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STATISTICAL CORRELATES OF URBAN GROWTH
IN THE CANADIAN PRAIRIE
REGION, 1941-1971

BY

Theresa White Lobsinger

Submitted in Fulfillment of the
Requirements of Geography 45:599

Department of Geography
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1978

The undersigned recommend to the Faculty of Graduate Studies
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"STATISTICAL CORRELATES OF URBAN GROWTH IN THE CANADIAN
PRAIRIE REGION"

submitted by Theresa White Lobsinger, B.A., in partial fulfilment
of the degree of Master of Arts.

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April 19, 1978

ABSTRACT

The Canadian prairie region has been one of Canada's most dynamic growing areas in recent years. Unfortunately, very little geographic research has been undertaken regarding urban growth in the region. This paper studies the changing prairie urban region during the period of its greatest change, from 1941 to 1971, to isolate statistical factors or correlates of growth.

Little theoretical work has been done on urban growth, especially by way of isolating factors related to urban growth and the manner in which they operate to result in growth. The theoretical review therefore consists of a search through historical and contemporary geographic literature in an attempt to present themes which are deductively and empirically analysed in following chapters.

In the early 1960's a paper was written by Gerald Hodge, entitled "The Prediction of Trade Center Viability in the Great Plains", which focused on the decline of small trade centers in Saskatchewan. He stressed location and community characteristics as the factors resulting in small trade center decline. The Hodge paper provided the inspiration for the work in this thesis, but for studying urban growth, not decline. The factors Hodge studied were considered along with the role of the petroleum industry, of demographic characteristics of the population and also the role of the manufacturing and service sectors of the economy. The results of the statistical analysis undertaken in this study illustrate that the petroleum industry and demographic characteristics came out as the strongest statistical correlates of urban population growth, for the eighteen largest cities in the region in 1971, for the period 1941 to 1971.

The regional economy at the beginning of the study period was rural based and primarily depended upon agriculture. In the forties, however, petroleum was discovered in Alberta and soon after the Albertan economy began to diversify and the region, except for Saskatchewan, experienced urban population gains. The basic premise and conclusion of the paper is that mineral discoveries since the forties, especially petroleum, have been responsible for the changing urban and regional economy. The contributions of the agricultural sector to the urban and regional economy are recognized, but not as an urban growth stimulant in the manner of the petroleum industry.

A second conclusion of the paper is that the petroleum industry, like agriculture, is a primary industry and unless the economic base of the region expands into more stable activities, the growth (experience) that has taken place will slow down.

PREFACE

The past two years have been years of many firsts for my husband and I - our first child, our first house renovation and my first major piece of work, this thesis. The first "first" was primarily an enjoyable experience and I am grateful to Alison, my daughter, for many things. I want to thank her for not crying in the night so I could charge up my batteries for further work, and I also want to thank her for her smiles and many distractions while doing my thesis. My second "first" was an interesting experience and I want to thank God that it is largely finished and that I was able to do the last few months of work on my thesis in the quiet of one of its new rooms. My last "first", the paper you see before you, was an often frustrating experience - it being my first research paper - but a very beneficial one for I learned many things about myself, about urban growth, and about putting together a research paper.

I would like to thank my advisors Mike Ray, Dave Bennett, and Iain Wallace for their great patience and help, and I would also like to thank Elizabeth, Margaret and Mary for their support and encouragement. Last and most important, I would like to thank my husband, John, for his love and his constant supply of encouragement.

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CHAPTER 1

INTRODUCTION

1.1 Purpose and General Discussion of the Thesis

Urban system growth is a fairly new topic of geographic study, the theory of which is associated with such diverse fields as region economic growth, urban economics, and diffusion. The purpose of the study is to examine regional economic growth first in terms of the historical and contemporary states of the theory and then to present a typology within which the urban development experiences of an area can be examined. The study region is the Canadian prairies, for the period from 1941 to 1971. In 1941 the prairies were predominantly agricultural, with only approximately thirty nine percent of the population living in urban areas, whereas by 1971 the urban population had grown to eighty percent of the total, and agriculture, while constituting an important part of the regional economy, was no longer its sole foundation. By way of comparison, in 1941 fifty-four percent of the Canadian population was classified as urban, compared to seventy-five percent in 1971. The thesis will therefore attempt to explain why the prairie region experienced such a marked change in thirty years.

The prairie region, Figure 1.1, was chosen because of the magnitude of change that took place, and also because very little research has been undertaken in the urban field for this area. Most Canadian urban geographical literature and analysis has been confined to central Canada because of the high concentration of urban population in that area and because of the importance of the area's economy within the nation. Because the economic histories of the two regions differed, the urban development paths also differed. One cannot, therefore, study or examine the central Canadian experience and assume that the experiences of the other Canadian regions were necessarily similar. Furthermore, urban policies for the prairies should not be based upon the experiences of Ontario and Quebec alone.

Urban growth can be measured in many ways, such as labour force statistics, changes in income, population, and so on. The definition of growth used here is net population change, 1941 to 1971; it includes natural population increase, through immigration and in-migration, and population increase through extension of the boundaries of cities. Growth is measured as percentage change over the study period.

The rate of population change has different implications for cities in different size classes. For example; a three percent change in an already large city generates

large absolute changes in demand for employment, housing, hospitals and other social services. It would have been preferable, therefore, to examine the population growth of all urban areas in the region, but due to difficulties in collecting data, (see footnote 4-1, Chapter 4), only those prairie cities with populations of 10,000 or more in 1971 are to be included in the study (Figure 1.1).

A common problem in regional studies is the selection of appropriate boundaries to define the region and a critical factor is the mechanics of data collection for the region. Many of the data collected for the study are taken from the Census of Canada, which has traditionally been collected on a provincial basis. Therefore, the boundary of the three provinces combined has been maintained for the study, this being the familiar Prairie region. However, aside from the need to maintain the region as defined by the political boundaries, the prairie provinces have shared similar historical experiences which led to their settlement and are also located within a natural physical region. Therefore in view of the criteria just presented, the region can be justly defined as the provinces of Alberta, Saskatchewan and Manitoba. It will be seen, however, that the economic developments that have taken place during the thirty years under study, are bringing about a different regional structure, whereby at least, in economic terms Alberta might be

more closely associated with British Columbia in the future and Saskatchewan and Manitoba might be more closely interrelated as an economic region. This latter theme, however, has been included not so much as an empirical issue that is to be discussed at length within the paper, but more as a hypothetical prospect for the future.

It is the aim of this paper that with the completion of each chapter the urban growth path of the region should become clearer.

1.2 Thesis Structure

Chapter two deals with selected theories of urban growth to isolate factors which may be responsible for or contribute to growth, regardless of how growth is measured or defined. Classical theories are discussed first, followed by a review of the more contemporary, open system analysis of growth. The concepts which fall into this latter category are innovation diffusion, corporate decision making, growth poles, the role of growth inducing industries, and so on. This chapter provides the foundation for the remainder of the study by introducing the variables that will be examined in the statistical analysis of the growth paths of the prairie urban areas.

In Chapter three, a historical descriptive account of the economic developments that took place from 1941 to 1971

is presented, and also the variables discussed in chapter two are isolated and evaluated in terms of the historical account. The purpose of this chapter is to determine with the use of census data how the urban and regional economies have developed from the base year, 1941, when the region was predominantly an agricultural society. Thus the region is presented in terms of 1941 census data and the urban development of the region is discussed in terms of urban-rural differentials. The role of agriculture and the industrial structure of the region in 1941 is presented in terms of labour force statistics. This is followed by a discussion of the economy as described by similar census data for the years 1951, 1961 and 1971. Finally the economic developments that took place within the region from 1941 to 1971 are discussed and tentative hypotheses are presented, pertaining to the way in which these developments have shaped the prairie regional and urban economies. This chapter is essentially background material on macro-changes in the character of the region, and relies heavily on census data and the work of a few authors.

In Chapter four the statistical evaluation of the hypotheses is presented. Having identified some of the factors potentially responsible for the development of the prairie urban system to its 1971 state the growth of the eighteen cities with 1971 populations over 10,000 is analysed

in terms of these factors, using multivariate analysis. Before the analysis the hypotheses to be tested will be formally presented. They deal with the roles of the petroleum industry, the demographic characteristics of the cities, manufacturing, and urban services and characteristics, in promoting or stimulating urban growth. The variables that are included in the statistical analysis are then presented in terms of the different hypotheses. These variables are subjected to a principal components analysis to reduce the dimensions of the data and derive independent factors or components for use in a step-wise multiple regression analysis of growth-oriented hypotheses. The dependency of growth is then tested in the multiple regression equations and the results are assessed for their statistical significance. By using a multiple regression model an attempt is made to derive an explanatory model of urban growth in the prairie region.

In the last chapter the results are discussed and evaluated with reference to the formal hypotheses presented in Chapter four. The growth experiences of the separate urban areas will be presented and discussed, and prospects for the future of the prairie urban and regional system are presented.

CHAPTER 2

THEORIES OF URBAN GROWTH

2.1 Introduction

The purpose of this chapter is not to present an all-encompassing theory of urban growth, but to sort through the literature which summarises present knowledge in order to identify the principal factors that have contributed to urban growth. The literature that will be examined dates back to the early twentieth century; it may not have been concerned with urban growth, per se, but it formed the foundation for subsequent urban studies and for the literature that is beginning to concentrate on urban growth as a topic in itself today.

It is still possible nowadays to pick up a book portraying Canada to foreigners - including some books written by Canadians - and get the impression, from scanning the subject headings and illustrations, that this is a country dominated by such industries as agriculture, mining, forestry, hydro-electric power and fishing. (Gertler & Crowley, 1977)

Canada's historical economic development has often been quite nicely described by the staple theory of growth (Gertler and Crowley, 1977; Innis, 1975). The increasing opinion of contemporary research, though, is that the staple theory was

fine to describe the earlier stages of Canada's economic development but that "future, so-called post-industrial economic growth will focus increasingly on metropolitan centres with their skilled labour pools and their management and financial resources" (Gertler & Crowley, 1977, p.105; Simmons, 1974; Ray, 1968). In fact,

The success of staples, especially wheat, as engines of growth in Canada's resource-oriented economy permitted the transformation to an advanced industrial and highly urbanized nation, no longer so dependent on staple exports. Of the "five F's" by which Griffith Taylor described the Canadian economy - fish, furs, forests, farms and factories - Canada's urbanized economy has gradually focused more and more on "the final F" and gone beyond to a service-oriented economy.

(Gertler & Crowley, 1977, p.109)

The above paragraph sets the tone of this chapter, in which geographical literature related to urban areas and urban growth, is studied. It will be seen, though, that contemporary literature may not best explain the development of the prairie region from 1941 to 1971. Classical location theories are discussed in terms of their contribution to the field of urban growth, and this is followed by an examination of more contemporary thinking on the subject. The former belong to a class of deductive models describing settlement patterns with a hierarchical ordering of cities in terms of their sizes. The latter could be said to belong to a more dynamic, more open class of theories in which time is taken into consideration. The dynamic class can be further divided into two sub-groups to take in research that studies

the growth of the individual city, and that which studies urban growth within a system of cities. Each of the above is discussed and their contribution to the subject of urban growth is noted.

2.2 Deductive Theories

The classical theorists are Johann Heinrich von Thünen (1826), Alfred Weber (1909), Walter Christaller (1933), and August Losch (1944). These normative models were developed for economies in which the industrial system was simple compared to the complex corporate structures that exist today. The models were also dependent upon strong assumptions concerning the world, such as the supposition of an unbounded isotropic plain with a homogeneous distribution of purchasing power, or an isolated state situated in a featureless plain, or homogeneous production and transport costs, and so on (Ray, 1968; Smith, 1971; Morrill, 1970). As a result of these two characteristics, the models' applicability to the topic of urban growth and to problems arising from the development of systems of cities is limited (Haggett, 1972; Lampard, 1968). Despite these limitations, some theorists (Denike, 1970; Parr, 1969) have attempted to apply these static models to the experiences and development of contemporary cities and to urban systems.¹ They have tried to modify the original framework in the hope that the economic structure and growth

paths of the contemporary city will fit in. Unfortunately because of the classical theorists' explicit commitment to partial or general equilibrium solutions, the results are not satisfying and the process of fitting contemporary urban structures into classical models does not lend any new insights into the processes of urbanization and urban growth seen in the western industrial societies. Alan Evans (1972, p.1) says that "Whilst central place theory may be adequate to explain the urban hierarchy in areas such as S. W. Iowa where there is little manufacturing, it is inadequate to explain the size distribution of cities and towns in manufacturing areas such as the N. E. United States or the U.K." and it is also inadequate to explain the processes of growth of these areas. This argument could also be applied to the work of Von Thünen and Weber, whose theories have limited applicability in explaining urban growth even in more industrialized and manufacturing areas. The problem does not remain with the classical theories in and of themselves, but stems from the consistent attempt of some theorists to incorrectly apply the theories to the process of urban growth.

Contemporary researchers such as Simmons (1974, 1975), and Bourne (1975) have taken the basic premises of classical theories, such as central place theory, and have reworked them to state, in a less rigid framework without the static

assumptions proposed by those earlier theorists, that hierarchies or systems of cities exist ranging from the many small cities to the metropolis. Within this framework authors such as Simmons and Bourne present arguments explaining urban growth processes in which the larger cities generate the most growth and this is passed on throughout the system.² Gertler and Crowley (1977, p.121) further add that

For whatever reasons, Canadians see the nation as rural or urban, or as provinces or regions, instead of as a highly interconnected network of urban nodes. Yet to understand Canadian growth and development, it is misleading to rely exclusively on the province or the region as the unit of analysis. Since the province rarely coincides with the boundaries of the urban system, the study of growth and decline among urban places must be examined on the basis of urban regions or urban field.

The purpose of the above brief discussion regarding urban systems is not to digress from the discussion of classical theories but to illustrate how the original framework of central place theory can be updated and used in a discussion of urban growth. It is not very satisfying to use classical theories to explain urban growth process in their original framework.

One could, however, by ignoring the normative locational aspects of the classical theories as well as recognizing their limitations, abstract many aspects pertinent to

the study of urban growth. The contribution of Von Thünen for example, is not the actual patterning of agricultural activities around urban areas but it is the fact that he illustrated the decisive role that transport cost-distance played in shaping spatial order (Lampard, 1968). The role of transport distance was critical in the "agricultural era" of the prairie region in shaping the patterning and growth of the settlement of the area. Today the reorganization of this same network has had, and still has, serious implications for the growth paths of many smaller centres (Hodge, 1965). It can also be added that

Given the vast geographical domain of Canada, perhaps the most significant technological changes have been the improvements in transportation which have rapidly whittled down the effective distance between urban places. This "shrinking" of the nation has tended to support the emergence of large metropolitan areas which have extended their economic dominance over broad regions.

(Gertler & Crowley, 1977, p.141)

It will also be illustrated in the following section how distance, as reflected in information flows, affects the growth paths of contemporary urban areas.

