 respectively, indicate that the growth of farm based services in towns is associated indirectly with the volumes of grain handled by towns. However, it is not the volume of shipments that is related to the growth of farm based services, but the centrality of having farm based services in growth oriented centres. In short, the grain producers are using the services offered in major towns at the expense of services offered in smaller communities. Consequently, a major implication arising from this phenomenon is that if the elevator facilities are removed, it will not endanger the economic viability of the remaining farm based services. Secondly, significantly negative coefficients of .864, between Z_1 and Z_5, show that the ratio of farm based services to total services and the number of fuel and implement dealers is inversely related. A coefficient of -.789 between lumber, hardware and garages and the ratio (Z_5) indicates that the percentage of farm based services has decreased as the total number of services has increased. Over the period 1945 to 1975, the population and total number of services increased, but the farm based services did not increase proportionately. In short, the actual growth of the grain handling operation of a town

Table 5.15

CORRELATION MATRIX - TOWNS
(AGGREGATED) 1945-1975
AGRICULTURALLY BASED SERVICES
MODEL 2

	Population (Y_1)	Fuel and Implement Dealers (Z_1)	Hardware Garages, Lumber Yards (Z_2)	Amount Grain Shipped (Z_3)	10 Year Average Grain Shipped (Z_4)	Ratio Z_1+Z_2/X_1 (Z_5)
Y_1	1.0					
Z_1	.913(a)	1.0				
Z_2	.804(a)	.905(a)	1.0			
Z_3	.600	.818(a)	.881(a)	1.0		
Z_4	.635	.853(a)	.915(a)	.984(a)	1.0	
Z_5	-.776(a)	-.864(a)	-.789(a)	-.719	-.765(a)	1.0

(a) Using a student t test,

$$t = r\sqrt{n-2}/\sqrt{1-r^2},$$

the following simple correlation coefficients are significant at a 5 percent level.

does not appear to generate a significant number of agriculturally based services. From Table 5.14, the association between the ratio Z_5 and the ten year average of grain handled by towns represented by -.765 indicates that as the volume of grain handled increases, the percentage of farm based services to total number of services decreases.

Correlation Analysis Model 2 for Prairie Farm Cities (Aggregated)

Table 5.16, the matrix table for the six prairie farm cities (aggregated) for the period 1945 to 1975 demonstrates similar results to Table 5.15 on towns. In short, similar conclusion to those drawn from the matrix table on towns can be made. However, the sample of prairie farm cities (only 6) is too small to perform statistical tests. Therefore the coefficients cannot be tested.

REGRESSION ANALYSIS
MODEL 3

The purpose of Model 3 is to show that distance is responsible to a large extent for the size (number of services) of a community. Models 1 and 2 have shown that the grain handling operation does not explain the performance variables. Christaller demonstrated that distance and population density went a long way to explaining the morphology of rural settlements. Using distance as the

Table 5.16

CORRELATION MATRIX - PRAIRIE FARM CITIES
(AGGREGATED) 1945-1975
AGRICULTURALLY BASED SERVICES
MODEL 2

	Population (Y_1)	Fuel and Implement Dealers (Z_1)	Hardware Garages, Lumber Yards (Z_2)	Amount Grain Shipped (Z_3)	10 Year Average Grain Shipped (Z_4)	Ratio Z_1+Z_2/X_1 (Z_5)
Y_1	1.0					
Z_1	.891	1.0				
Z_2	.861	.850	1.0			
Z_3	.700	.843	.787	1.0		
Z_4	.710	.798	.717	.949	1.0	
Z_5	- .903	- .811	- .835	- .511	- .505	1.0

only explanatory variable, cross-sectional regressions were run using the diversity of services as the dependent variable.

If the economic base is responsible only in part for the size, location and number of communities, what governs the hierarchical distribution and size of central places in the Brandon study area? Several of the independent explanatory variables used in Models 1 and 2 had little contribution to make in explaining the morphology of communities of the study area. One factor that appears to govern the size and strength of a community is the actual distance separating service centres.

The single equation used to investigate the relationship between distance and size was the following:

$$S = a + cD + e$$

where:

S = diversity of service of a community

D = distance between a central place and next nearest higher ordered central place

a = constant

Using cross-sectional data on all four categories of communities in the study area, regressions were run for the following years: 1945, 1948, 1951, 1954, 1957, 1960, 1963, 1966, 1969, 1972 and 1975. Results of regression for each of the years listed above are shown in Table 5.17. Several important observations can be drawn from Table 5.17. First, all coefficients of determination are statistically

significant. Secondly, from observation, most individual coefficients of regression are fairly close to the mean of .751. And thirdly, all parameter estimate are highly significant.

This cross-sectional study for the period 1945 to 1975 indicates that the distance factor has remained an important variable in explaining the size and strength of a community (measured by the independent variable, diversity of services).

In order to demonstrate the consistency and stability of the explanatory variable (distance) the eleven regression equations are plotted on Figure 5.1. The stability and consistency of the regression coefficients are indicated by the closeness of the simple regression lines. In conclusion, it may be stated that the potential of any community is governed by its uniqueness (services) in attracting people. In short, the distance separating communities governs to a large extent the number and diversity of services. The more diversified a community is, the greater is its potential to survive and grow.

Table 5.17

RELATIONSHIP BETWEEN DISTANCE AND SIZE OF COMMUNITIES
REGRESSION EQUATIONS CROSS-SECTIONAL ANALYSIS
MODEL 3

Time	Regression Equation[a]	R^2	Standard Error
1945	S = -.026 + .565D* (.797) (.011)	.972	.140
1948	S = -.010 + .718D* (.251) (.206)	.947	.247
1951	S = -.032 + .743D* (1.459) (.155)	.968	.180
1954	S = .036 + .760D* (.616) (.105)	.986	.128
1957	S = .009 + .729D* (3.76) (.251)	.928	.269
1960	S = -.084 + .778D* (4.10) (.060)	.899	.266
1963	S = .015 + .817D* (2.76) (2.15)	.955	.246
1966	S = .019 + .808D** (.576) (.310)	.912	.385
1969	S = .049 + .784D** (.944) (.325)	.915	.249
1972	S = .033 + .763D* (.694) (.216)	.936	.192
1975	S = .034 + .798D** (1.40) (.324)	.893	.272