Weber's original thesis, also has limitations in explaining contemporary urban growth because he restricted his attention to single plant, single product firms, while today's corporate structure is characterised by the multi-plant, multi-product firm. Weber did not elaborate how the

economic base of cities is related to the process of growth because of agglomeration and localization economies. Contemporary theorists are aiming to more clearly link the economic base of cities and urban growth by removing some of the stringent simplifying assumptions and making the model more open to other factors, as well as updating the description of the type of industrial structure being studied. As a result the contribution of the industrial sector to urban growth is being recognized. Again this will be discussed in more detail in the following section.

The assumptions of the work of Christaller and Lösch, as well as the orientation of the theories in and of themselves, preclude the use of central place theory to explain the process of urban growth. The theories are equilibrium-oriented, not genetic in nature. But again, if one ignores the deductive mechanics of the theories, the factors that contribute to urban growth can be abstracted. The role of distance and transport cost is mentioned again by these theories. The new addition, however, to the field of urban growth as a result of these theories is the recognition of the role of agglomeration economies and urban functions in altering the growth paths of regions. This takes place by way of forward linkages, backward linkages and final demand linkages.³ Contemporary researchers have recognized these contributions and have expanded them so they can be applied

to modern industrial society.

In summary, therefore, it can be said that in assessing the usefulness of classical theories for urban growth the limitations of the theories must be kept in mind. The assumptions are empirically unrealistic in that they remove many relevant factors, and the theories have little explanatory or predictive power. Nonetheless it was shown above that by ignoring these limitations many of the factors that may shape the growth and development paths of urban areas can be identified. In the following section, it will be seen how contemporary theorists have abstracted these factors and are using them in their explanations of the growth and development of cities. Von Thünen, Weber, Christaller and Lösch provided the foundation for future work in urban growth studies to the extent that they indirectly pointed out that distance in terms of transport cost affected growth, that growth involved the supply and demand of goods and services, that industrial location might affect growth, and that not all cities would be the same initial size and therefore would experience different rates of growth, even under equal stimulation.

2.3 Contemporary Research in Urban Growth Analysis

2.3.1 Introduction

Contemporary research into urban growth is conspicuously process oriented, wherein time is an implicitly recog-

nized element. Growth research could be said to fall into two categories; studies of the growth of the individual city and studies of the growth paths of cities within a system of cities. Research on the individual city tends to be more conservative and more closed in outlook, as usually only one or two factors are recognized. Nonetheless this type of research is necessary because, due to its simplification of exogenous factors, more rigorous examination of the factors causing growth can be examined. The theory concentrating on one or two growth factors, discussed in this section is growth pole theory, which relates urban and regional development with expanding industries. The expanding industries supposedly set off chain reactions of minor expansions throughout a hinterland. The second theory that is discussed is export base theory which recognizes the importance of exports in affecting urban growth.

The research on urban growth, in the system framework, is a more dynamic, more open view⁴ of urban growth whereby the association of many factors with growth is recognized, even if they are not all stated. Perhaps the greatest contributor to this area and method of analysis is Allan Pred (1966). Pred takes studies of growth inducing factors and links them to create a systems typology for studying urban growth (1973; 1975). Other contributors to the systems view of urban development are J. Simmons (1974, 1975) and L. Bourne (1975). Their con-

tributions, along with that of Pred will be reviewed following a discussion of theories pertaining to the individual city. A systems framework was not used in this study, however, because of the difficulties in acquiring data regarding interaction patterns for some of the smaller centres.

Before proceeding, however, it should be noted that most contemporary research is preoccupied with cities whose economic base contain a significant amount of dynamic growth-inducing activities such as manufacturing industry and large corporations in particular. All too often the importance of other functional types of cities such as resource towns or retirement towns are ignored; their economic contribution to regions and nations is not acknowledged and thus their contribution to the theory of urban growth is not recognized. Very few studies can be found which analyse and associate the contribution of the small resource towns to the urban development of a regional system. Because of this gap in the literature, the theories to be discussed below only pertain to the more dynamic sectors of the economy.

2.3.ii Growth Theories Pertaining to the Individual City
Growth pole theory, as developed by Perroux (1955), is one of the earliest contributions in contemporary literature which studies the association of regional development and urban development. According to Perroux economic growth derives from structural changes and it was these that Perroux wanted to explain (Thomas, 1972; Lasuén, 1969). Dominant economic units or activities are the focal point of Perroux's framework and they are often referred to as the

propulsive or key firms or industries. Perroux, unfortunately, never really explained very well the definitions of the dominant activities nor did he illustrate how they functioned to stimulate the local economy; it is in fact this vagueness which causes many problems because of the inability for theorists to interpret the theory. The essence of the growth pole is that "... when a propulsive industry raises its output, it induces expansions in the outputs of other industries. In cases where the induced growth in outputs is greater than the initial growth of the propulsive industry's output, such a propulsive industry is called a key industry" (Thomas, 1972, p.24; Lasuén, 1969, pp.22-23). The structural changes which result are not restricted locally, but can be traced through the national economy in the form of backward and forward linkages.

Although growth pole theory is often included in urban and regional discussions, it has never been truly accepted as a theory that contributes an understanding to growth processes. It has been criticized because, although it stresses inter-industry linkages, no explanation is given concerning how these linkages function; no explanation is given for the location of propulsive industries in geographic space; no explanation is given concerning the manner in which growth is initiated; and operationally feasible models have not been successful in incorporating all of the principal

components and relationships elaborated in the theory (Pred, 1973, pp.12-15). According to Lasuén, (1969, p.23):

In Perroux's framework the basic definitions and hypotheses ought to answer: 1) what are the characteristics of a leading industry? (2) what are those of the industrial complex? (3) what are the sectoral and spatial interrelations between the leading industry and the industrial complex? (4) what are the interrelations between the growth of the polarized industrial clusters and that of the nation? He did not answer these questions properly. His definition of the leading industry is imprecise; that of the industrial complex is incomplete. His explanation of the interrelations between the leading industry and the complex is partial; that of the relations between the growth of the pole and that of the nation is at least partly erroneous.

Followers of growth pole theory have failed to recognize that the activity creating a growth centre stimulated economic change not because of its size, or multiplier effect per se, but because it was innovative. Lasuén clearly points out that it is the process by which firms adopt successive sets of innovations that new growth is generated and thus "the relevant development subprocesses are those relative:

1) to the generation of innovations, 2) to the diffusion of knowledge of new innovations and 3) to the spread of adoptions" (Lasuén, 1969, p.29). It is those areas in which multi-plant, multi-product firms are located, which must adopt and innovate to maintain a competitive position, that will experience economic growth. Compounding the shortcomings outlined by Lasuén above, input-output analysis, the

methodology frequently chosen to analyse the economic developments of growth poles is itself a static methodology. So what began as a dynamic theory is reduced to a static forecasting framework in its implementation because of the methodology. The continuous development process of a city cannot best be analysed within a static framework.

The second problem does not pertain to the theory itself, but relates to its use and interpretation. It is often assumed that the mere placement of a plant at any location will generate economic growth in the vicinity. It is not, however, the mere presence of a plant which results in growth, but it is the innovative process which maintains the firm's competitive position, as well as the manner in which the results of these innovations are transferred throughout the economy via multiplier spread affects, that yields growth.

In addition to growth pole theory, export base theory has often been used to explain urban and regional development processes. The premise of export base theory is that urban growth is a function of urban and regional demand, whereby the basic activities are "exported" in response to exogenous demand and are growth-inducing activities, while the non-basic activities satisfy local, that is intra-urban, demand and are thus serving or sustaining activities.

Emphasis is placed on the "openness" of urban and regional economies, whereby changing demand patterns alter urban and regional growth. It is assumed that multiplier effects come into action, upon satisfying demand, to reinforce and stimulate economic performance; the manner in which these multipliers operate is not explained. It is often assumed that agglomeration economies act to stimulate urban development; but again the explanation for this is not given (Thompson, 1966; Richardson, 1973; Ray, 1968).

The principal deficiencies in export base theory and therefore in its relevance to urban growth processes, relate to the two assumptions of the theory which were stated above, but also that it is a static model that fails to recognize the economic importance of the city - serving or non-basis activities of cities. In other words, the multiplier effects, initiated by economic functions, would be restricted to exporting industries, while the development capabilities of industries serving local markets would be suppressed. Even the model's descriptive capabilities are limited because the theory ignores the growth processes of the non-basic activities (Richardson, 1973; Pred, 1966).

Wilbur Thompson isolated yet another shortcoming of the model by suggesting that the importance of the export sector varies with urban size. He states that:

To hold the prime role for an export sector that accounts for a half of all local activity in an urban place of 10,000 population is a far cry from retaining that role when metropolitan areas reach one-half million and over and where the export sector may account for only one-quarter of all activity. (And this applies even in cyclical analysis, where shifts in local investment and in the "local-consumption-of-local-production" function probably come to rival export multipliers in local cyclical impact.) Clearly, then, the relative role of the export and local service sectors change with the relevant time period and the size of the urban region under analysis. (Thompson, 1972, pp.45-46)

Thus because of the diminishing relative role of the export sector associated with increasing urban size, together with the theory's preoccupation with the export sector, completely ignoring the non-basic activities, the model's potential for explaining urban growth is limited. The common element in growth pole and export base theories is that they both recognize the urban growth-inducing effects of the multiplier. The role of the multiplier is discussed in the following section.

2.3.iii Growth Theories viewed in a Systems Framework

What has evolved, perhaps in answer to the inherent deficiencies of the theories reviewed so far, is a more macroscopic or systems way of presenting and studying growth processes. This is not to say that all classical geographical studies are in any absolute sense unhelpful in discussions of urban growth, for they do isolate many of the variables that affect and are affected by growth processes. It is more correct to say that currently theorists and re-

searchers prefer to study growth in a less rigid, more open framework where the method by which growth inducing factors operating to alter urban development can be identified empirically. In other words, contemporary work is less concerned with creating models with unrealistic assumptions and is more concerned with discovering growth inducing factors.

Great importance is placed on the role of multi product/multi-plant/multi-city types of firms in current studies of growth, and the manner in which their operations and corporate organization are associated with the urban hierarchy and urban growth is of great interest. The key here is that such enterprises are those which innovate to survive. Due to the technological changes in communication and transportation, the time period between successive stages of innovations is rapidly decreasing, (Lasuén, 1969), and in order for firms to maintain their competitive positions, they must have access to information and must move freely from product to product, or in other words, they must always be ready to diversify their production lines (Pred, 1973). Thus the current line of thought is one that equates urban economic development with the ability of industry to adopt innovations (Gertler and Crowley, 1977). In the past, and this pertains to some extent in the present, the lack of concern for innovation, according to Pred, was and is "... a manifes-

tation of the traditional tendency to isolate many of the locational aspects of manufacturing and cities, rather than to view industry and urbanization as interacting spatial "processes" (Pred, 1966, p.141). The purpose of this section, therefore, is to isolate the manner in which corporations behave and how this alters the urban development paths of cities.

Four factors or characteristics of corporations are important: the diffusion of information flows; the multiplier and how it operates; corporate structure and the manner in which corporate decision making affects urban systems development; and the role of agglomeration economies. In a most elementary form it can be said that it is the ready access to information flows which is necessary for the firm and it is the availability of urbanization or agglomeration economies that affects most the location of industries. Both of these factors, along with the administrative structure of corporations, have a great affect on corporate decision making. The impact of these decisions will be passed on throughout the economy via multiplier spread effects and alter the urban system by either stimulating growth or in some cases causing relative or absolute stagnation or decline. Gertler and Crowley (1977, p.160) state that

The initial multiplier from the introduction of industry into the urban economy also serves to stimulate secondary multiplier effects, as the

enlarged payroll in the community and the increased personal income of households raise the demand in the "consumer-oriented" service, government and construction sectors. Business services expand and transportation and other public infrastructure improves. These, in turn, provide the climate for self-generating growth which is further accelerated by (1) technological interdependencies of firms, (2) organizational decision-making which favours expansion in known locations and (3) specialized information exchange which leads to concentration of headquarters functions.

Pred singles out three types of innovations that may induce economic and population growth via the firm: those of final demand goods and services, those that involve the use of new production processes, and those of organizational innovations which are related to the corporation's structural and operational changes (Pred, 1973, p.27). The diffusion of these types of innovations are dependent upon the spread and circulation of specialized information and this, in turn, is a function of who is seeking it, since not all people are interested in acquiring similar information, and it is a function of existing interaction patterns (Pred, 1973; Lasuén, 1969).

There is a whole field of literature on the topic of the diffusion of information, which distinguishes several patterns by which information sought by businesses is spread, one being a hierarchical pattern from larger to smaller centres. Geographers studying information flows throughout an

urban system have often assumed, with the use of central place theory, that the path of information flows is hierarchical, from larger to smaller centres. However the empirical evidence, pertaining to information flows indicates that the hierarchical pattern does not necessarily occur and that there is a need for an alternative understanding (Pred, 1973). In fact the information flow path, as illustrated by empirical evidence can pass from smaller centres to larger centres, across the hierarchy or down the hierarchy (Pred, 1973, pp.30-32). Pred thus provides an alternative thesis to the hierarchical pattern described above which states that upon receipt of information in time period one, information will be passed on in the next time period to any smaller, larger or similarly sized centre. This information is passed to or passed from cities which are on the sending or receiving end of goods, capital, or services (Pred, 1973). Those seeking the information, by way of any of the paths described above, are the relevant businesses and corporations, who require the information to maintain a competitive position. It remains true though, that the flows down the hierarchy predominate.

It is at this point that corporate organization and corporate decision making should be included in the discussion because these characteristics will affect the manner in which information is interpreted and used. Major decision-making

usually takes place at head offices; thus any information pertaining to the firm or corporation will be sought by and/or directed to the head office. Furthermore, since these decisions pertain to the structuring and operation of the firm or corporation, they will have a great impact on the local and even non-local economic base by generating further growth or perhaps causing a recession (Pred, 1973). Gertler and Crowley (1977, p.150) summarize the manner in which this occurs as follows:

Innovations, whether they take the form of providing new products, involving the use of new production processes or the restructuring of an organization, all stimulate city growth. Jobs are provided; enhanced productivity frees resources for investment elsewhere; one innovation paves the way for subsequent ones....

They further state the features of urban areas that have contributed to this role:

- Institutions with sufficient financial, technical and organizational resources for invention/innovation are found in greater numbers in large cities.
- Entrepreneurial creativity, aggressiveness and managerial skills tend to focus in the city.
- Large cities are information-saturated environments with higher potential for interaction than smaller communities.
- As the innovation experience is repeated, attitudes and expectations receptive to further innovation are fostered; the process becomes institutionalized.
- Certain innovations are feasible only with large markets available in a metropolis.

(Gertler & Crowley, 1977, p.150)

Thus the decisions regarding innovations, made by head offices, can affect the local economic base as well as the eco-

conomic base of urban areas in which subsidiaries are located (Pred, 1973).

The head office makes the decision and acts upon it in time period one; the information and innovation¹ is then passed on to subsidiary plants in the next time period. Because of this the economic base of the home of the head office is the first to be affected and in many cases this home tends to be the larger urban areas because of the greater access to information and agglomeration economies. Also the "... spatial bias in the circulation of specialized information also means that firms situated in larger places are more likely to know of new innovations than firms in smaller towns." Also if "... growth of an industry is fastest in the early stages, then presumably, larger centres which host the newest "growth" industries can be expected to grow proportionately faster than peripheral places which are the recipients of "mature" industries" (Gertler and Crowley, 1977, p.151).

Due to the shorter time periods between successive sets of innovations, competition is enhanced and so firms must alter their lines of production, by adopting new innovations, relatively quickly to maintain their competitive positions. As a result, head offices also generally prefer to locate within larger cities so that a great part of the

firm's production functions can be subcontracted out to facilitate technological and innovation mobility, while the head office would retain exclusive management over the assembly of all the pieces (Lasuén, 1969; Pred, 1973; Pred, 1966; Ray, 1968). Once the head office accepts the innovation, the decision is filtered to subsidiary plants, as stated above, and sets a chain of non-local multipliers into action, which will alter the growth of these other centres.

Pred says that

Virtually every urban job-providing establishment has direct or indirect linkages with activities in other cities. These non-local multipliers can be seen in part as the outcome of existing interurban circulation patterns of specialized information and as contributors to subsequent patterns of interurban specialized circulation.

(Pred, 1973, p.16)

It must be kept in mind, however, that these non-local multiplier effects do not always work to stimulate urban growth, for they also have their negative, or job-reducing, counterparts that are set in motion by a reduction in the scale of some operations in one city (Pred, 1973). Also, as the growth-inducing potential of new innovations decreases as elapsed time increases, the last to accept and adopt the innovation will experience least growth (Pred, 1973; Gertler and Crowley, 1977).

In general, one could infer from the above discussion on urban growth and industry, that the larger cities have the

highest probabilities for further growth. The agglomeration economies available in larger cities, in areas such as financing, labour, inputs from surrounding industries, and so on, more easily facilitate the acceptance of new innovations, and would ensure greater success rates. Because of this, the ranking of larger cities will be perpetuated as well as their control over the urban system's development (Simmons, 1974; Pred, 1973; Gertler & Crowley, 1977).

It would have been difficult to study the prairie region in a systems framework because of problems acquiring appropriate data and because the region does not constitute an isolated system. Few head offices of large firms are located in the prairies; the region's industries are greatly dependent upon head offices in Vancouver, Toronto, Montreal, as well as cities in the United States (Ray, 1976). A systems framework could be more readily applied on the broader national scale.

Empirical studies have shown that the economic sector that has contributed most to urban growth in North America, in the manner described above is the manufacturing industry. Pred (1966) illustrates the important role that the manufacturing sector played, together with improvements in transportation, in altering the development path of the U.S. urban system, due to its innovations and non-local multiplier ef-

fects. Growth studies undertaken for central Canada further confirm the conclusions regarding the need for diversification and the way in which dynamic industries are associated with urban growth. Central Canadian cities that experienced more rapid growth were those in which a larger proportion of the labour force was engaged in manufacturing or other growth industries (Golant, 1972; Ray, 1968; Gertler and Crowley, 1977).

2.4 Summary

It was seen in the discussion of Classical theories, that their utility in explaining urban growth processes is limited because of their normative equilibrium nature, as well as the fact that they were not developed to explain urban growth processes. However, ignoring their restrictive framework, many factors which can be associated with urban growth have been isolated from these theories. The factors which were deemed important were distance as measured by transport cost, the location of industries, the role of urban functions and agglomeration economies. Having these theories as the foundation for further research, contemporary theorists have taken these factors and have expanded upon them to determine the manner in which they are associated with urban growth.

The discussion of contemporary research dealt with studies which rigorously examined one factor, i.e. propulsive industries, or basic, exporting activities and studies which proposed a systems view with the examination of more than one factor. It was seen that the more rigorous examination of one factor is useful because the many possibilities by which a single factor could affect and alter urban growth could be closely studied. But at the same time this examination required that many other important factors associated with growth be ignored or not explained well.

The systems view of growth proved to be the most successful way of isolating the factors and determining how they inter-relate to alter the urban development paths of cities within a system. The factors that were examined were those isolated from previous work, but they were presented in a more dynamic fashion. These factors included the role of information flows, the role of agglomeration economies, the role of growth-inducing urban activities and the role of the urban multiplier spread effects.

It has become apparent from the above discussion on the growth of cities, that the definitive theory of urban growth does not exist. What can be seen, though, is that theorists in the past and in the present have all contributed, by their works, to the subject as a whole, some more helpfully than others. The factors that have more successfully explained urban growth processes and thus are more significant for the purpose of this study are the multiplier linkages, innovation diffusion, corporate decision making, and the role of growth industries in urban and economic development. One could view the historical development of the prairie economy in a central place framework up to the point where the economy diversified from an agricultural base to an industrial base. The central place framework, however, is too simplistic to describe let alone to explain the situation that developed after 1941. What is necessary, instead, is

to attempt to sort out from the history of the economic developments from 1941 to 1971 exactly what factors did in fact alter the development of the prairies.

What will be seen is that a diversified economy evolved and still is evolving and it is this diversification that is forming the characteristics of the present urban system. It was stated earlier in the chapter that the future post-industrial economic growth, in Canada, will focus increasingly on metropolitan centres and the "final F-factories". This is true, but it will be seen that the high growth rates experienced in the urban prairie region from 1941 to 1971 are not best explained by the current geographical literature on urban growth which focus on the "final-F". One could perhaps add a P to Griffith Taylor's description of the Canadian economy to represent the petroleum discoveries of the Prairies.

The mineral discoveries of the forties made possible, through the growth in per capita income, the transition from an agricultural to a more industrial economy but the evolving economy was still very dependent upon the staples of the land. The petroleum industry stimulated the prairie economy through so-called spread effects which promoted growth of secondary and tertiary activity. It will be seen that, even though the economy was not completely dependent

upon growing industries in 1971, a beginning was being made whereby multiplier linkages were able to come into effect to help further stimulate other sectors. One could infer, however, from the review regarding the current state of urban growth literature that if the prairie economy is to continue to develop and remain a dynamic economic region it must further diversify to include more the "final-F". The situation is evolving to one where innovation and diffusion and corporate decision-making will have an even greater impact in shaping the cities of the region and where a system of growing centres will evolve.

FOOTNOTES FOR CHAPTER 2

¹From the systems perspective, the urban places of a region are viewed as tightly interconnected with one another by flows of managers and labourers, money and goods, ideas and information. The systems outlook suggests that cities are interdependent so that any significant change in economic activities, employment structure, population composition or income levels of one city will affect other cities in the system.

(Gertler & Crowley, 1977, p.121;
Berry, 1974; Simmons, 1974)

²Urban growth forces are spread throughout the system by way of multiplier effects due to the connections among cities. Gertler and Crowley (1977, p.127) state that

The intensity and complexity of connections among cities of the urban system have also increased. Rapid escalations have taken place in the mobility of people, the movement of commodities, the flow of information and the transfer of capital as new modes of transport have been introduced, travel time and costs decreased, and communications become generally better. Yet the greatest improvements in accessibility and the most rapid upswing in contacts occurred between the most populous areas from which the early transportation network fanned out, and perhaps more important, from which the decisions to build or expand routes and facilities emanated. This self-reinforcing process of strengthening linkages more between larger places than among smaller places is an important aspect of growth ...

It should also be noted that researchers such as Simmons who have dedicated much work to the area of urban systems have not explicitly or empirically shown how the larger cities control the system.

³ Backward linkages cause increased production among suppliers to the exporting industry; forward linkages cause domestic processing of staple outputs before exporting; and final demand linkages cause consumer goods to be produced for domestic consumption by workers in staple export industries.

(Gertler and Crowley, 1977, p.106;
Hoover, 1971, pp.215-216)

⁴ It was briefly described in footnote 2 above, the manner in which urban systems function and interrelate. By open or openness of the system, the contacts or linkages are the factors that are being referred to. For example, in the Canadian case, one could say that contact or interaction is more intense among Canadian cities than with the outside urban world. Therefore the Canadian urban system is more open within the nation itself, than with the outside world.

(See also Simmons, 1974;
Gertler and Crowley, 1977)

CHAPTER 3

THE PRAIRIE REGIONAL ECONOMY - 1941 TO 1971

3.1 Introduction

From Confederation to the 1940's the economy of the prairies was predominantly rural and agricultural; until the 1940's agriculture provided the stimulus for settlement and subsequent development. In the 1940's, however, a new stimulus for development arose, in the way of mineral discoveries, which altered the economic positions of the three provinces.

This chapter outlines the economic history of the region from 1941 to 1971, and using census data, identifies factors which were responsible for changes in the urban and regional systems. This is done by first describing the regional economy in 1931 and 1941, explaining why the 1941 base year was chosen, followed by an evaluation and comparison with the economy of the years 1951, 1961 and 1971. Hypotheses are presented as to why the economic developmental positions of the three provinces were altered.

The economic history of the prairies from Confederation to the 1930's is not discussed, because the events that

occurred during that time, although they determined the settlement of the area, have little to do with the economic developments that followed (Stabler, 1969; Smith, 1972). Discussion will be restricted to the period 1931 to 1971 since this contains the years of rapid urbanization and industrialization.

The period from 1931 to 1941 was the time of the Depression and of severe drought, the result being a stagnating economy. The agricultural product which contributed most to the regional economy was wheat, and production dropped due to the drought. This, together with falling prices and falling demand for wheat, yielded disastrous results (Smith, 1972). The combination of a loss of domestic and foreign markets, falling prices, and lower agricultural production, almost brought about a collapse of the prairie governments. The trough in the economic decline was in the mid-thirties, after which the prairie economy began to recover (Stabler, 1969). Thus the decade marking the end of the period of initial settlement and physical development of the agricultural economies was not a prosperous time for the region; however by 1941 the economy had begun to recover. Data for 1931 will be presented and compared with 1941 data to provide a summary of developments in the decade which marked a turning point for the regional economy.

The data that will be used to describe this evolving economy includes urban and rural population distributions, employment data and agricultural data. Ideally it would have been preferable to include data pertaining to the contribution of the various sectors to gross provincial product, but data of this nature was not available. Origin-destination data regarding rural-urban migration, as well as immigration from outside the region, would also have been useful in assessing the population shifts within the region that came about as a result of the changing economies. But again data of this nature could not be found. Therefore the employment data will be used to note the changing role of the industrial sectors of the provincial economies, and urban and rural distributions will be used to indicate population shifts and the development of the urban system.

3.2 The Prairies in 1931 and 1941

The Prairies in 1931 and 1941 were a rurally based society and economy, with over fifty percent of the provincial populations for those years classified as rural. Saskatchewan had the highest percentage of rural population in 1931 and 1941 (Table 3.1) and Manitoba had the lowest proportion of people classified as rural. As well as being the least rural of the three prairie provinces, Manitoba had the highest urban concentration in the region for the years 1931 and 1941. This higher urban concentration was due to the

Table 3.1 URBAN-RURAL DISTRIBUTIONS

Province		Urban Pop.		Rural Pop.		Total Pop.
		Number	%	Number	%	Number
Manitoba	1931	315,969	45.1	384,170	54.9	700,139
	1941	321,873	44.1	407,871	55.9	729,744
	1951	384,429	49.5	392,112	50.5	776,541
	1961	545,823	59.2	375,863	40.8	921,686
	1971	686,445	69.5	301,800	30.5	988,250
Saskatchewan	1931	290,905	31.6	630,880	68.5	921,785
	1941	295,146	32.9	600,846	67.1	895,992
	1951	370,681	44.6	461,047	55.4	831,728
	1961	527,484	57.0	397,697	42.9	925,181
	1971	490,630	53.0	435,610	47.0	926,240
Alberta	1931	278,508	38.1	453,097	61.9	731,605
	1941	306,586	38.5	489,583	61.5	796,169
	1951	488,188	51.9	451,313	48.0	939,501
	1961	894,899	67.2	437,045	32.8	1,331,944
	1971	1,196,255	73.5	431,620	26.5	1,627,875
Canada	1931	5,572,058	53.7	4,804,728	46.3	10,376,786
	1941	6,252,416	54.3	5,254,239	45.6	11,506,655
	1951	7,941,222	56.7	6,068,207	43.3	14,009,429
	1961	11,068,848	60.7	7,169,399	39.3	18,238,247
	1971	16,410,785	75.1	5,157,525	24.9	21,568,310

Sources:

Census of Canada, 1931 - General Characteristics

Census of Canada, 1941 - General Characteristics

Census of Canada, 1951, Population - General Characteristics, Table 14

Census of Canada, 1961, Population - Geographical Distributions, Table

Census of Canada, 1971, Population - Urban and Rural Distributions

Table 3.1a PERCENT CHANGE IN URBAN SHARE OF TOTAL POPULATION
1931-1941, 1941-1951, 1951-1961, 1961-1971, 1941-1971

Province	Urban/Rural				
	1931-1941	1941-1951	1951-1961	1961-1971	1941-1971
Manitoba	-1.0	+5.4	+9.7	+10.3	+25.4
Saskatchewan	+1.4	+11.7	+12.4	-4.0	+20.0
Alberta	+0.5	+13.5	+15.2	+6.0	+34.9
Canada	+0.6	+2.3	+4.0	+14.4	+20.8

presence of Winnipeg and its role as the regional service centre and gateway city to the west (Burghardt, 1971; Nader, 1975). The population of Winnipeg was about three times that of any of the other major cities within the region at the time and within Manitoba itself 40 and 41 percent of the provincial population was concentrated within the city of Winnipeg for the years 1931 and 1941 respectively (Table 3.2, Table 3.3). Burghardt states that

Since entrance into an extended hinterland is of the essence of a gateway, such a city will tend to be located on a site of considerable transportation significance, i.e. either at a bulk-breaking point or at a node of transport lines ... but also in the structure of employment; the gateway city should be more heavily committed to transportation and wholesaling ...

(Burghardt, 1971, p.270)

From the time of Confederation to the 1940's all the characteristics described above which were necessary for the making of a gateway city applied to Winnipeg and it was due to this fact that Winnipeg became the largest city in the region and that Manitoba had become the most urban of the three prairie provinces by 1931 and 1941. Winnipeg was located at the only point through which settlers could move into the Canadian west and

As the rail lines fanned out across the Prairies, speculation fever hit the city and lots in present Saskatchewan, Alberta and even British Columbia were sold and resold in Winnipeg. The city obtained the principal railway yards and stockyards, and dominance over the grain trade of the West. It served as the "clearing house for labor" for

Table 3.2 POPULATION GROWTH IN METROPOLITAN AREAS, 1931-71

	1931	1941	1951	1961	1971
POPULATION					
Winnipeg	284,129	299,937	354,069	476,543	534,685
Regina	53,209	58,245	71,319	112,176	138,956
Saskatoon	43,291	43,027	53,268	95,564	125,079
Calgary	83,761	93,021	139,105	279,062	400,154
Edmonton	79,197	97,842	173,075	337,568	490,811
POPULATION GROWTH (per cent)					
	1931-41	1941-51	1951-61	1961-71	
Winnipeg	6	18	34	12	
Regina	9	22	57	24	
Saskatoon	1	24	79	31	
Calgary	6	50	101	43	
Edmonton	18	77	95	45	

SOURCE: Dominion Bureau of Statistics, Census of Canada, 1941, 1951, and 1961; 1971 data from advance releases by Statistics Canada.