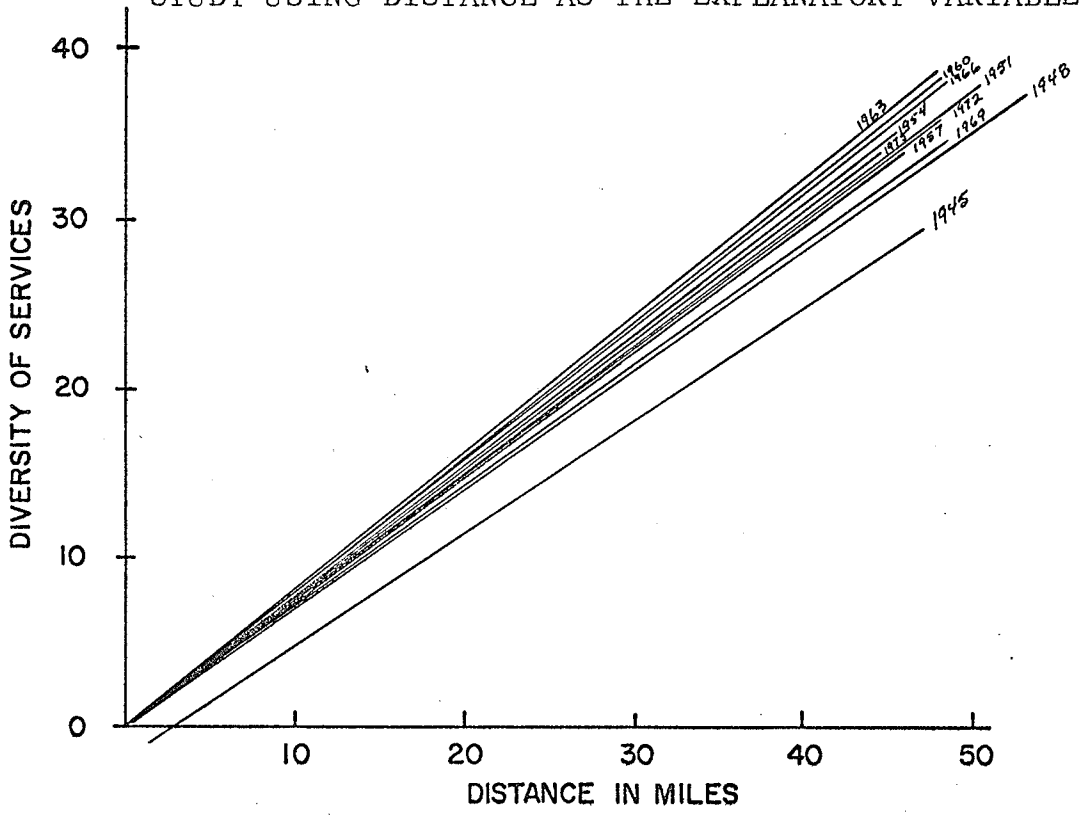
(a) Numbers in parenthesis are the standard errors of the estimates.

* Using a student t test, significant at a 5 percent level

** Significant at a 1 percent level.

Figure 5.1

REGRESSION EQUATIONS (1945-1975) CROSS-SECTIONAL STUDY USING DISTANCE AS THE EXPLANATORY VARIABLE



CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this last chapter is to summarize the results of the correlation and regression analysis and to suggest implications of these results. In addition to the summary of findings, some policy implications are also indicated. A section detailing the limitations of the study is followed by a section on suggestions for further research.

SUMMARY OF FINDINGS

The primary objective of the study was to identify what relationships exist between the grain handling operation at various delivery points and the performance variables of a community. Using a modified central place theory and correlation analysis, regressions were run using Models 1 and 2.

Results from Model 1 for Hamlets show that the performance variables are not significantly related to the grain handling operation. In fact, in the case of Hamlets inverse relationships between the performance variables and the volume of grain handled are shown. Similar results are found in the case of Villages. The correlation matrix table for Towns shows that no statistically

significant relationships exist between the volume of grain handled and the size of Towns. The correlation matrix table for Prairie Farm Cities, illustrates that the performance variables are not related to the volume of grain handled.

Of the total quantity and variety of services offered in a central place, a certain number of these are believed to be strongly associated with grain production. Model 2, set up to investigate the relation between the grain handling operation and the agriculturally based services, provided a means to studying more closely what relationships do exist.

A correlation matrix table was constructed for each category of community. Results for Hamlets indicate that the number of agriculturally based services have continued to decrease even while the volume of grain handled by Hamlets has increased over the years. The matrix table for Villages, demonstrates very similar relationships as in the case of Hamlets. In the case of Towns, the coefficients demonstrate that as the volume of grain shipped has increased, the number of farm based services has also increased. No causality is implied. These coefficients only explain a degree of association. In short, it is not the volume of grain handled that has caused the growth of farm based services, but the centrality and commercial power of growth oriented centres. The major implication of this trend is that eventually only the larger prairie

farm cities will have the farm based services. Historically, all communities had a full complement of farm based services. Today, the small communities are dissociated from the agricultural resource base. Any special program called upon to expand the regional economic base by injecting funds in any but the largest of rural communities will have a negligible effect on their economic viability. There is a strong tendency for migration from smaller to larger rural communities to continue in the future. Irrespective of programs that are set up, their impact could be negligible.

The matrix table for Prairie Farm Cities, shows similar results as in the case of Towns. Statistically significant correlation coefficients between farm based services and the volume of grain handled indicate a positive relationship. Negative correlation coefficients between grain handled by a community and the ratio of farm based services to the total number of services indicate that as the volume of grain handled increases, the ratio decreases. These results are found in all four categories of communities. In short, even though there is a positive relationship between the volume of grain handled and farm based services, as in the case of towns and prairie farm cities, the results are far from convincing. Negative coefficients between Z_4 and Z_5 indicate that non-farm services are increasing at a much faster pace than farm

based services, even though the volume of grain handled has increased.

Results from Model 3, indicate that the distance separating communities explains to a significant extent the size of communities. Results illustrate that all regression equations were statistically significant. In short, the distance separating communities explains to an appreciable extent the number of services offered by communities.

Results from Model 1 and 2 illustrate that no statistically significant relationships exist between the volume of grain handled by a community and its economic performance. Model 3, as an attempt at demonstrating the distance separating communities, explains the size of communities.