Table 3.3 CONCENTRATION OF POPULATION IN THE METROPOLITAN AREAS, 1931-71

	1931	1941	1951	1961	1971
PER CENT OF PROVINCIAL POPULATION					
Winnipeg (Manitoba)	40	41	46	52	54
Regina (Saskatchewan)	6	6	8	12	15
Saskatoon (Saskatchewan)	5	5	6	10	14
Calgary (Alberta)	11	12	15	21	25
Edmonton (Alberta)	11	12	18	25	30
PER CENT OF PRAIRIE POPULATION					
The five metropolitan centres	23	24	31	41	48
PER CENT OF PRAIRIE URBAN POPULATION					
The five metropolitan centres	77	80	76	70	71

SOURCE: Dominion Bureau of Statistics, Census of Canada, 1961 and 1966, and 1971.

the West Clearly, Winnipeg functioned as
"The primary wholesale center of the prairies".
(Burghardt, 1971, p.274)

The presence of Winnipeg obviously affected the urban and rural distributions for Manitoba causing it to differ from those of the other Prairie provinces.

The percentage share of the population classified as rural within Saskatchewan was 68 and 67 percent respectively for the years 1931 and 1941. The figures for Alberta were slightly lower for the same years (Table 3.1). The total population for Saskatchewan had fallen from 1931 to 1941, but this drop in population was felt equally in both the urban and rural areas. On the other hand, the total population for Alberta had slightly increased from 1931 to 1941 and the percentage share of this increase was felt equally in both the urban and rural areas. The major urban centers within the provinces of Alberta and Saskatchewan in 1931 and 1941 were Calgary, Edmonton, Regina and Saskatoon. The population of each of these cities lagged far behind that of Winnipeg for the period and the proportions of the provincial populations within these metropolitan areas were also low compared to that for Winnipeg (Table 3.2, Table 3.1). For example, only 11 percent of the total Saskatchewan provincial population resided in the cities of Regina and Saskatoon in the two years being discussed, and only 22 and 24 percent of the total Albertan provincial population resided in the

cities of Calgary and Edmonton in 1931 and 1941. It should also be noted that of the people who were classified as urban, the majority lived in villages and hamlets with populations less than one thousand. Saskatchewan, for example, had 433 localities with populations under one thousand, and only 33 with populations ranging from 1,000 to 53,209 (Census of Canada, 1931).

Before continuing, it should be pointed out that of the five major cities in the region, in 1931 and 1941, Edmonton had experienced the highest percent population growth during that decade. Winnipeg remained the largest metropolis but its percent growth during the period was one third that of Edmonton's (Table 3.2). Burghardt (1971) suggests that Edmonton was opening up and beginning to function as the gateway to the Canadian northwest.

It can be said, therefore, that the Prairie urban system was in its early stages of development in 1931 and 1941. There were only five major urban centres and the greater share of the region's population was classified as rural during those years.

Aside from the urban-rural population distribution, the "youth" of the Prairie urban system and regional economy can be recognized in the regional dependence on agriculture. Labour force statistics for 1941 (Table 3.5) show that

approximately fifty percent of the region's labour force¹ was employed in agriculture during that time, while manufacturing, for example, only employed an average of eight percent of the labour force. Of the three provinces Saskatchewan had the highest concentration of the labour force engaged directly in agriculture and Manitoba had the lowest concentration employed in that sector in 1931 (Table 3.4). The lower concentrations in Manitoba can again be attributed to the presence of Winnipeg with its gateway functions. Alberta, also had a significant number of people employed in the agricultural sector in 1931. Three other sectors which employed significant proportions of the provincial populations were transportation and communication, trade and service, all of which were in some way directly related to agriculture. The trade and transportation sectors were important in the export of commodities and the high proportions of people employed in the service sector reflects the need for central places to provide agricultural as well as non-agricultural services to the predominantly dispersed agricultural society of the time.

The employment figures for 1941 illustrate an even greater importance of the agricultural sector as an employer in the region, by the vast increases in the provincial populations employed in that sector. These data reflect the improvement of the post depression economy, as well as the

Table 3.4 DISTRIBUTION OF THE LABOUR FORCE - 1931

Wage-Earners, 10 yrs of age and over, by industry 1931									
Province	Agriculture	Mining Quarrying & Wells	Manufac- turing	Transportation & Communication	Trade	Finance & In- surance	Service	Other	Total
(no.)	19,930	1,929	25,427	22,555	24,497	6,264	42,306	27,831	170,739
Manitoba									
(%)	11.67	1.13	14.89	13.21	14.34	3.66	24.78	16.32	100.00
(no.)	37,788	778	8,442	19,502	14,816	4,225	40,258	19,759	145,568
Saskatchewan									
(%)	25.96	0.54	5.80	13.40	10.18	2.90	27.65	13.57	100.00
(no.)	26,142	10,815	13,048	18,415	15,598	4,077	37,139	17,187	142,421
Alberta									
(%)	18.37	7.59	9.16	12.93	10.95	2.86	26.07	12.07	100.00
(no.)	198,592	68,962	606,617	283,675	281,107	82,963	585,413	462,768	2,580,097
Canada									
(%)	7.69	2.70	23.65	10.99	10.92	3.42	22.69	17.94	100.00

SOURCE: Census of Canada, 1931.

recovery from the drought years of the thirties. Also reflected in the 1941 employment figures is the greater need for foodstuffs in the emergent war-time economy, for in each province the percentage of the labour force in agriculture more than doubled from 1931 to 1941, while the percentage of people employed in other sectors, for example the service industry, fell. The most important sectors during the war were agriculture and manufacturing as well as the trade sector. Looking at the employment data for 1931 and 1941, one can see the declining importance of the other sectors compared to the relative stability in the trade and manufacturing sector and the increasing importance of the agricultural sector. The agricultural sector was important not only in the Prairie region and economy, but also in the nation as a whole; this can be realized when comparing the 1931 and 1941 employment figures for the nation, noting the proportionate increase. The manufacturing sector, on the other hand, as well as the trade sectors were relatively stable, in employment terms from 1931 to 1941, while the other sectors experienced slight decreases. It can be said, therefore, that the wartime economy was such that the employment structure shifted, and people were better utilized in more critical sectors as food and manufacturing at the cost of the less critical sectors mentioned above. This was experienced at both the regional and national levels of the economy.

The prairie region at the beginning of the study period, however, had a rural society and economy still greatly dependent upon agriculture compared to Canada's increasing economic diversification. Barr stated that "The economic development of the prairie provinces proceeded initially on the basis of agriculture, and during the first three decades of the twentieth century a significant share of Canadian gross capital formation was composed of prairie farm and transport investment" (Barr, 1972, p.65). Other economic activities existed, (Table 3.5), but their individual importance as employers was not as great as the agricultural sector. The rural nature of the region can be further realized when noting that over fifty percent of the population in 1941 was classified as rural (Table 3.1) and the urban system that existed at that time was still young. There existed only a total of eleven cities whose populations were greater than ten thousand, and only one of those centres - Winnipeg - was in the one hundred thousand or greater population class.

3.3 The Prairie Economy from 1941 to 1971

3.3.1 Introduction

The period from 1941 to 1971, on the other hand, was one in which the prairie urban and regional economy greatly matured from its agricultural-rural base to the urban-oriented society that existed in 1971. Due to varying circumstances, however, the paths of development differed in the

three provinces, and consequently the process of urbanization-industrialization differed in the respective provinces.

Comparing the provincial figures with the national figure of seventy-five percent urban, Table 3.1 illustrates that Saskatchewan was still quite rural in 1971. However, when noting the actual change in the percentage share of total population in the urban classification, (Table 3.1a); from 1941 to 1971 it can be seen that the proportionate population shift for Saskatchewan was the same as that for Canada. The changes in the urban share of population during the intervening years, however did not take place at similar points in time. Saskatchewan, for example, experienced greater increases than Canada in the percent urban classification for the period 1941-1951 and 1951-1961, while the period 1961-1971 was one in which the percent urban for Saskatchewan experienced a decline. The Canadian experience for the latter time period was such that there was an increase in the percent urban.

The percent share of Alberta's total population classified as urban was highest from 1951 to 1971; implying that Alberta's urbanization development was the most advanced of the three prairie provinces at that time. This was not so at the opening of the study period when Manitoba's urban share of total population in the prairies was highest. The

changes can be seen in Table 3.1a. Not only did the proportionate amounts change, to make Alberta the most urbanized province, but also the total population figures changed. It can be seen for each time period recorded that Alberta's total and urban population increased more than it did in Manitoba as well as Saskatchewan (Table 3.1). Also by 1971 the proportion of Alberta's urban population was only two percentage points behind the national figure. Thus in the thirty year period from 1941 to 1971 Alberta's urban developmental position, in terms of urban distribution, shifted from second to first place within the region. Saskatchewan's position, on the other hand, did not change in the sense that it was still the least economically developed of the prairie provinces in 1971; Manitoba, in terms of economic development, shifted from first to second position.

9 The magnitude of the population changes within each province can be realized by looking at data in Table 3.1a. The population shifts within each province from rural to urban for each decade from 1941 to 1971 were marginal compared to the shift over the entire period. For example, Alberta's share of urban population increased steadily each decade from 1941 to 1971 with the result that during the thirty year period, the urban share of total population almost doubled. To provide a comparison, it can be seen that Alberta's shift in the population distribution was even greater than the

national average for the period. The change in the percent urban for Manitoba was not as extreme as Alberta's change, but it too was greater than the national average, while Saskatchewan's total change for the period about equalled the national average.

Thus it can be said that the prairie rural society as seen in 1941 had changed and was becoming more urban, in terms of population distribution, at a rate equal to, if not more than, the national average from 1941 to 1971. Also it is evident from the figures that a pattern exists in which the western edge of the region has experienced a population shift from rural to urban at a higher rate than the central or eastern edge of the region. It is hypothesized that this population change, marking a decline in the proportion of rural population, is due to the changing nature of agriculture that has been evident since 1941, and also due to the type of economic functions that have evolved to replace the traditional agriculturally based economy. Manitoba, for example, up to 1941 was the most economically advanced of the three provinces, having achieved its importance as the regional service centre for the agricultural based activities that supported the west at that time. It was mentioned above that in fact the province, with its major city Winnipeg, has been called the gateway to the west (Nader, 1975; Smith, 1972; Burghardt, 1971). Nonetheless, the economic circumstances in

the period that resulted in a lessening of the prairie's dependence on agriculture, also resulted in a slower rate of growth for Manitoba since 1941. Manitoba's Winnipeg-based industries were related to agriculture, (i.e. wholesaling, slaughtering and meat packing, transportation), and when the region's economic base reoriented itself to other activities or in other words diversified, the impact of this change was felt strongly in Winnipeg. Because Winnipeg was the dominant city in the province in 1971 a decline in its rate of economic growth would clearly affect the growth of the province as a whole (see concentration of population in 1971 - Table 3.3, as well as percent population growth from 1931 to 1971 - Table 3.2; Burghardt, 1971).

Thus, restricting one's attention solely to the urban-rural distributions for the prairies, it can be hypothesized that in order for the region to have urbanized at the rate it did, the economic activities must have been available to provide an alternative to agriculture and that the greater part of the region therefore underwent economic diversification to expanding sectors.

3.3.ii The Changing Employment Structure

The above hypothesis can be readily substantiated by reviewing Tables 3.6-3.8 which summarize the employment distribution for the region and Canada at each decade from 1941 to 1971. In 1941, as was discussed earlier, the greater pro-

Table 3.6 DISTRIBUTION OF THE LABOUR FORCE - 1951

Province	Wage-Earners, 14 yrs of age and over, by industry 1951								
	Agriculture	Mining Quarrying & Wells	Manufacturing	Transportation & Communication	Trade	Finance & Insurance	Services	Other	Total
(no.)	73,827	2,154	33,903	23,560	18,361	1,674	30,422	114,600	298501
Manitoba (%)	24.73	0.72	11.36	7.89	6.15	0.56	10.19	38.39	100.00
(no.)	147,580	8.49	14,019	20,435	15,372	10.74	23,048	79,705	302112
Saskatchewan (%)	48.85	0.28	4.64	6.76	5.09	0.36	7.63	26.38	100.00
(no.)	111,745	7,475	25,492	26,251	20,335	2,254	35,126	121,869	353898
Alberta (%)	32.52	2.11	7.20	7.42	5.75	0.64	9.93	34.44	100.00
(no.)	830,441	65,291	841,368	413,307	308,573	32,305	516,782	2,278,086	5,286,153
Canada (%)	15.71	1.24	15.92	7.82	5.84	0.61	9.78	43.10	100.00

SOURCE: Census of Canada, 1951, Occupations and Industries, Table 4.

Table 3.7 DISTRIBUTION OF THE LABOUR FORCE - 1961

Province	Wage-Earners, 14 yrs of age and over, by industry 1961								
	Agriculture	Mining Quarrying & Wells	Manufac- turing	Transporta- tion & Commu- nication	Trade	Finance & In- surance	Service	Other	Total
(no.)	59,301	5,620	46,713	39,735	57,348	12,226	64,042	57,657	342,642
Manitoba (%)	17.31	1.64	13.63	11.60	16.74	3.57	18.69	16.83	100.00
(no.)	119,237	4,007	15,177	30,316	45,601	7,116	58,762	45,373	325,589
Saskatchewan (%)	36.62	1.23	4.66	9.31	14.01	2.19	18.05	13.94	100.00
(no.)	103,573	17,350	42,217	47,435	80,096	14,695	93,424	90,721	489,511
Alberta (%)	21.16	3.54	8.62	9.69	16.36	3.00	19.09	18.53	100.00
(no.)	640,786	121,702	1,404,865	603,286	991,490	228,905	1,263,362	1,217,454	6,471,850
Canada (%)	9.90	1.88	21.71	9.32	15.32	3.54	19.52	18.81	100.00

SOURCE: Census of Canada, 1961, Industries by Sex, Table 1.