CONCLUSIONS AND POLICY IMPLICATION

What are the implications of rationalization for the various communities in the system? The small communities and especially hamlets may feel the economic effects of rail and elevator abandonment, if for no other reason than for the removal of the elevator agent and his family. The larger communities may hardly feel any economic effects due to rationalization. Apart from farmers using the rail services, there are several other types of enterprises that do make use of the railroads. However, the volume of goods, other than grains, has decreased over

the past twenty years. Today, most rural businesses use road transport for the movement of goods.

The future of a community is not governed uniquely by the size of the grain handling operation. Model 3 demonstrated that distance and the diversity of services of a community govern to a large extent its uniqueness in attracting people. Model 2 attempted to show that the agriculturally based services should at least be related to the volume of grain shipped into a community. However, the results indicate that most farm related services tended to agglomerate in communities that had a greater diversity of services. Such results indicate that farmers may be marketing their grain locally, but are purchasing farm supplies in larger regional growth centres.

Rural community inhabitants and resident farmers, not only in the Brandon region, but in all the prairie provinces are becoming more aware than ever of the conveniences and variety of goods offered in major growth centres. Better roads, more efficient means of transportation and the savings from volume buying have facilitated the mobility of rural residents. Result is a tendency for the gradual decrease in the economic importance of smaller communities. In the event of the removal of certain low density rail lines and the subsequent elevator abandonment, the economic implications for most communities will be negligible.

In the past several years, most governments have instituted programs to expand and improve the regional economic resource base. The fact that such programs as DREE and FRED are never called upon to inject the necessary capital in any but the largest of rural communities indicates that, in the case of smaller communities, the costs may perhaps outweigh the benefits. In other words, irrespective of what policy tools are used to strengthen the economic viability of any but the larger communities, its effects may be negligible. Currently, the Province of Manitoba is providing rural communities with a water and sewage disposal program. Under this program, any community can apply for financial assistance in order to put in a community well and subsequent sewage disposal facilities. The criteria used in evaluating which rural communities are eligible is based on several community performance factors of which size, population and tax base are the most important. The weighting system for priorities used, favours larger communities. Review of the program substantiates the fact that only economically viable communities have benefited from the program. This study showed that the centrality of a community has an important contributory effect for growth. Any efforts directed at improving the viability of any but the large centres may not prove beneficial. In addition, capital injected and directed at smaller communities will eventually trickle up to the prairie farm cities.

LIMITATIONS OF THE STUDY

This study does contain a number of recognizable limitations and, for future researchers, they are brought to light here. The limitations of this study are divided into two categories: those dealing with regression analysis and those dealing with the central place theory.

Perhaps the most damaging limitations of the study concern the compilation of data and the aggregation of this data. The communities surrounding the Brandon study area were grouped into four categories. Two points are important with respect to using regression analysis on grouped data. Variance estimates from grouped data are larger than with ungrouped data. This is due to the loss of information included in the variation of the observations within the sample, which is unknown if the data are given in grouped form. Second, the overall correlation coefficients in the "grouped" model are higher than in the ungrouped regression. The higher the degree of aggregation the stronger the correlation will appear to be. This is due to the fact that the group means tend to cluster closer around the regression line. Briefly, the explanatory variables must be measured without error. Apart from the usual stochastic assumptions of ordinary least squares, the explanatory variables must not be linearly correlated. Two specific explanatory variables show cause for concern with

respect to linear correlation: the total number of services and the diversity of services.

In addition to the two statistical limitations, "grouped" data (aggregated) pose several basic problems elaborated in Chapter 4. In averaging and grouping communities into specific categories, differences in demography, economic resource base, and geography are not taken into consideration.

The other primary source of limitations rests with the "central place theory" developed by Christaller and modified to meet the specifications of this study. Limitations with respect to central place theory rest with the assumptions used. The first assumption that is questionable is that of a homogeneous plain with equal access in all directions; in other words, the free movement between central places. A strict mathematical scheme of central place hierarchy is as imperfect as the simplifying assumptions. In the area under study, changes occur in the nature and prices of goods and services, in population and in purchasing power, and in the quality and costs of transportation; that is, the parameters determining threshold, range and profitability change.

The system of central places developed on the basis of range of central goods uses the assumption that all areas are able to be served from a minimum of central places. This Christaller called the "marketing or supply principle." But there are other factors. The principles

of traffic say that the distribution of central places is at an optimum where as many important places as possible lie on one traffic route. Principles of traffic are fundamentally linear, those of marketing spatial. The political-social principles are based upon ideas of separation for purposes of protection, religion or political affiliations. Briefly, the traffic and political-social principles distort the validity of the assumptions.

In addition to the limitations mentioned above, it must be remembered that the model is basically a static framework. For this reason, Christaller's theory suffers from the same limitations as do other static location theories.

SUGGESTIONS FOR FURTHER RESEARCH

As emphasized in this study, rationalization of the grain handling and transportation system is a social as well as an economic problem. While the scope of this study was to specifically look at the economic effects abandonment has on rural communities, the social effects were not studied. It is becoming increasingly important that the social life of a community is relevant when one is studying the entire picture of rural community life. In the light of this observation, it would seem fair to suggest that a closer investigation at the social level and the possible effects there might be from rationalization would prove to be a worthwhile project.

Another possible area of research would be to investigate those communities situated on low density lines and study the direct effects rationalization might have on communities. Such direct effects as the loss of related business, elevator agents, loss of municipal tax revenue, and the changes needed in the road network could prove to be worthwhile projects for investigation.

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APPENDIX A

Regression Equation and Correlation Matrix for Each Hamlet

TABLE A1

REGRESSION EQUATION AND CORRELATION MATRIX FOR WELLWOOD (1945-1975)

Regression Equation:

$$Y_1 = \underset{(12.02)}{80.433} - \underset{(.155)}{7.039X_1}^{(a)} + \underset{(.156)}{13.215X_2}^{(a)} - \underset{(.0001)}{.001X_3} - \underset{(.0005)}{.0005X_4} + \underset{(.544)}{1.570X_5}$$

$$R^2 = .827$$

Standard error of estimate = 9.888

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.522	1.0				
X_2	- .252	.356	1.0			
X_3	- .0005	.330	.093	1.0		
X_4	.431	.507	- .147	- .111	1.0	
X_5	.854[(b)]	.632	- .385	.199	.618	1.0

(a) Using a student t test, the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A2

REGRESSION EQUATION AND CORRELATION MATRIX FOR FORREST (1945-1975)

Regression Equation:

$$Y_1 = \underset{(.118)}{11.002} - \underset{(8.70)}{5.708X_1} + \underset{(.00006)}{.005X_2}^{(a)}$$

$$\underset{(.0004)}{-.00005X_3} - \underset{(.0001)}{.00004X_4} + \underset{(.390)}{.682X_5}$$

$$R^2 = .511$$

Standard error of estimate = 11.877

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	- .325	1.0				
X_2	- .240	.878[b]	1.0			
X_3	- .201	.595	.421	1.0		
X_4	- .457	.739[b]	.514	.502	1.0	
X_5	.203	.656	.552	.657	.375	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A3

REGRESSION EQUATION AND CORRELATION MATRIX FOR LAUDER (1945-1975)

Regression Equation:

$$Y_1 = \underset{(11.537)}{-135.592} + \underset{(3.38)}{21.699X_1}^{(a)} + \underset{(6.57)}{8.339X_2} + \underset{(.0001)}{+.001X_3} + \underset{(.0004)}{.0004X_4} + \underset{(.355)}{.390X_5}$$

$$R^2 = .899$$

Standard error of estimate = 11.438

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.881[(b)]	1.0				
X_2	.909[(b)]	.910[(b)]	1.0			
X_3	- .327	- .385	- .478	1.0		
X_4	.169	.104	- .005	.034	1.0	
X_5	.808[(b)]	.713	.817[(b)]	- .536	.021	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A4

REGRESSION EQUATION AND CORRELATION MATRIX FOR GRISWOLD (1945-1975)

Regression Equation:

$$Y_1 = \underset{(9.58)}{-6.578} + \underset{(5.67)}{7.578X_1} + \underset{(5.66)}{27.906X_2}{}^{(a)} \underset{(.0001)}{-.00007X_3} + \underset{(.0002)}{.0001X_4} + \underset{(.343)}{.599X_5}$$

$$R^2 = .902$$

Standard error of estimate = 13.686

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.881(b)	1.0				
X_2	.874(b)	.922(b)	1.0			
X_3	-.742(b)	-.652	-.601	1.0		
X_4	-.373	-.248	-.271	.647	1.0	
X_5	.438	.119	.234	-.453	-.554	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A5

REGRESSION EQUATION AND CORRELATION MATRIX FOR MEDORA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(8.749)}{147.04} + \underset{(4.368)}{5.924X_1} - \underset{(4.894)}{16.926X_2}{}^{(a)}$$

$$+ \underset{(.0005)}{.0005X_3} - \underset{(.0001)}{.001X_4} - \underset{(.484)}{.359X_5}$$

$$R^2 = .677$$

Standard error of estimate = 8.119

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.379	1.0				
X_2	.006	.856(b)	1.0			
X_3	- .671	- .417	- .071	1.0		
X_4	- .729(b)	- .469	- .122	.960(b)	1.0	
X_5	- .501	- .253	- .038	.843(b)	.724	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A6

REGRESSION EQUATION AND CORRELATION MATRIX FOR NESBITT (1945-1975)

Regression Equation:

$$Y_1 = \underset{(6.73)}{68.055} - \underset{(5.23)}{44.523X_1}^{(a)} + \underset{(6.700)}{1.970X_2} - \underset{(.0004)}{.00008X_3} - \underset{(.00008)}{.0006X_4} + \underset{(.318)}{.440X_5}$$

$$R^2 = .811$$

Standard error of estimate = 5.642

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.352	1.0				
X_2	.320	.932[b]	1.0			
X_3	- .860[b]	- .491	- .340	1.0		
X_4	- .790[b]	- .638	- .502	.953[b]	1.0	
X_5	.723	.594	.646	- .591	- .624	1.0

(a) Using a student t test the following regression coefficients are significant at 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A7

REGRESSION EQUATION AND CORRELATION MATRIX FOR MARGARET (1945-1975)

Regression Equation:

$$Y_1 = 93.68 + \underset{(.421)}{.4351X_1}^{(a)} - \underset{(.929)}{.996X_2} - \underset{(.0001)}{.00003X_3} - \underset{(.0002)}{.0001X_4} - \underset{(.912)}{1.401X_5}$$

$$R^2 = .619$$

Standard error of estimate = 7.486

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.463	1.0				
X_2	.406	.932[b]	1.0			
X_3	- .649	- .148	- .157	1.0		
X_4	- .706	.212	- .152	.831[b]	1.0	
X_5	.738[b]	.381	.332	- .903[b]	- .905[b]	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A8

CORRELATION MATRIX FOR BELLEVIEW (1945-1975)

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.813(b)	1.0				
X_2	.813(b)	1.0	1.0			
X_3	.401	.501	.501	1.0		
X_4	.635	.586	.586	.608	1.0	
X_5	.708	.828(b)	.828(b)	.785(b)	.777(b)	1.0

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE A9

CORRELATION MATRIX FOR FRANKLIN (1945-1975)

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.873(b)	1.0				
X_2	.873(b)	1.0	1.0			
X_3	.622	.726	.726	1.0		
X_4	.786(b)	.959(b)	.959(b)	.652	1.0	
X_5	.861(b)	.857(b)	.857(b)	.415	.805(b)	1.0

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

APPENDIX B

Regression Equation and Correlation Matrix for Each Village

TABLE B1

REGRESSION EQUATION AND CORRELATION MATRIX FOR MINTO (1945-1975)

Regression Equation:

$$Y_1 = \underset{(8.366)}{105.957} - \underset{(2.07)}{4.714X_1}^{(a)} + \underset{(4.74)}{3.072X_2} - \underset{(.00003)}{.00007X_3} - \underset{(.0001)}{.00006X_4} + \underset{(.3436)}{.774X_5}^{(a)}$$

$$R^2 = .973$$

Standard error of estimate = .973

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.767(b)	1.0				
X_2	.713	.932(b)	1.0			
X_3	- .278	- .527	- .387	1.0		
X_4	- .738(b)	- .411	- .194	.889(b)	1.0	
X_5	.934(b)	.794(b)	.808(b)	- .708(b)	- .555	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B2

REGRESSION EQUATION AND CORRELATION MATRIX FOR PIPESTONE (1945-1975)