Table 3.8 DISTRIBUTION OF THE LABOUR FORCE - 1971

Province	Wage-Earners, 15 years of age and over, by industry 1971								
	Agriculture	Mining Quarrying & Wells	Manufacturing	Transportation & Communication	Trade	Finance & Insurance	Service	Other	Total
(no.)	47,865	7,805	56,945	40,015	65,215	15,815	94,520	86,530	413,915
Manitoba (%)	11.37	1.88	13.75	9.66	15.75	3.82	22.83	20.90	100.00
(no.)	100,675	7,370	19,895	27,735	51,695	10,595	81,675	72,225	371,070
Saskatchewan (%)	27.13	1.98	5.36	7.47	13.93	2.85	22.01	19.46	100.00
(no.)	86,705	26,595	62,420	54,540	104,205	25,260	168,485	160,070	688,290
Alberta (%)	12.59	3.86	9.06	7.92	15.13	3.66	24.47	23.25	100.00
(no.)	481,190	139,035	1,707,330	571,065	1,269,290	358,060	2,041,390	1,959,565	8,626,925
Canada (%)	5.57	1.61	19.79	7.77	14.71	4.15	23.66	22.71	100.00

SOURCE: Census of Canada, 1971, Industries.

portion of the people were engaged in agricultural activities, from over fifty percent in Saskatchewan, to forty-seven percent in Alberta and thirty-three percent in Manitoba. Approximately half of the Canadian labour force was spread evenly in agricultural and manufacturing activities, with the remaining labour force spread throughout other activities. Manitoba, the more economically diversified of the three provinces, had a greater proportion of its population engaged in manufacturing in 1941 than either Alberta or Saskatchewan, but only half the proportion for Canada as a whole. It should be noted, however, that the manufacturing sector in Manitoba at that time only employed one-third the proportion of people employed by the agricultural sector. Comparing these figures with the employment statistics for 1971 and the intervening decades, the changing regional economy can be recognized. In short it can be said that since the 1930s and 1940s

... growth in production has been chiefly related to mineral extraction, while the need for agricultural labour has been more than halved by improved farming techniques. The result has been a radical shift in employment structure, along with equally radical shifts in population distribution and the location of economic activity. Rural-urban migration and rapid urbanization have become major trends; Winnipeg's domination of the urban system has been greatly reduced; the role of the railways has been diminished under the impact of road, air, and pipeline transportation; the plains area has become a significant petroleum producer; and the Canadian shield has witnessed major increases in the production of non-ferrous metals ...

(Barr, 1972, p.65)

In Canada in 1971 only five and a half percent of the population was engaged in agriculture (Table 3.9), about twenty percent in manufacturing and almost twenty-four percent in the service industry. The country in thirty years, had moved from a more or less rural agricultural society to a more industrially diversified one. The development paths for each of the three prairie provinces, on the other hand, had not changed as much as that of Canada, but their changing economic structure is readily apparent.

Saskatchewan, in 1971, was still the most rural, least industrially developed of the three prairie provinces, with agriculture still employing the greatest proportion of the population (Table 3.9). However the data in Table 3.10 illustrates that the importance of agriculture in Saskatchewan has been declining since 1941 at a fairly constant rate. The only other employment sectors which experiences any notable changes during the study period were the trade and sectors; both of which experienced proportionate increases in the 1951-61 period. In fact these two sectors experienced approximately the same proportionate increases during that time in all three prairie provinces as well as in Canada as a whole. Aside from these two sectors the other sectors experienced only slight proportionate increases in Saskatchewan from 1941 to 1971. Thus the Saskatchewan economy, from 1941 to 1971, still had a strong agricultural

Table 3.9 CHANGE IN PERCENTAGE SHARE OF
THE LABOUR FORCE
1941-1951, 1951-1961, 1961-1971
1941-1971

Activity	Year			
	1941-1951	1951-1961	1961-1971	1941-1971
Manitoba				
Agriculture	- 8.71	- 7.42	- 5.94	-22.07
Mining Quarrying & Wells	- 0.58	+ 0.92	+ 0.24	+ 0.58
Manufacturing	- 1.47	+ 2.27	+ 0.12	+ 0.92
Transportation & Comm.	- 0.16	+ 3.71	- 1.94	+ 1.61
Trade	- 6.74	+10.59	- 0.99	+ 2.86
Finance & Insurance	- 1.78	+ 3.01	+ 0.25	+ 1.48
Service	- 7.99	+ 8.50	+ 4.14	+ 4.65
Other	+29.12	-21.56	+ 4.07	+11.63
Saskatchewan				
Agriculture	- 8.64	-12.23	- 9.49	-30.36
Mining Quarrying & Wells	- 0.10	+ 0.95	+ 0.75	+ 1.60
Manufacturing	- 0.41	+ 0.02	+ 0.70	+ 0.31
Transportation & Comm.	+ 0.93	+ 2.55	- 1.84	+ 1.64
Trade	- 2.95	+ 8.92	- 0.08	+ 5.89
Finance & Insurance	- 0.78	+ 1.83	+ 0.66	+ 1.71
Service	- 7.81	+10.42	+ 3.96	+ 6.57
Other	+21.29	-12.44	+ 5.52	+13.37
Alberta				
Agriculture	-14.75	-11.36	- 8.57	-34.68
Mining Quarrying & Wells	- 1.35	+ 1.43	+ 0.32	+ 0.40
Manufacturing	- 0.95	+ 1.42	+ 0.44	+ 0.91
Transportation & Comm.	+ 1.23	+ 2.27	- 1.77	+ 1.73
Trade	- 3.44	+10.61	- 1.23	+ 5.94
Finance & Insurance	- 0.75	+ 2.36	+ 0.66	+ 2.27
Service	- 6.23	+ 9.16	5.38	+ 8.31
Other	+27.55	-15.91	+ 4.72	+11.68
Canada				
Agriculture	- 9.16	- 5.81	- 4.33	-19.30
Mining Quarrying & Wells	- 0.98	+ 0.64	- 0.27	- 0.61
Manufacturing	- 6.81	+ 5.79	- 1.92	- 2.94
Transportation & Comm.	+ 1.50	+ 1.50	- 1.55	+ 1.45
Trade	- 5.17	+ 9.48	- 0.61	+ 3.70
Finance & Insurance	- 1.54	+ 2.93	+ 0.61	+ 2.00
Service	- 8.47	+ 9.74	+ 4.14	+ 5.41
Other	32.07	-24.29	+ 3.91	+11.68

SOURCE: Derived from Tables 3.5 - 3.8.

Table 3.10 AGRICULTURAL STATISTICS

Province	Population			Farms		Area (acres)		
	Total Pop.	Farm Pop.	% of Tot. Pop.	No. of Farms	Area in Farms	% of Tot. Area	Avg. area per Farm	
Manitoba	1931	700,139	256,305	36.6	58,104	15,131,685	11.2	279
	1941	729,744	249,599	34.2	62,295	16,891,322	12.5	291
	1951	776,541	219,233	28.2	52,383	17,730,393	12.6	339
	1961	921,686	172,946	18.8	43,306	18,169,951	13.4	420
	1971	988,247	131,202	13.3	39,573	19,008,059	14.0	543
Saskatchewan	1931	921,785	564,012	61.2	152,899	55,673,460	39.5	408
	1941	895,992	514,677	57.4	157,250	59,960,927	42.6	432
	1951	831,728	399,473	48.0	112,018	61,663,195	40.5	551
	1961	925,181	305,740	33.0	93,924	64,415,518	45.7	686
	1971	926,242	233,792	25.2	95,509	65,056,875	46.2	845
Alberta	1931	731,605	375,097	51.3	106,706	38,977,457	24.5	400
	1941	796,169	383,964	48.2	109,216	43,277,295	27.2	434
	1951	939,501	345,222	36.7	84,315	44,459,632	27.9	527
	1961	1,331,944	287,814	21.6	73,212	47,228,653	29.7	645
	1971	1,627,874	237,924	14.6	70,319	49,506,287	31.4	790

Source: Census of Canada, 1931, Agriculture
 Census of Canada, 1941, Agriculture
 Census of Canada, 1951, Agriculture
 Census of Canada, 1961, Agriculture
 Census of Canada, 1971, Agriculture

input but its importance as an employer was decreasing as other sectors were becoming more important. However, when comparing the 1971 manufacturing employment figures it can be seen that Saskatchewan has not been developing an industrial base to replace agriculture. Its industrial development in manufacturing employment terms still lagged behind the Canadian figure by a significant proportionate amount (Table 3.9). The proportions employed in the other sectors, nonetheless, were quite similar to the national average. For example, seven percent of Saskatchewan's labour force was employed in the transportation and communication sector - the corresponding figure for Canada was seven and three-quarters percent. Thus it can be seen that the province's non-agricultural, urban activities were more diversified in 1971 than in 1941 in the sense that these sectors or activities employed a greater proportion of the labour force. However this greater diversification did not include a significant amount in manufacturing, which has been recognized as a growth sector (Chapter 2). A large proportion of the provincial labour force was engaged in slower growth, service related activities, whose non-local multiplier effects are limited. Though, overall, service employment has been growing faster than manufacturing employment for some time.

Manitoba's economy also underwent changes in the period from 1941 to 1971 and experienced a decline in the proportion

Figure 3.1

Net Value of Production in Commodity
Producing Industries by Value and Percent Contribution
to Total, Alberta, 1971 - 1975

Alberta bureau of statistics - 1975

of the labour force engaged in agriculture. This diminishing dependence on agriculture can be realized when noting that the 1971 proportion employed in that sector was two-thirds lower than it was in 1941 (Tables 3.5, 3.8). The proportions of the labour force in other sectors increased slightly, but none of the increases were as great as they were in Saskatchewan (Table 3.9). The activity classification which indicates the greatest proportional change over the selected time periods since 1941 is the sector called other. It includes the following activities: forestry, defence, as well as the construction industry, the last of which is responsible for the greatest percentage of the changes in this classification. The increase in the proportion of manufacturing employment since 1941 was slight, but these figures indicate that despite its slow growth it maintained an important position in the provincial economy. This becomes apparent when noting (Table 3.8) that the proportions employed in manufacturing in Manitoba were not markedly lower than the proportions employed in Canada. The employment figures for the remaining sectors were similar to Canadian figures for 1971, with the figures for the Manitoban transportation and communication sector as well as the trade sectors being slightly higher. Thus it can be seen that despite the still greater proportion of people employed in agriculture in Manitoba, compared to the Canadian figure,

its importance had declined relative to the growing urban related activities.

Alberta's economic diversity had improved significantly by 1971 to the point where in terms of the distribution of labour, its economic situation was similar to Manitoba's. The importance of agriculture as an employer declined even more markedly than in any of the other Prairie provinces with a drop of a little more than thirty percent in the proportion of people employed in that sector. There was only a slight increase in the proportion of people engaged in manufacturing from 1941 to 1971 (Table 3.9) and this figure was ten percent lower than the national average. The greatest changes took place in the trade and service sectors, with increases of about six and eight percent respectively for the years 1941 to 1971. Changes in the proportion of people employed in the remaining sectors were slight. Thus again it becomes apparent that the role of agriculture as an employer has been diminishing, its replacement being the more urban related activities.

It would have been useful to supplement the employment distribution data with net value of production data for each sector and time period in each province, to further document the declining contribution of agriculture to the regional economy. The argument has been presented above in terms of

the declining proportion of people employed in agriculture and the accompanying increases in the other sectors of the economy. Unfortunately, as mentioned previously, with the exception of Alberta, production data for the period 1941 to 1971 could not be located. Nonetheless the data for Alberta are useful and, with limitations, allow inferences to be drawn with reference to the other provinces concerning the economic contribution, in dollar terms, of the individual employment sectors. The data in Figure 3.1 illustrate the greater importance of the mining and construction industries to the Albertan provincial economy, compared to the contributions of the agricultural sector for the years 1971 to 1975. Thus it can be seen that even though employment distribution data may not be the most appropriate to explain economic development changes over a period of time, they can be used to do so when faced with data limitation problems. The data represented in Figure 3.1, regarding Alberta's economic situation, do point out that agriculture was not the leading sector of the economy in 1971, when it was in 1941.

It should be noted, however, that the decline in the number of people engaged in agriculture does not imply a reduction in the amount of activity for this sector in the prairie region. From Table 3.10 it can be seen that the overall acreage under cultivation, for all provinces, has increased since 1941; more improved land has come under culti-

Figure 3.1

Net Value of Production in Commodity
Producing Industries by Value and Percent Contribution
to Total, Alberta, 1971 - 1975

vation. More important though, changes took place in the number of farms and the average area per farm from 1941 to 1971. In all three provinces the number of farms declined by at least thirty percent and the average farm size has almost doubled in the thirty years from 1941 to 1971. The reason for these changes is that agriculture is now a capital-intensive industry.

Investment in the basic resource -land- remains important. However, especially within the last 25 years, emphasis has been placed on investment in buildings, machinery, equipment, and the application of other improved technological innovations which enable the individual worker to handle larger acreages and greater numbers of livestock more efficiently.

(Proudfoot, 1972, pp.57-58)

Thus the role of agriculture as an employer, and its importance to the regional economy, has shifted since 1941. In Alberta it has lost its position as the number one contributor to gross provincial product. In 1971 agriculture contributed "... less than one-third of the value added in the goods-producing industries and employs, directly, fewer than one in seven of the total labour force" (Proudfoot, 1972, p.51). The improvements in agricultural technology facilitated these transformations in the industry, and as a result of the increased productivity which came about, agriculture in terms of "crop output", contributes more if not the same to the regional economy in 1971 as it did in 1941 (Stabler, 1969, pp.152-157). These changes in crop produc-

tion, however, emphasize the current dilemma of prairie agriculture whereby yields are increasing but in dollar terms the contribution to the economy, compared to other sectors, is declining. The problem lies with the inability of producers to alter prices in the market.

Increasingly sophisticated methods of production are available which will increase yields, yet, concurrently, the market for many prairie products is declining or at best static, often in terms of both volume demanded and price offered. Moreover, the major markets for prairie products are external to the region, if not outside Canada. Only in limited parts of the Canadian market, and nowhere on international, do prairie producers command a dominant or near monopolistic position, so that they generally have little impact on market prices.

(Proudfoot, 1972, p.63)

The shifts in the regional economy from 1941 to 1971 have been presented above. In the following section the developments that took place which have been replacing agriculture as the major contributor to the economy will be studied.

3.4 Factors Contributing to the Regional Transformations

The real question therefore, is not whether the role of agriculture declined but what did these agricultural changes mean to the prairie economy as a whole, and what other factors came about to produce the increase in urbanisation and the employment transformations of the economy.

Farm mechanization in itself would have implied a satisfactory level of per capita income, a decline of rural populations, and a long run decline of total population. Nonetheless the population figures in Table 3.1 illustrate that the long run decline of total population, in the region as a whole, never came about. Population increases were felt in all provinces, and these changes occurred at a faster rate in Alberta. The population in Alberta doubled from 1941 to 1971, while Manitoba's population increased by one-third and Saskatchewan's dropped by ten percent, then rose to maintain a nearly stationary position. The question to be answered therefore pertains to the relationships between the acceptance of farm mechanization and the increase, rather than decrease in total population from 1941 to 1971. Briefly it can be said that the factor responsible for this "salvation" of the prairie economy was the development of new mineral resources such as petroleum.

In the decades preceding 1947 almost no petroleum was produced in Canada; however, in the following period from 1947 to 1956 the main discoveries of Canadian oil came about. Before oil was discovered at Leduc, in 1947, a surge of out-migration was taking place from the region (Hansen, 1972; Stabler, 1969, pp.158-163). The discovery of petroleum changed this and led to the creation of new regional industries and occupations as well as increases in the population,

income, wealth and prestige of the region, especially Alberta. More explicitly, pipelines were built to Canadian and American markets, providing jobs as well as improving regional incomes via export sales. Refineries and natural gas processing facilities were also constructed and the establishment of a small petrochemical industry took place (Stabler, 1969, pp.160-163). The new jobs that were created by the petroleum industry further stimulated the population-oriented sectors of the manufacturing, trade and service industries.