Regression Equation:

$$Y_1 = \underset{}{292.06} - \underset{(17.377)}{5.336X_1} + \underset{(9.088)}{3.975X_2} + \underset{(.0002)}{.00002X_3} - \underset{(.0003)}{.002X_4} - \underset{(.487)}{.057X_5}$$

$$R^2 = .379$$

Standard error of estimate = 12.582

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.098	1.0				
X_2	.013	.904(b)	1.0			
X_3	- .435	- .765(b)	- .563	1.0		
X_4	- .502	- .649	- .405	.966(b)	1.0	
X_5	- .448	- .049	.148	.465	.502	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B3

REGRESSION EQUATION AND CORRELATION MATRIX FOR BROOKDALE (1945-1975)

Regression Equation:

$$Y_1 = \underset{(18.577)}{203.177} + \underset{(6.344)}{2.139X_1} - \underset{(10.913)}{18.361X_2}{}^{(a)} + \underset{(.0002)}{.00008X_3} - \underset{(.0002)}{.0002X_4} + \underset{(1.016)}{.045X_5}$$

$$R^2 = .620$$

Standard error of estimate = 22.088

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.340	1.0				
X_2	.163	.833[b]	1.0			
X_3	- .629	- .213	.036	1.0		
X_4	- .779[b]	- .321	- .148	.796[b]	1.0	
X_5	.067	.377	.473	- .363	- .052	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B4

REGRESSION EQUATION AND CORRELATION MATRIX FOR DUNREA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(19.486)}{182.592} + \underset{(8.140)}{10.018X_1} + \underset{(7.798)}{17.533X_2}{}^{(a)} - \underset{(.0001)}{.00003X_3} - \underset{(.0003)}{.0005X_4} + \underset{(.767)}{1.403X_5}{}^{(a)}$$

$$R^2 = .908$$

Standard error of estimate = 18.040

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	- .223	1.0				
X_2	- .524	.860(b)	1.0			
X_3	- .896(b)	.315	.622	1.0		
X_4	- .893(b)	.411	.681	.928(b)	1.0	
X_5	.720	- .730(b)	- .837(b)	- .738(b)	- .729	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B5

REGRESSION EQUATION AND CORRELATION MATRIX FOR WASKADA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(23.934)}{280.928} + \underset{(6.34)}{7.191X_1} + \underset{(7.830)}{19.275X_2}{}^{(a)} - \underset{(.00008)}{.00003X_3} - \underset{(.0002)}{.0005X_4} - \underset{(1.280)}{2.051X_5}$$

$$R^2 = .940$$

Standard error of estimate = 20.506

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.699	1.0				
X_2	- .115	.534	1.0			
X_3	- .691	- .699	- .240	1.0		
X_4	- .451	- .684	- .619	.726[(b)]	1.0	
X_5	.834[(b)]	.414	- .436	- .380	.251	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B6

REGRESSION EQUATION AND CORRELATION MATRIX FOR ELGIN (1945-1975)

Regression Equation:

$$Y_1 = \underset{(28.040)}{370.328} + \underset{(5.664)}{4.740X_1} + \underset{(7.097)}{4.080X_2} - \underset{(.0001)}{.0001X_3} - \underset{(.0003)}{.0003X_4} - \underset{(2.371)}{.379X_5}$$

$$R^2 = .573$$

Standard error of estimate = 23.923

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.586	1.0				
X_2	.077	.673	1.0			
X_3	- .567	- .771(b)	- .398	1.0		
X_4	- .670	- .753(b)	- .286	.954(b)	1.0	
X_5	.264	.251	.128	- .210	- .345	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B7

REGRESSION EQUATION AND CORRELATION MATRIX FOR OAK RIVER (1945-1975)

Regression Equation:

$$Y_1 = \underset{(9.506)}{105.515} - \underset{(2.124)}{3.761X_1} + \underset{(3.681)}{3.994X_2} + \underset{(.00007)}{.00009X_3} - \underset{(.0001)}{.00004X_4} + \underset{(.745)}{1.043X_5}$$

$$R^2 = .631$$

Standard error of estimate = 8.535

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.516	1.0				
X_2	.600	.905(b)	1.0			
X_3	- .106	- .460	- .380	1.0		
X_4	- .244	- .398	- .377	.916(b)	1.0	
X_5	.347	.409	.316	- .846(b)	- .878(b)	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B8

REGRESSION EQUATION AND CORRELATION MATRIX FOR KENTON (1945-1975)

Regression Equation:

$$Y_1 = \underset{(6.772)}{140.391} + \underset{(1.129)}{2.533X_1}^{(a)} + \underset{(2.630)}{1.215X_2} - \underset{(.0003)}{.00002X_3} - \underset{(.00002)}{.0001X_4} + \underset{(.429)}{.464X_5}$$

$$R^2 = .768$$

Standard error of estimate = 5.991

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.709	1.0				
X_2	.558	.900(b)	1.0			
X_3	- .143	.281	.312	1.0		
X_4	- .241	.264	.319	.752(b)	1.0	
X_5	- .468	- .870(b)	- .940(b)	- .329	- .303	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B9

REGRESSION EQUATION AND CORRELATION MATRIX FOR RESTON (1945-1975)

Regression Equation:

$$Y_1 = \underset{(4.352)}{152.474} + \underset{(.307)}{5.613X_1}^{(a)} + \underset{(.907)}{3.139X_2}^{(a)} - \underset{(.0002)}{.00007X_3} + \underset{(.00003)}{.00007X_4} + \underset{(.284)}{2.570X_x}^{(a)}$$

$$R^2 = .992$$

Standard error of estimate = 3.512

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.707	1.0				
X_2	.919(b)	.805(b)	1.0			
X_3	.421	.363	.556	1.0		
X_4	.494	.420	.598	.956(b)	1.0	
X_5	.897(b)	.619	.723(b)	.022	.095	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B10

REGRESSION EQUATION AND CORRELATION MATRIX FOR WAWANESA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(16.967)}{116.712} + \underset{(2.944)}{14.542X_1}^{(a)} + \underset{(4.398)}{4.760X_2} - \underset{(.00012)}{.0001X_3} - \underset{(.003)}{.0005X_4} + \underset{(1.123)}{2.325X_5}^{(a)}$$

$$R^2 = .938$$

Standard error of estimate = 11.670

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.654	1.0				
X_2	.899(b)	.873(b)	1.0			
X_3	.405	- .109	.212	1.0		
X_4	.352	- .110	.181	.864(b)	1.0	
X_5	.782(b)	.297	.612	.599	.299	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B11

REGRESSION EQUATION AND CORRELATION MATRIX FOR NAPINKA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(5.924)}{130.235} + \underset{(3.164)}{9.103X_1}^{(a)} + \underset{(4.513)}{10.480X_2}^{(a)} - \underset{(.00008)}{.0008X_3} - \underset{(.0001)}{.0001X_4} + \underset{(.305)}{.615X_5}$$

$$R^2 = .901$$

Standard error of estimate = 13.702

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.655	1.0				
X_2	.788(b)	.722(b)	1.0			
X_3	- .634	- .264	- .366	1.0		
X_4	- .571	- .084	- .327	.539	1.0	
X_5	.637	.405	.240	- .404	- .342	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B12

REGRESSION EQUATION AND CORRELATION MATRIX FOR ALEXANDER (1945-1975)

Regression Equation:

$$Y_1 = \underset{}{215.245} + \underset{(18.878)}{13.526X_1} - \underset{(16.364)}{3.106X_2} + \underset{(.0001)}{.00008X_3} - \underset{(.0003)}{.00009X_4} - \underset{(1.171)}{.527X_5}$$

$$R^2 = .464$$

Standard error of estimate = 27.188

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.635	1.0				
X_2	.621	.928(b)	1.0			
X_3	- .206	- .567	- .474	1.0		
X_4	- .262	- .454	- .329	.438	1.0	
X_5	.208	.441	.188	- .128	- .572	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B13

REGRESSION EQUATION AND CORRELATION MATRIX FOR OAK LAKE (1945-1975)

Regression Equation:

$$Y_1 = \underset{(32.743)}{457.233} + \underset{(6.434)}{21.482X_1}^{(a)} + \underset{(11.534)}{34.963X_2}^{(a)} - \underset{(.0002)}{.0002X_3} - \underset{(.0006)}{.0010X_4} + \underset{(.447)}{1.871X_5}^{(a)}$$

$$R^2 = .936$$

Standard error of estimate = 20.563

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.208	1.0				
X_2	.135	.911(b)	1.0			
X_3	.179	- .354	- .206	1.0		
X_4	.723(b)	- .040	.261	- .093	1.0	
X_5	.858(b)	.054	.302	- .017	.786(b)	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B14

REGRESSION EQUATION AND CORRELATION MATRIX FOR LENORE (1945-1975)

Regression Equation:

$$Y_1 = \underset{(11.245)}{28.177} + \underset{(1.235)}{.895X_1} - \underset{(1.053)}{6.758X_2}{}^{(a)} - \underset{(.00008)}{.0001X_3} + \underset{(.0001)}{.0001X_4} + \underset{(.570)}{1.123X_5}$$

$$R^2 = .902$$

Standard Error of estimate = 14.059

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.510	1.0				
X_2	.063	.742(b)	1.0			
X_3	- .797(b)	- .569	- .386	1.0		
X_4	- .273	- .320	- .329	.436	1.0	
X_5	.899(b)	.643	.159	- .711	- .377	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE B15

REGRESSION EQUATION AND CORRELATION MATRIX FOR NINETTE (1945-1975)

Regression Equation:

$$Y_1 = \underset{(7.567)}{382.964} + \underset{(4.041)}{15.961X_1}^{(a)} + \underset{(3.980)}{24.532X_2}^{(a)} - \underset{(.0001)}{.0002X_3} - \underset{(.0002)}{.0001X_4} + \underset{(.385)}{5.592X_5}^{(a)}$$

$$R^2 = .991$$

Standard error of estimate = 8.201

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.076	1.0				
X_2	.153	.843(b)	1.0			
X_3	- .359	.375	.556	1.0		
X_4	- .366	.273	.507	.947(b)	1.0	
X_5	.753(b)	- .012	.309	.251	.259	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

APPENDIX C

Regression Equation and Correlation Matrix for Each Town

TABLE C1

REGRESSION EQUATION AND CORRELATION MATRIX FOR RAPID CITY (1945-1975)

Regression Equation:

$$Y_1 = \underset{(43.43)}{356.850} - \underset{(7.480)}{2.385X_1} + \underset{(9.656)}{10.117X_2} - \underset{(.0002)}{.0005X_3} - \underset{(.0007)}{.0003X_4} + \underset{(1.807)}{.622X_5}$$

$$R^2 = .307$$

Standard error of estimate = 50.495

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.316	1.0				
X_2	.450	.557	1.0			
X_3	- .243	- .372	- .032	1.0		
X_4	- .325	- .330	- .103	.551	1.0	
X_5	.260	.690	.143	- .449	- .429	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE C2

REGRESSION EQUATION AND CORRELATION MATRIX FOR BOISSEVAIN (1945-1975)

Regression Equation:

$$Y_1 = \underset{(117.00)}{138.339} + \underset{(.702)}{6.687X_1}^{(a)} + \underset{(16.400)}{27.341X_2}$$

$$+ \underset{(.0003)}{.0004X_3} + \underset{(.0005)}{.0003X_4} - \underset{(3.185)}{1.990X_5}$$

$$R^2 = .902$$

Standard error of estimate = 95.156

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.893(b)	1.0				
X_2	.920(b)	.859(b)	1.0			
X_3	.829(b)	.804(b)	.789(b)	1.0		
X_4	.778(b)	.697	.740(b)	.943(b)	1.0	
X_5	.757(b)	.919(b)	.741(b)	.674	.494	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE C3

REGRESSION EQUATION AND CORRELATION MATRIX FOR SOURIS (1945-1975)

Regression Equation:

$$Y_1 = \underset{(107.17)}{56.755} + \underset{(5.123)}{25.762X_1}^{(a)} + \underset{(2.230)}{11.480X_2}^{(a)} - \underset{(.0004)}{.0001X_3} + \underset{(.0008)}{.0005X_4} + \underset{(2.136)}{4.323X_5}$$

$$R^2 = .878$$

Standard error of estimate = 77.770

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.760(b)	1.0				
X_2	.636	.902(b)	1.0			
X_3	.240	.706	.712	1.0		
X_4	.395	.705	.815(b)	.840(b)	1.0	
X_5	.281	- .275	- .461	- .726(b)	- .616	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE C4

REGRESSION EQUATION AND CORRELATION MATRIX FOR HARTNEY (1945-1975)