Petroleum was also discovered in Saskatchewan, but at a later date. The discoveries in Saskatchewan, on the other hand, helped raise the value of the province's mineral production, but have not generated the linkage effects that took place in Alberta. The reason is that these discoveries were simply treated as an extension of Albertan development (Stabler, 1969, p.163). However, the resource that will more than likely contribute a great deal to Saskatchewan's economic development is potash. Production was initiated in the late 1950's and the extraction and production of the mineral will make Saskatchewan the world's largest producer of potash (Stabler, 1969, p.164).

A result of the discovery of oil and potash was the rise in per capita income, which in turn led to the increase

in the number of service related jobs that came about since 1941 (Table 3.9). Before presenting an explanation regarding the increase in service activities, a description of the service sector will be given which may help explain the changing employment structure. The service industries, which provide public goods or services for all individuals, have two basic characteristics. First, they experience slower rates of productivity than capital intensive industries, because of their labour content, and, second, they are characterized by high income elasticities of demand (Hirsch, 1973, p.297). The higher per capita income in the region satisfied the higher income of elasticities of demand characteristic and, as a result, services were more in demand. The high labour content of the service industry meant that an increase in the demand for services, followed by an increase in their supply, resulted in the opening of many jobs.

The totality of the changes have thus resulted in attracting migrants within the region to the urban centres and reversing the flow of outmigration from the provinces. It can be inferred, therefore, that the net effect of these mineral discoveries was to increase local (prairie) population thresholds, especially in Alberta, which were necessary to help sustain the new industries that came into existence.

Without economic development based on mineral discoveries, the prairie provinces in 1972 could have been a sparsely settled agricultural region primarily dependent on the cruel vagaries of the international grain market and on the small Canadian market in which prairie agricultural produce faces both domestic and foreign competition. It has been suggested, for example, that if petroleum had not been discovered, the largest Alberta export after World War II might well have been people Hanson has estimated that without the petroleum and mining industries, the population of the prairie provinces in 1966 would have been only half of their 3.4 million: the petroleum industry alone accounts for more than a million additional people The growth of the petroleum industry and the creation of employment in manufacturing and service industries have allowed the prairie economy to diversify away from the previous agricultural base, and the exploitation of coal, potash sodium sulphate, sulphur, nickel, and wood pulp resources has helped to broaden the primary industrial base. (Barr, 1972, pp.65-67)

3.5 Summary

From 1941 to 1971 the prairie economy experienced considerable economic development; the economy in 1941 was greatly dependent upon the agricultural sector, and has progressed to the point where in 1971 it had diversified more into the secondary and tertiary sectors as well. This diversification was greatly facilitated by the mineral discoveries.

The rapid urban development that has taken place in the prairies, during the thirty year period under study, was not due solely to the mechanization of agriculture, because it was seen above that mechanization of agriculture, alone,

would have resulted in a large outflow of people from the area. The role of agriculture was important, but its greater importance was restricted to the period of the early settlement of the west.

Pred (Chapter 2) and a few other theorists suggest that urban growth is a function of urbanization and diversification of the economy into growth sectors. The above description of the economic history of the region, from 1941 to 1971, illustrates that this in fact has been and is occurring in the area. The mineral discoveries behaved as a catalyst to the economic developments that have taken place. However, mechanization of agriculture was necessary as well, because the release of individuals from the farms helped satisfy the population thresholds that were required to support much of the urban employment that followed. Nonetheless, in order for the cities to experience more growth they must diversify their economic bases to take in growth inducing industries that generate local and non-local multiplier effects. Thus cities with higher proportions of manufacturing activities or other growth related industries will experience higher rates of growth. Other growth inducing activities might be construction, transportation or finance.

The predominant factor that stimulated the Albertan urban and regional economy was the discovery of oil and the resultant petroleum industry. It increased regional per capita incomes, which resulted with more jobs in the service sector and opened up a whole new industrial complex related to petroleum. As a result more employment opportunities were opened up in the Albertan cities and multiplier effects were beginning to take place which further reinforced the urban growth that came about.

Two other factors related to urban growth pertain to demographic characteristics and community characteristics. Growing urban centres are characterized by a large proportion of the urban population lying between the ages of 15 and 65. People within this age bracket provide an active labour force for the economic activities found in cities and also help raise urban and regional per capita income levels. Community characteristics, on the other hand, may also help stimulate urban growth by attracting immigrants to a particular region because of the amenities they offer. People may come to a city because it has good schools and hospitals, good police protection and so on, as well as the job opportunities that are available. So in a discussion of urban growth, the factors related to community characteristics should also be kept in mind.

The relationship between mechanization of agriculture and prairie urban and regional development has been discussed above. The remaining hypotheses will be discussed in the following chapter using multivariate analysis.

FOOTNOTES FOR CHAPTER 3

¹These figures including all persons working in agriculture - owners and hired workers. The Census of Canada defines the labour force as persons

... who, in the week prior to enumeration, worked for pay or profit, helped without pay in a family business or farm, looked for work, were on temporary lay-off, or had jobs from which they were temporarily absent because of illness, vacation, strike, etc.

(Census of Canada, 1971, Industries).

CHAPTER 4

A MULTIVARIATE MODEL OF GROWTH

4.1 Introduction

This chapter examines the growth of the eighteen largest prairie cities in 1971, for the period 1941 to 1971. These cities, whose populations are over ten thousand, were chosen because of the greater availability of data for cities of this size as compared to smaller cities.¹ Growth is defined as the percentage increase in urban population over this period. This increase could be due to natural population growth, to a net influx of migrants, or to adjustments in municipal boundaries. The latter case, though, does not really apply to prairie cities since most population growth took place within existing urban boundaries (Stone, 1968). The changing urban system will be studied according to the following outline: a) the hypotheses will be listed; b) a discussion of the growth of the urban system will be presented; c) the independent variables will be discussed and grouped using principal components analysis; and d) the percent urban growth for each city from 1941 to 1971 will be tested, to determine its correlates, and the results of the multiple regression will be tested for statisti-

cal significance.

4.2 Hypotheses

4.2.1 Introduction

The first hypothesis concerning growth and the urban system is associated with the role of agriculture as it was discussed in the previous chapter. In summary it can be stated that the role of agriculture as a stimulant to urban growth and urban system development is diminishing. Urban centres whose economic base depends predominantly upon servicing an agricultural population will either stagnate or decline (Hodge, 1965). The previous chapter suggested that the prairie region would have experienced population decline as a result of the mechanization of agriculture, had the economy not diversified into other growth inducing activities. As a result of this diversification, the urban system grew faster than the national average for the time period under study. The hypotheses to be discussed and analysed in this chapter therefore will be restricted to those concerning the diversification of the urban and regional economies.

4.2.ii The Petroleum Industry

The petroleum industry provided a strong stimulus to the regional economy and was the predominant factor responsible for the great urban growth that took place from 1941-1971. Urban Alberta and Manitoba experienced growth rates

higher than the national average for the period while Saskatchewan's rate of urban growth kept pace with the national average for the period. The manner in which the petroleum industry stimulated the regional economies took place as follows - regional per capita incomes increased due to the development of the oilfields; employment opportunities opened up in the primary and secondary sectors of the economy as a result of the mineral discoveries; employment opportunities in the tertiary sector of the economy became available due to the increases in per capita income (Chapter 3; Stabler, 1969). As a result of these changes the region became an attractive area for people to migrate to, or, for those already there, in which to remain. As a result, those prairie cities located near the petroleum fields developed economic bases related to the petroleum industry in which positive economic benefits were felt throughout the urban economy. These benefits thus resulted in economic development and population growth. Therefore it is postulated that the petroleum industry initiated a series of local and non-local multiplier effects that behaved to stimulate urban growth in the regional economy.

4.2.iii Growth Inducing Economic Activities

The third hypothesis to be tested pertains to the presence of economic activities with high growth potential which are necessary to stimulate urban growth (Chapter 2).

CANADIAN OIL AND GAS MAP.

THE ROYAL CANADIAN MOUNTED POLICE
AND THE CANADIAN DEPARTMENT OF MINES
EDMONTON, ALBERTA.

OIL FIELDS
GAS FIELDS

It has already been mentioned that the sector that has generated much economic growth in the United States and in Central Canada is manufacturing industry. It was seen that the ability of manufacturing industry to stimulate growth is related to the necessity of firms to diversify their product lines quickly in order to maintain competitive positions. The location of the corporate head office is also critical in influencing which cities will benefit from the presence of a manufacturing firm because firms wish to minimize the uncertainty factor in their decision making process. One way of doing so would be to locate subsidiary plants close to the head office (Ray, 1968). The purpose of this hypothesis, however, is not to test the theoretical growth inducing abilities of the manufacturing sector but to determine whether it played a significant role in stimulating the prairie urban economy. Therefore the hypothesis to be tested can be stated as follows: the manufacturing sector contributed significantly to the overall growth of the prairie urban system, and those cities whose economic activities included manufacturing, experienced higher rates of growth.

4.2.iv Growth Inducing Community Characteristics

The fourth hypothesis to be tested relates to community characteristics or degree of physical development. In order for cities to maintain or attract new populations they must be attractive to the people who live there and offer social

benefits to attract migrants. These services can be in the form of a greater number of schools and hospitals, or can be related to the per capita expenditure on police and fire protection, or can even be the amount and type of cultural facilities offered to the residents (Bish, 1971; Hirsch, 1973; Gillespie, 1971). Obviously the amenities offered by cities are not the only factors that would attract potential migrants, but the services offered do help make a city, and the characteristics should therefore be included in the study. Nonetheless, the variables chosen are dependent upon the availability of data. It is therefore proposed that cities which offer a wide range of social, educational and other services will be more attractive to migrants and will have greater success in retaining indigenous population and will thus experience greater rates of growth.

4.2.v Demography of Urban Areas

The final hypothesis relates to the demographic characteristics of urban areas. The hypothesis to be tested is that growing urban centres have the following characteristics - a greater proportion of the population being between the ages of 15 and 65, higher proportion of adults with university education, higher male to female sex ratios, and a high proportion of recent immigrants within the urban population; characteristics describing the work force of cities.

The hypotheses pertaining to the role of community characteristics and of demography in stimulating growth may be more appropriate for the next thirty years as opposed to the thirty years actually studied. There is some ambiguity with some of the variables which were included to satisfy the hypotheses, (Table 4.3), as to their cause/effect role with urban growth. It seems logical to imply that the variables under the sub-heading "Community Characteristics" would be a result of the urban growth from 1941 to 1971, not necessarily a cause of that growth. Demographic variables which could fit into this group of "effect" are POPDEN and POP71. As a result great care must be taken in analysing the role these variables had in the growth of the urban prairie region from 1941 to 1971.

4.3 Growth of the Prairie Urban System

The previous chapter showed that the region underwent rapid urbanization between the years 1941 and 1971. In this section the growth rates of individual cities will be presented and analysed briefly before proceeding on to the statistical analysis. The growth rates of individual cities are listed in Table 4.1. The table shows that the growth rates of the cities varied greatly; it can be seen that a large part of the growth took place in Alberta and that cities in Manitoba experienced slower rates of growth. Looking at the individual growth experiences of the urban areas from 1941 to 1971 is one method of comparing the urban development path of the cities within the region. Another approach to studying growth has been adopted in some recent studies (Ray, 1974; Ray et al., 1975), and it analyzes growth in terms of allometries. In other words, for the purposes of this study, the growth of each individual urban area can be compared to the urban growth of the region as a whole, to determine whether the cities grow slower, or at the same rate, or faster than the regional average for the period under study.

The law of allometry relates the changes in the proportionality of the parts of any system to the size of the system as a whole (Ray, 1974, p.21). The allometries to be calculated in this study measure the proportionality of the

Table 4.1 URBAN POPULATION 1941, 1971 AND
GROWTH RATE 1941 TO 1971

<u>Urban Area</u>	<u>Population 1941</u>	<u>Population 1971</u>	<u>Percent¹ Growth 1941-1971</u>
Brandon	17,383	31,150	79
Calgary	88,904	403,319	354
Edmonton	93,817	495,702	428
Flin Flon	12,833*	11,201	-12
Grande Prairie	1,724	13,079	659
Lethbridge	14,612	41,217	182
Medicine Hat	10,571	28,773	172
Moose Jaw	20,753	31,854	53
North Battleford	4,745	15,148	219
Portage la Prairie	7,187	12,950	80
Prince Albert	12,508	28,464	128
Red Deer	2,924	27,674	846
Regina	58,215	140,734	142
Saskatoon	43,027	126,449	194
Swift Current	5,594	15,415	176
Thompson	3,418*	19,001	456
Winnipeg	221,960	540,262	143
Yorkton	5,577	13,430	141

¹Percent Growth calculated as follows:

$$\frac{\text{Pop. 1971} - \text{Pop. 1941}}{\text{Pop. 1941}} \times 100$$

*These are 1961 figures taken from Canadian Urban Trends, ed. by D. M. Ray.

Source: For all other data - Census of Canada, 1941, 1971.

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OF/DE

growth of each individual city to the growth of the total prairie urban region and allometries will also be calculated to measure the growth of each individual city to the growth of the Canadian urban system. Mathematically allometry can be stated as follows:

... When Y is the size of a part and X is the size of the whole $Y = bX^a$, or $\log Y = \log b + a \log X$ and a measures the allometry. When a is 1.0 the part grows at the same rate as the whole ($Y = bX$). When a is less than 1, the part grows more slowly than the whole (for example, if $a = 0.5$, $Y = b \times 0.5$ or $Y = b \sqrt{X}$ and the part grows at half the rate of the whole). When a exceeds 1, the part grows more rapidly than the whole (ex., $Y = bX^2$ is a situation in which the part grows at double the rate of the whole.
(Ray, 1974, p.21)

Table 4.2, lists the allometries of the eighteen cities in the study with reference to the growth of the region itself and secondly to the growth of the Canadian urban system. The allometry of city and region compare the growth of each individual city to the average urban growth for the region. The regional urban growth is calculated as an average only of the eighteen cities. The allometries of cities and Canadian system compares the growth of each city to the total urban growth of the Canadian urban population for the years 1941 to 1971.

The data in Table 4.2 illustrate that there is an east/west gradient in the growth of the region itself; all the cities in Manitoba have allometries of less than one, while

Table 4.2 ALLOMETRIES OF 18 PRAIRIE CITIES
1941-1971

<u>Location</u>	<u>Allometries of City and Region</u>	<u>Allometries of Cities and Canadian System</u>
Brandon	0.61	0.61
Calgary	1.57	1.60
Edmonton	1.55	1.58
Flin Flon ₁	-	-
Grande Prairie	2.17	2.20
Lethbridge	1.07	1.08
Medicine Hat	0.94	0.94
Moose Jaw	0.46	0.45
North Battleford	0.98	0.98
Portage la Prairie	0.63	0.62
Prince Albert	0.82	0.83
Red Deer	2.27	2.28
Regina	0.90	0.92
Saskatoon	1.14	1.17
Swift Current	1.06	1.07
Thompson ₁	-	-
Winnipeg	0.12	0.11
Yorkton	0.89	0.91

¹No data available before 1961

those in Alberta have allometries of almost one or more. These data substantiate the hypotheses stated earlier that the western part of the urban system has grown more in population size than the eastern edge.

Another interesting result is that the data show that the prairie urban system in total grew at virtually the same rate as the Canadian system during this time period. This can be realized by noting that the allometries of city and prairie region are similar to the allometries of city and the Canadian urban system. Nonetheless, the growth rates of the individual prairie cities differ greatly from the growth of the Canadian system. For example, Grande Prairie grew at a rate of a little more than twice the Canadian rate for the period; its allometry is 2.20. Thus the region as a whole may have grown at the same rate as the national system, but the growth rates of individual cities differ markedly. But leaving aside the differing growth rates, the allometries which imply that the region grew at the same rate as the whole Canadian system may not be as accurate or as statistically significant as one would wish. Data presented in Chapter 3 show that the proportionate increase of the prairie urban population increased more rapidly than the proportionate increase of the Canadian urban population from 1941 to 1971. The difficulty of interpreting these allometries, accurately, may be due to the fact that the growth

experiences of the prairie urban populations were only compared to the overall regional urban growth of only the eighteen cities as opposed to the overall regional urban growth including all prairie cities. The data, on the other hand, for the Canadian urban system is comprised of the total Canadian urban population.

4.4 Independent Variables and Principal Components Analysis

4.4.i Analysis of the Initial Principal Components Test

A total of thirty six variables were input into a principal components program, (from the SPSS system of computer programs), in order to transform or group these variables into a new set of factors that are orthogonal or uncorrelated to each other.² The variables to be factored are the 1971 (or later) characteristics of each of the eighteen cities under study; the factors are later to be used in a multiple regression model, as independent variables, to test for the dependency of growth. The original thirty six variables are listed in Table 4-3.

The variables were grouped into the following categories: a) demographic characteristics, b) community characteristics, c) economic characteristics, and d) agricultural characteristics, in order to satisfy the criteria necessary for each of the hypotheses listed above. The agricultural characteristics were initially included to see if the results could lend any further insights to the conclusions arrived at

Table 4.3 VARIABLES INCLUDED IN THE
PRINCIPAL COMPONENTS ANALYSIS

Variable Labels	Definition of Label
<u>Demographic Characteristics</u>	
POP71	Population - 1971
POPDEN	Population density - 1971
PERC15	Percent of population under age 15 - 1971
PERC65	Percent of population over age 65 - 1971
SEXRAT	Sex ratios - 1971
AVGFAY	Average family income - 1971
ELEMED	Percentage of adults with elementary education - 1971
UNIVED	Percentage of adults with university education - 1971
IMPER46	Immigrants landed before 1946 as a percentage of total immigrants - 1971
IMPERTOT	Total immigrant population as a percentage of total population - 1971
<u>Community Characteristics</u>	
INVESTCO	Estimated value of construction - 1971
HOUSUAL	Median housing value - 1971
UTILITY	Per capita expenditures on utilities - 1974/75
PROTCAP	Per capita expenditures on protection services - 1974/75
TRANSCAP	Per capita expenditures on transportation services - 1974/75
RECCAP	Per capita expenditures on recreation and cultural facilities 1974/75
<u>Economic Characteristics</u>	
PERMFG	Percent of labour force in manufacturing activities - 1971
PERTRAN	Percent of labour force in transportation activities - 1971
PERRETAIL	Percent of labour force in retail activities - 1971
PERWHOL	Percent of labour force in wholesale activities - 1971
PERFIN	Percent of labour force in finance activities - 1971

continued

Table 4.3 continued

Variable Labels	Definition of Label
PERPUBAD	Percent of labour force in public administration - 1971
NOMFGBLD	Number of manufacturing establishments - 1971
SICNO	Number of SIC functions - 1971
CHGMFG	Change in manufacturing employment, 1961-1971
PERPETR	Percent of labour employed in the oil industry ¹ - 1971
DISTOIL	Average distance to major oil fields ² - 1976
DISTGAS	Average distance to major gas fields ³ - 1976
<u>Agricultural Characteristics (of area surrounding the municipalities)⁴</u>	
FARMSIZ	Average farm size - 1971
AGPROSO	Average value of agricultural products sold - 1971
DISTHUBA	Distance to Thunder Bay
DEGDAY	Number of degree days over 42 degrees - 1968
FRFRDA	Number of frost free days - 1968
MEANJAN	Mean January temperature - 1968
PRECIP	Total Precipitation - 1968
SUNHRS	Number of sunshine hours - 1968

SOURCES: Census of Canada, 1971;
The Canada Land Inventory, Department of Forestry and
Rural Development, Report #3 - 1966;
Climatic Normals - Vol. 1 - Temperature,
- Vol. 2 - Precipitation,
- Vol. 3 - Sunshine, Cloud, Pressure and
Thunderstorms,
- Vol. 6 - Frost Data - 1968;
Canadian Urban Trends, 1976;
Annual Report of the Department of Municipal Affairs, Pro-
vince of Saskatchewan, 1976;
Municipal Statistics - Province of Alberta, 1974;
Statistical Information respecting the Municipalities of the
Province of Manitoba, 1975;
The Royal Bank of Canada, Oil and Gas Department, Calgary,
Alberta, 1974 and 1976;
Canadian Business Directory, Dunn and Bradstreet, 1977.

continued

Table 4.3 continued

¹Employee totals in the petroleum industry were derived from the Canadian Business Directory. These figures were then taken as a percentage of the total working force of the population to derive the figures used in the analysis.

^{2,3}The principal oil and gas fields were defined by the Oil and Gas Department in Calgary of the Royal Bank of Canada - data for 1976. In order to derive the average distances a matrix was drawn up, upon which distances from each city to the mid point of each field was recorded. These were then totalled and averaged to obtain the figures used in the analysis.

⁴Data, where possible, were obtained for the subdivisions surrounding each urban area. The subdivisions used for each urban area are listed as follows:

<u>Location</u>	<u>Division</u>	<u>Subdivision</u>
Brandon	3	1, 7
	7	1, 2, 3, 7, 8
Calgary	5	2, 6
	6	31, 44
Edmonton	10	9, 13, 22, 30
	11	20, 25, 31, 90
Flin Flon	16	4, 6, 14
Grande Prairie	15	1, 16, 19
Lethbridge	1	2, 3
	4	34
Medicine Hat	1	1, 2, 3, 8
Moose Jaw	6	130, 160, 190
	7	131, 132, 161, 162, 191
North Battleford	12	408, 438
	16	406, 436, 437, 467
Portage la Prairie	6	1, 2, 4
	7	5
	9	4
Prince Albert	15	430, 431, 460, 461, 463,
		490, 491
Red Deer	7	6
	8	14, 23
Regina	6	128, 129, 130, 158, 159, 160,
		189
Saskatoon	11	314, 343, 344
	12	344, 345
	15	344, 373

continued

Table 4.3 continued

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<u>Location</u>	<u>Division</u>	<u>Subdivision</u>
Swift Current	3	106
	4	107
	7	136, 166
	8	137, 138, 167, 168
	16	11, 12, 19
Thompson	1	5, 7
Winnipeg	5	4
	6	1, 3
	9	2
	20	1, 2, 3, 4, 5, 6
	5	213, 214, 215
Yorkton	9	243, 244, 245, 273, 274, 275

One characteristic of the data used may have contributed to the inconsistent pattern of residuals as seen in Figure 4.2. This characteristic pertains to the normality of the data which was input into the principal components analysis. Correlation coefficients resulting from a principal components analysis can be misleading measures of association if the variables are highly skewed. Scattergrams were drawn up for each of the variables used, the result being that some of the data were seen to be skewed. The variables that have a negatively skewed distribution are POP71, POPDEN, NOMFGBLD, SICNO, PERPETR, DISTOIL and DISTGAS. According to the scattergrams the remainder of the variables used in the second principal components analysis conform to a normal distribution. The variables which exhibit a skewed distribution should ideally

be transformed in order to maximize the likelihood of the errors being normally distributed. The variables which reflect city size could be log transformed to make them more normal and the square root of the distance variables could be used to make them more normal.

above concerning the role of agriculture in its relation to urban growth. The climate data were used as surrogates for the productivity of the land in terms of the physical constraints. For example, a longer growing season and a greater total number of sunshine hours, would result, *ceteris paribus*, in a greater diversity of crop types and greater yields. The size of farm is also important for the larger the farm, the greater the possibilities for mechanization which result with higher yields per person.

Principal-components analysis, which attempts to discern all the underlying dimensions existent within a data matrix, begins by calculating that dimension which accounts for the greatest proportion of the total variation. This is described as the principal or first component and its interpretation relates to the degree to which it represents the variables.³ The degree of representation between each of the original vectors and the resolution vector, or principal component can be determined by the correlation coefficient between each respective variable and the abstract mathematical component; this coefficient is referred to as the factor loading. The squares of these correlation coefficients, or factor loadings, will indicate the proportions of variation in the variables that are associated with the variation in the component, and the sum of the squared factor loadings, referred to as an eigenvalue, is used to de-

termine the proportion of total variation that is summarized by the component (Yeates, 1974; Nie et al., 1975).

A principal components analysis was run using the varimax rotation, and using the thirty six variables in Table 4.3 requesting only those factors with an eigenvalue of at least 1.0. These eight factors were rotated; Table 4.4 shows the results.

Table 4.4 RESULTS FROM INITIAL PRINCIPAL COMPONENTS ANALYSIS

<u>Factor</u>	<u>Eigenvalue</u>	<u>Percent of Variation</u>	<u>Cumulative percent</u>
1	9.30	25.8	25.8
2	7.97	22.1	48.0
3	5.20	14.4	62.4
4	3.29	9.2	71.6
5	2.64	7.3	78.9
6	1.74	4.8	83.7
7	1.30	3.6	87.4
8	1.00	2.8	90.1

The data in Table 4.4 indicate that the first four factors account for 71.6 percent of the total variation. The remaining four factors do not contribute significantly to the total explanation. The factor loadings, which summarize the degree to which each variable is associated with or represented by the factor, further reinforces the greater importance of the first four factors, as opposed to the last four factors in contributing to the total explanation of the variables (Table 4.5). The loadings on factors five through eight do

Table 4.5 TABLE OF FACTOR LOADINGS FROM INITIAL PRINCIPAL COMPONENTS TEST

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Pop71								
POPDEN								
PERC15	-.83	.94						
PERC65	.94	.83						
SEXSRAT	-.90							
AUGFAY	-.83							
ELEMED	.76							
UNNED		.60		.58				
IMPER46	.86							
IMPERIOT		.63	.63				.53	
INVESTCO			.66		.54			
HOUSVAL	-.70						.96	
UTILITY								
PROTCAP			.60					
TRANSCAP								
REOCAP		.65	.84					
PERMFG								
PERTRAN	.69							
PERETAIL	.68							
PERWHOL				.79				
PERTIN		.60						
PERPUBAD	.60				.70			
NOMFGBLD		.97						
SICNO		.95						
CHGMFG				.55				
PERPETR								
DISOIL								
DISIGAS								
FARMSIZ								
AGPROSO								
DISTHUBA								
DEGDAY	.74					.60		
						.80		
								-.78

continued

Table 4.5 continued

Variable	Factor 1	Factor 2	Factor 3	Factor 4 ^a	Factor 5	Factor 6	Factor 7	Factor 8
FFRPOA MEANJAN PRECIP SUNHRS			.86	-.79	.70 -.50			

not yield any consistent patterns that would suggest useful interpretations. It also becomes apparent that the data pertaining to agricultural statistics did not group together logically under any one factor. For example, the variable DEGDAY has a high loading on the first factor which seems to explain or summarize the demographic characteristics of the people and it seems illogical to assume that there could be any association between the number of degree days over 42°F and the age or education structure of the population.

It was therefore decided that another analysis would be done with the following changes: a) the number of requested factors to be rotated would be reduced to four, and b) all the agricultural variables would be deleted from the study. The latter change was also justified because the agricultural data did not fit under one factor to be used as the agricultural variable in the regression model. The data provided in the previous chapter, therefore, will be those used to substantiate the conclusions concerning the role of agriculture and urban growth.

4.4.ii Modified Principal Component Analysis

Thus a principal components analysis using varimax rotation and incorporating the above changes was run for the eighteen cities listed in Table 4.1. The variables included in this test were those listed in Table 4.3 from POP71 to DISTGAS, a total of twenty eight. The results are listed

below in Table 4.6.

Table 4.6 MODIFIED PRINCIPAL COMPONENTS ANALYSIS

<u>Factor</u>	<u>Eigenvalue</u>	<u>Percent of Variation</u>	<u>Cumulative Percent</u>
1	8.77	31.3	31.3
2	6.40	22.8	54.2
3	3.48	12.4	66.6
4	2.24	8.0	74.6

Normally, the number of factors to be used is determined by the cutoff point of an eigenvalue of one. King suggests "... that all components contributing less than five percent to the overall explanation should be excluded on the basis that any component explaining less than this proportion must contain a large random-error variance" (Yeates, 1974, p.221). Also, the analysis of the factor loadings of factors four to eight, of the first run, which had eigenvalues of one or more and which explained five percent or more of the variation of the data, yielded inconsistent results. No common pattern of the data could be found in those factors. It is for this reason that the results from this run with eigenvalues of 2.25 or more have been accepted.

Factor One:

Using a minimum factor loading of 0.60 as the cut-off point,⁴ this factor could be said to explain the demographic characteristics as well as the affluence characteristics of

two types of cities (Table 4.7). The first type of city has a higher proportion of its population over 65, a higher percentage of the adult population with only elementary education, a higher percentage of immigrants who landed before 1946, and a higher percentage of the labour force engaged in the transportation, retail and public administration sectors. The second type of city, according to the results, is characterized by a high proportion of the population under the age of fifteen, higher sex ratios, higher average family incomes, and higher housing values. Generally it can be said, by looking at the factor scores, that the more western cities in the region fall in the category of the second type of city (negative factor scores to match with negative factor loadings), and the slower growth, more eastern cities fall into the first category of cities (positive factor scores to match with positive factor loadings), (Table 4.8).