Regression Equation:

$$Y_1 = \underset{(74.677)}{554.648} + \underset{(7.222)}{7.406X_1} + \underset{(1.411)}{5.481X_2}{}^{(a)} - \underset{(.0004)}{.0005X_3} + \underset{(.001)}{.002X_4} - \underset{(2.993)}{3.329X_5}$$

$$R^2 = .765$$

Standard error of estimate = 28.295

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.672	1.0				
X_2	.508	.941(b)	1.0			
X_3	.864(b)	.717	.620	1.0		
X_4	.397	.550	.659	.992(b)	1.0	
X_5	- .223	.312	.538	.187	.242	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE C5

REGRESSION EQUATION AND CORRELATION MATRIX FOR GLENBORO (1945-1975)

Regression Equation:

$$Y_1 = \underset{(112.56)}{-\ 484.067} + \underset{(1.609)}{14.258X_1}^{(a)} + \underset{(3.061)}{39.095X_2}^{(a)}$$

$$\underset{(.0002)}{.0003X_3} - \underset{(.0005)}{.0001X_4} + \underset{(2.158)}{2.484X_5}$$

$R^2 = .967$

Standard error of estimate = 47.328

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.861(b)	1.0				
X_2	.741(b)	.980(b)	1.0			
X_3	.208	.552	.451	1.0		
X_4	.082	.556	.517	.813(b)	1.0	
X_5	.320	- .251	- .312	- .473	- .681	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE C6

REGRESSION EQUATION AND CORRELATION MATRIX FOR DELORAINE (1945-1975)

Regression Equation:

$$Y_1 = \underset{(44.369)}{563.120} + \underset{(3.481)}{8.367X_1}^{(a)} + \underset{(9.020)}{5.358X_2} - \underset{(.0002)}{.00004X_3} - \underset{(.0004)}{.0001X_4} - \underset{(.828)}{5.681X_5}^{(a)}$$

$$R^2 = .881$$

Standard error of estimate = 39.734

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.834(b)	1.0				
X_2	.810(b)	.909(b)	1.0			
X_3	.601	.855(b)	.754(b)	1.0		
X_4	.675	.903(b)	.867(b)	.964(b)	1.0	
X_5	.700	.924(b)	.850(b)	.829(b)	.878(b)	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

APPENDIX D

Regression Equation and Correlation Matrix for Each Prairie Farm City

TABLE D1

REGRESSION EQUATION AND CORRELATION MATRIX FOR MINNEDOSA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(245.85)}{127.474} + \underset{(9.812)}{4.555X_1} + \underset{(5.159)}{35.851X_2}{}^{(a)} + \underset{(.0011)}{.0005X_3} + \underset{(.0009)}{.0001X_4} - \underset{(8.642)}{2.461X_5}$$

$$R^2 = .914$$

Standard error of estimate = 134.500

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.874(b)	1.0				
X_2	.892(b)	.977(b)	1.0			
X_3	.543	.252	.317	1.0		
X_4	.139	- .204	- .201	.536	1.0	
X_5	.494	.210	.238	.942(b)	.661	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE D2

REGRESSION EQUATION AND CORRELATION MATRIX FOR NEEPAWA (1945-1975)

Regression Equation:

$$Y_1 = \underset{(381.456)}{295.551} + \underset{(6.819)}{24.619X_1}^{(a)} + \underset{(5.594)}{32.911X_2}^{(a)} + \underset{(.0025)}{.002X_3} + \underset{(.0008)}{.008X_4} + \underset{(8.919)}{17.314X_5}^{(a)}$$

$$R^2 = .926$$

Standard error of estimate = 126.919

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.899(b)	1.0				
X_2	.910(b)	.916(b)	1.0			
X_3	.567	.349	.318	1.0		
X_4	.294	- .100	.286	.597	1.0	
X_5	.786(b)	.510	.694	.938(b)	.761(b)	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE D3

REGRESSION EQUATION AND CORRELATION MATRIX FOR KILLARNEY (1945-1975)

Regression Equation:

$$Y_1 = \underset{(112.48)}{150.569} + \underset{(5.569)}{14.943X_1}^{(a)} + \underset{(2.469)}{18.956X_2}^{(a)} - \underset{(.0002)}{.0001X_3} + \underset{(.0005)}{.0007X_4} - \underset{(1.315)}{2.785X_5}^{(a)}$$

$$R^2 = .971$$

Standard error of estimate = 88.893

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.925(b)	1.0				
X_2	.950(b)	.953(b)	1.0			
X_3	.679	.762(b)	.674	1.0		
X_4	.886(b)	.722	.667	.975(b)	1.0	
X_5	.844(b)	.915(b)	.885(b)	.715	.685	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE D4

REGRESSION EQUATION AND CORRELATION MATRIX FOR VIRDEN (1945-1975)

Regression Equation:

$$Y_1 = \underset{(264.88)}{1363.622} + \underset{(8.092)}{30.228X_1}^{(a)} + \underset{(6.176)}{78.203X_2}^{(a)} - \underset{(.002)}{.003X_3} - \underset{(.002)}{.0006X_4} + \underset{(1.003)}{9.598X_5}^{(a)}$$

$$R^2 = .860$$

Standard error of estimate = 30.561

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.840(b)	1.0				
X_2	.775(b)	.915(b)	1.0			
X_3	.499	.810(b)	.794	1.0		
X_4	.481	.744(b)	.731	.928(b)	1.0	
X_5	.460	.743(b)	.769(b)	.961(b)	.905(b)	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE D5

REGRESSION EQUATION AND CORRELATION MATRIX FOR MELITA (1945-1975)

Regression Equation:

$$Y_1 = \underset{}{-247.321} + \underset{(172.77)}{6.985X_1} + \underset{(4.554)}{21.811X_2}^{(a)} \underset{(3.613)}{}$$

$$\underset{}{-.0003X_3} - \underset{(.0007)}{.0001X_4} + \underset{(.0009)}{11.329X_5}^{(a)} \underset{(4.312)}{}$$

$$R^2 = .891$$

Standard error of estimate = 93.685

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.899(b)	1.0				
X_2	.938(b)	.955(b)	1.0			
X_3	.730(b)	.913(b)	.802(b)	1.0		
X_4	.736(b)	.758(b)	.810(b)	.940(b)	1.0	
X_5	.819(b)	.877(b)	.855(b)	.829(b)	.841(b)	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

TABLE D6

REGRESSION EQUATION AND CORRELATION MATRIX FOR CARBERRY (1945-1975)

Regression Equation:

$$Y_1 = \underset{(90.592)}{972.342} + \underset{(7.479)}{21.971X_1}^{(a)} + \underset{(1.511)}{18.305X_2}^{(a)} - \underset{(.001)}{.0007X_3} + \underset{(.003)}{.002X_4} - \underset{(5.581)}{8.516X_5}$$

$$R^2 = .940$$

Standard error of estimate = 62.877

Correlation Matrix:

	Y_1	X_1	X_2	X_3	X_4	X_5
Y_1	1.0					
X_1	.925(b)	1.0				
X_2	.947(b)	.945(b)	1.0			
X_3	.207	.381	.163	1.0		
X_4	- .018	- .091	- .101	- .314	1.0	
X_5	- .942(b)	- .953(b)	- .918(b)	- .372	.107	1.0

(a) Using a student t test the following regression coefficients are significant at a 5 percent level.

(b) Using a student t test, $t = r\sqrt{n-2}/\sqrt{1-r^2}$, the following simple correlation coefficients are significant at a 5 percent level.

APPENDIX E

Regression Equation on Population for Each Community

APPENDIX E

Statistics on population of rural communities is available only on census years. Population figures for non-census years were interpolated by constructing linear regression lines for each community in question. Over 25 communities which are too small to classify have no available data; and for this reason no regressions were run.

A single equation linear regression model was used, for which the following equation is:

$$Y = a + b_1 x_1 + c$$

where:

a = constant

b_1 = regression coefficient

Y = population

x_1 = year

Results from the linear regression are on Table E-1.

TABLE E1

REGRESSION EQUATION ON POPULATION FOR EACH COMMUNITY IN BRANDON STUDY AREA (1941-1971)

Community	Regression Equation	Coefficient of Determination
Carberry	$Y = 676 + 6.71X_1$**	$R^2 = .784$
Killarney	$Y = -7133 + 151.7X_1$*	$R^2 = .874$
Elgin	$Y = 677.6 - 6.60X_1$**	$R^2 = .789$
Minto	$Y = 451.0 - 4.80X_1$*	$R^2 = .934$
Glenboro	$Y = 329.0 + 7.12X_1$	$R^2 = .519$
Boissevain	$Y = -228.0 + 24.87X_1$*	$R^2 = .864$
Wawanesa	$Y = 401.0 + 1.01X_1$**	$R^2 = .612$
Rapid City	$Y = 238.3 - 3.29X_1$**	$R^2 = .634$
Deloraine	$Y = -5034 + 99.9X_1$**	$R^2 = .739$
Souris	$Y = 1301 + 8.90X_1$	$R^2 = .601$
Ninette	$Y = 1528 - 16.36X_1$**	$R^2 = .710$
Medora	$Y = 92 - .04X_1$	$R^2 = .241$
Griswold	$Y = 310 - 2.91X_1$*	$R^2 = .920$
Lauder	$Y = 226.7 - 2.51X_1$*	$R^2 = .936$
Lenore	$Y = 253.4 - 2.63X_1$*	$R^2 = .943$
Holmfield	$Y = 181.3 - 1.25X_1$**	$R^2 = .739$
Hartney	$Y = 460.0 + 9.60X_1$	$R^2 = .590$
Pipestone	$Y = 209 - 1.46X_1$	$R^2 = .463$

(continued)

TABLE E1--continued

Community	Regression Equation	Coefficient of Determination
Reston	$Y = 210.6 + 2.19X_1$	$R^2 = .633$
Oak Lake	$Y = 914.3 - 9.18X_1$*	$R^2 = .992$
Oak River	$Y = 281.6 - .381X_1$**	$R^2 = .711$
Alexander	$Y = 249.9 + .118X_1$**	$R^2 = .761$
Napinka	$Y = 519.9 - 5.18X_1$ *	$R^2 = .919$
Kenton	$Y = 486.2 - 5.78X_1$**	$R^2 = .617$
Belmont	$Y = 854.0 - 8.64X_1$*	$R^2 = .974$
Elgin	$Y = 1116.6 - 14.60X_1$	$R^2 = .478$
Forrest	$Y = 11.65 + .945X_1$	$R^2 = .455$
Dunrea	$Y = 328.2 - 2.25X_1$*	$R^2 = .954$
Nesbitt	$Y = 145.5 - 1.18X_1$*	$R^2 = .850$
Margaret	$Y = 129.4 - 1.96X_1$	$R^2 = .612$
Melita	$Y = 634.4 + 5.55X_1$**	$R^2 = .690$
Minnedosa	$Y = 564.0 + 28.30X_1$	$R^2 = .620$
Neepawa	$Y = 791.4 + 26.91X_1$**	$R^2 = .711$
Virden	$Y = 115.3 + 45.39X_1$**	$R^2 = .659$
Fairfax	$Y = 81.47 - .702X_1$**	$R^2 = .777$
Ninga	$Y = 444.9 - 5.26X_1$*	$R^2 = .855$
Rivers	$Y = 351.6 + 30.25X_1$*	$R^2 = .927$
Harding	$Y = 114.9 - 1.19X_1$*	$R^2 = .902$

(Continued)

TABLE E1--continued

Community	Regression Equation	Coefficient of Determination
Kemnay	$Y = 4.50 + 1.62X_1$*	$R^2 = .825$
Bradwardine	$Y = 191.4 - 2.46X_1$**	$R^2 = .731$
Stockton	$Y = 150.1 - 1.375X_1$**	$R^2 = .740$
Rounthwaite	$Y = 29.6 - .341X_1$*	$R^2 = .933$
Elva	$Y = 89.4 - 1.66X_1$*	$R^2 = .961$
Broomhill	$Y = 36.6 - .310X_1$*	$R^2 = .890$
Dand	$Y = 36.9 - .297X_1$*	$R^2 = .867$
Regent	$Y = 33.8 - .215X_1$**	$R^2 = .711$
Argue	DATA NOT AVAILABLE	
Croll		
Orthez		
Hathaway		
Fairview		
Ingelow		
Gregg		
Moorepark		
Mentmore		
Cordova		
Rufford		
Largs		

(Continued)

TABLE E1--continued

Community	Regression Equation	Coefficient of Determination
Floors	DATA NOT AVAILABLE	
Carroll		
Oberon		
Smart		
Justice		
Penennis		
Rhodes		
Mentheith		
Hilton		
Carnagie		
Belleview		
Franklin		

* Using a student t test, the following regression coefficients are significant at a 5 percent level.

** Statistically significant at a 10 percent level.