Factor Two:

Using a minimum factor loading of 0.60 as the cut-off point, this factor could be said to explain or describe manufacturing types of cities with larger populations. The variables that had high factor loadings are, in declining order of importance: number of SIC functions, number of manufacturing establishments, population - 1971, population density, percent of the labour force in finance activities, percent of adults with university education, total immigrant

Table 4.7 FACTOR LOADINGS FROM MODIFIED
PRINCIPAL COMPONENTS TEST

Variable	Factor 1	Factor 2	Factor 3	Factor 4
POP71		.90		
POPDEN		.85		
PERC15	-.84			
PERC65	.96			
SEXRAT	-.89			
AUGFAY	-.84			
ELEMED	.73			
UNIVED		.65		
IMPER46	.85			
IMPRTOT		.63		
INVESTCO			.73	
HOUSVAL	-.64			
UTILITY				.68
PROTCAP				
TRANSCAP				.73
RECCAP			.72	
PERMFG		.61		
PERTRAN	.72			
PERETAILE	.75			
PERWHOL				
PERFIN		.69		
PERPUBAD	.61			
NOMFGBLD		.93		
SICNO		.94		
CHGMFG				.78
PERPETR				
DISTOIL			-.90	
DISTGAS			-.92	

Table 4.8 LIST OF INDEPENDENT VARIABLES
FOR MULTIPLE REGRESSION

Location	Independent Variables ¹			
	Demographic-Affluence	Manufacturing	East/west - Constr.	Services & change in Mfg.
Brandon	.62	.18	-1.0	- .08
Calgary	- .90	1.24	1.50	- .84
Edmonton	- .74	1.13	1.04	- .86
Flin Flon	- .91	-1.02	-1.70	.34
Grande Prairie	- .53	- .46	.80	2.88
Lethbridge	- .05	.31	1.04	1.40
Medicine Hat	.70	- .31	.60	- .24
Moose Jaw	1.10	- .31	- .10	-1.90
North Battleford	.76	- .85	.43	- .25
Portage le Prairie	.78	- .67	-1.45	.12
Prince Albert	.32	- .67	.05	- .40
Red Deer	- .50	- .88	1.14	- .07
Regina	.30	.75	.17	- .11
Saskatoon	.03	.21	.22	- .36
Swift Current	.73	- .48	.41	- .14
Thompson	-3.01	- .69	-1.07	- .80
Winnipeg	.24	3.0	-1.64	.68
Yorkton	1.08	- .42	- .40	.60

¹ All data are factor scores rounded to two decimal places, taken from the factor analysis.

population as a percentage of total population and percent of the labour force in manufacturing activities. The loadings (Table 4.7) range from a high of .942 for the variable SICNO (number of SIC functions), to .608 for the variable PERMFG (percent of the labour force in manufacturing activities).

The factor scores (Table 4.8), which illustrate the manner in which each city rates or is characterized by each factor, also have positive and negative values. The cities which have negative factor scores are most characterized by those variables in the factor loadings with negatives values.

The same is true for positive values. All the significant factor loadings for Factor two were positive, and characterize large cities with manufacturing activities. The cities which had high positive factor scores for Factor two were the largest cities in the region, namely Calgary, Edmonton and Winnipeg. Of the three Winnipeg scored the highest. The city that scored the lowest on this factor is Flin Flon, indicating the lack of manufacturing activity in the city (Table 4.9).

Factor Three:

Using a minimum factor loading of 0.70 as the cut-off point, this factor could be said to explain or describe an east/west dimension of the system under study, in relation to distance from the petroleum industry. The variables DISTGAS⁵ (average distance to major gas fields) and DISTOIL⁵

Table 4.9 CLASSIFICATION OF CITIES
ACCORDING TO FACTORS, IN RANK
ORDER OF FACTOR SCORES

Factor One Demographic- Affluence	Factor Two Manufacturing	Factor Three East/West - Construction	Factor Four Services & Change in Manufacturing
Thompson (-3.01)	Winnipeg 456 (3.0)	Calgary 143 (1.50)	Grande Prairie 354 (2.88) 659
Flin Flon (-.91)	Calgary -12 (1.24)	Red Deer 354 (1.14)	Lethbridge 846 (1.40) 182
Calgary (-.90)	Edmonton 354 (1.13)	Lethbridge 428 (1.04)	Winnipeg 182 (.68) 143
Edmonton (-.74)	Regina .428 (.75)	Edmonton 142 (1.04)	Yorkton 428 (.60) 141
Grande Prairie (-.53)	Lethbridge 659 (.31)	Grande Prairie 182 (.80)	Portage la Prairie 659 (.12) 80
Red Deer (-.50)	Saskatoon 846 (.21)	Medicine Hat 194 (.60)	Flin Flon 172 (.34) -12
Lethbridge (-.05)	Brandon 182 (.18)	North Battleford 79 (.43)	Red Deer 219 (-.07) 846
Saskatoon (.03)	Moose Jaw 194 (-.31)	Swift Current 53 (.41)	Brandon 176 (-.08) 79
Winnipeg (.24)	Medicine Hat 143 (-.31)	Saskatoon 172 (.22)	Regina 194 (-.11) 142
Regina (.30)	Yorkton 142 (-.42)	Regina 141 (.17)	Swift Current 142 (-.14) 176
Prince Albert (.32)	Grande Prairie 128 (-.46)	Prince Albert 659 (.05)	Medicine Hat 128 (-.24) 172
Brandon (.62)	Swift Current 79 (-.48)	Moose Jaw 176 (-.10)	North Battleford 53 (-.25) 219
Medicine Hat (.70)	Portage la Prairie 172 (-.67)	80	Saskatoon (-.36) 194
Swift Current (.73)	Thompson 176 (-.69)	Yorkton 456 (-.40)	Prince Albert 141 (-.40) 128
North Battleford (.76)	Prince Albert 219 (-.69)	Brandon 128 (-1.0)	Thompson 79 (-.80) 456

continued

Table 4.9 continued

Factor One Demographic- Affluence	Factor Two Manufacturing	Factor Three East/West - Construction	Factor Four Services & Change in Manufacturing
Portage la Prairie (.78)	North Battleford (-.85)	Thompson (-1.07)	Calgary (-.84)
80			354
Yorkton (1.08)	Red Deer (-.88)	Portage la Prairie (-1.45)	Edmonton (-.86)
141	846	80	428
		Winnipeg (-1.64)	143
Moose Jaw (1.10)	Flin Flon (-1.02)	Flin Flon (-1.70)	Moose Jaw (-1.90)
53	-12	-12	53

(Figures in parentheses are factor scores)
Other figures are percentage growth 1941-1971.

(average distance to major oil fields) had the highest loadings (Table 4.7); of -.92 and -.90 respectively. Figure 4.1 gives the location of the major oil and gas fields. Two other variables that had relatively high loadings on this factor were INVESTCO (estimated value of construction - 1971) and RECCAP (per capita expenditure on recreation and cultural facilities 1974/1975), with loadings of .73 and .72 respectively. The cities that had the highest scores on this factor were the Albertan cities (Table 4.8) with Calgary having the highest score of 1.50. These cities are located in the main area of activity for the oil and gas fields and it is suggested that they thus have a greater amount of con-

struction and recreation related activities. The greater amount of recreation related activities could be due to the proximity of these cities to the Rocky Mountains, which would generate much in the way of tourist related activities; or one could assume that because of the petroleum industry that has developed in Alberta the average per capita income for these cities is higher and therefore recreation and cultural activities are more affordable.

The cities that scored lowest on this factor were the Manitoban cities with, for example, scores of -1.65 and -1.70 respectively for Winnipeg and Flin Flon. These results confirm the east/west dimension of this factor since those cities closest to the main area of petroleum activity have the highest loadings, while the more easterly cities of the region have the lowest loadings.

Factor Four:

Using a cut-off point of 0.60, the variables that had significant loadings on this factor were UTILITY (per capita expenditures on utilities - 1974/75) with a loading of .68, TRANSCAP (per capita expenditures on transportation services 1974/75) with a loading of .73, and CHGMFG (change in manufacturing employment 1961-1971) with a loading of .78. This factor, therefore, seems to describe cities that spend more per capita on services such as transportation and uti-

lities and cities that seem to be experiencing greater change in the manufacturing sector. The city that scored highest on this factor is Grande Prairie (Table 4-8), followed by Lethbridge; the city with the lowest score is Moose Jaw. Looking at the growth rates in Table 4.1 and the allotments in Table 4.2, it can be seen that both Grande Prairie and Lethbridge grew more than the region as a whole from 1941 to 1971 while Moose Jaw had a growth rate lower than the regional average. Cities such as Calgary and Edmonton, however, which also experienced rapid growth from 1941 to 1971 did not score highly on this factor. A solution to this apparent anomaly can be found by looking at the initial population size of these five cities in 1941, and realizing that Grande Prairie and Lethbridge had much smaller populations compared to Calgary or Edmonton, with Moose Jaw being situated between the two groups. It is inferred therefore that in 1941 Edmonton and Calgary had already established a large proportion of their transportation networks and had already installed a large proportion of their utility services and had already introduced some manufacturing activity within the cities themselves. Moose Jaw did not experience as much growth during this period and therefore no great need existed to install these services. It could be said, therefore, that the higher loadings of cities on this factor indicate a relationship between cities which

are expanding their physical development and population growth.

Summary of Results

Table 4.9 classifies or groups the cities under study according to the derived factors in order of highest rank to lowest rank, with reference to the factor scores. The cities which score high under factor one are male-dominated, youthful resource dependent towns and frontier towns. The growth rates for these cities are listed opposite the factor scores. It can be seen that these cities experienced much growth from the years 1941 to 1971. The cities which scored on the lower end of factor one are characterized by a higher percentage population over age 65, a higher percentage of the adult population with only elementary education, a higher proportion of immigrant population who arrived before 1946, and a higher proportion of the labour force engaged in the transportation, retail and public administration sectors. These cities could all be termed agricultural service centres.

Cities that scored high on factor two are the larger cities that have a higher proportion of the labour force engaged in manufacturing compared to the smaller cities with little or no manufacturing.

The cities which scored highest on factor three are the cities in the western edge of the region located near the centre of activity of the petroleum industry. Also the cities in the western edge of the region spend proportionately more on cultural and recreational activities and are the scene of a greater amount of construction activity.

The cities that scored highest under factor four are the cities which are spending more per capita on physical expansion of their infrastructure. They are also experiencing an increase in the amount of manufacturing activity.

The data presented in Table 4.9 seem to indicate a relationship between urban functions and urban growth. It seems that the frontier and resource related cities are the ones that have been experiencing the greatest amount of growth.

4.5 A Multiple Regression Model - Testing the Hypotheses

4.5.i Introduction

The hypotheses concerning growth can be examined jointly in a multiple-regression equation of the form:

$$y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + e,$$

where y = percentage population growth, 1941-1971;

a = the constant, or y intercept;

the b 's = the partial regression coefficients or slope;

X_1 = factor one, demographic/affluence;

X_2 = factor two, manufacturing;

X_3 = factor three, east/west;

X_4 = factor four, services;

e = standard error of the estimate.

One of the requirements of multiple regression is that the conceptually independent variables be statistically independent of each other, since this lack of independence may lead to spurious results (Yeates, 1974). This criterion of the test has been satisfied by the use of principal components analysis in the previous section where the original twenty-eight variables have been reduced, summarized and grouped in a total of four orthogonally independent factors.

An additive stepwise multiple regression was performed in order to determine the relative importance of the different independent variables in explaining growth. The data that were input to the program have been listed previously in Table 4.8. The parameters for the regression equation listed in order of those giving most to least explanation, are estimated to be

$$y = 247.39 + 121.96 X_3 - 114.51 X_1 + 51.78 X_4 - 17.85 X_2$$

where X_1 = factor one, demographic/affluence;
 X_2 = factor two, manufacturing;
 X_3 = factor three, east/west;
 X_4 = factor four, services (see Table 4.10).

The multiple correlation coefficient R , which measures the degree of combined association between the four independent variables and the dependent variable, has a value of .811. Thus the four independent variables together explain ($R^2 \times 100$) 62.3 percent of the variation in the dependent

Table 4.10 SUMMARY TABLE OF THE RESULTS
OF THE MULTIPLE REGRESSION

Variable	Multiple-R	R-Square	Residual Change	Zero-order R	b	Beta
EASTWEST	.56	.30	.30	.55	121.96	.55
DEMOGRAP	.75	.60	.26	-.51	-114.51	-.51
SERVICES	.79	.62	.05	.23	51.78	.23
MANUFACT	.79	.62	.01	-.08	- 17.85	-. 8
Constant (a) = 247.39						

variable.

We will proceed by analysing and testing for significance the results that came about at each step in the regression that cumulated to the final equation listed above.

4.5.ii Variable Entered on Step Number 1

The parameters for the regression equation are estimated to be

$$y = 247.39 + 121.96 X_3,$$

where X_3 is the EASTWEST factor.

The partial regression coefficients were tested for statistical significance by Student's t . The expected values of t with $n-2 = 16$ degrees of freedom are 2.12 at the five percent level, and 2.92 at the one percent level. The calculated t for b_3 is 2.61; the regression coefficient is significant at the five percent level, but not at the one percent level. Therefore it can be said that the EASTWEST

variable was a significant factor, explaining the growth of the prairie urban system from 1941 to 1971.

The t-test is used to test for "... the significance of the contribution of additional independent variables to the explained variation in a multiple-regression model." (Yeates, 1974, p.131). A further step would be to test for the significance of the overall equation; the test used to do this is the F-test or analysis of variance. The null hypothesis to be tested in the F-test is that the equation is not significantly different from zero. The F value which is given as part of the output of the regression program is compared to the expected F value at the .05 confidence level with the appropriate degrees of freedom. The observed F is 6.82 and the expected F, at .05 level of confidence and 1 and 16 degrees of freedom, is 4.49. At the .01 level of confidence and 1 and 16 degrees of freedom, the expected F is 8.53. The equation is therefore only significant at the five percent level.

4.5.iii Variables Entered on Step Number 2

The parameters for the regression equation in Step number 2 are estimated to be

$$y = 247.39 + 121.96 X_3 - 114.51 X_1,$$

where X_3 is the EASTWEST factor and X_1 is the DEMOGRAP, demography-affluence, factor. The t-test and the F-test were again performed to test for the significance of the partial

regression coefficients and to test for the significance of the overall equation.

The calculated t for the EASTWEST factor in this second step is 3.2 and is significant at both the .05 and the .01 level of confidence. The calculated t for the DEMOGRAP factor is 3.0, and is also significant at both levels of confidence. Therefore the contribution of both these independent variables to the growth of the prairie cities is not due to chance variation within the data.

The calculated F for the equation is 9.64; the expected F and 2 and 15 degrees of freedom at the .05 confidence level is 3.68 and at the .01 confidence level is 6.36. Therefore the significance of the overall equation to explain growth at this second step is valid at both confidence levels using the independent variables EASTWEST and DEMOGRAP.

4.5.iv Variables Entered on Step Number 3

The parameters for the regression equation in step number 3 are estimated to be

$$y = 247.39 + 121.96 X_3 - 114.51 X_1 + 51.79 X_4,$$

where X_4 is the SERVICES factor. The t -test was performed for each independent variable, and an F -test was performed on the overall equation.

The calculated t for the EASTWEST factor in this third step is 3.3, and is significant at both the .05 and .01 levels

of confidence. The calculated t for the DEMOGRAP (demographic/affluence) factor 3.1, is also significant at both levels of confidence. However, the calculated t for the SERVICES factor is 1.4 and because it is less than the expected t at both confidence levels, the regression coefficient for this variable is not significant. Therefore the contribution of the two former independent variables, tested in this section, to the growth of the prairie region is not due to chance variation in the data. The contribution of the SERVICES variable, on the other hand, to the growth of the prairie region cannot be adequately determined, according to the regression test.

The standard error of the overall equation from step one through to step three has declined from 192.53, to 157.09, to 152.27. So despite the fact that the contribution of the SERVICES variable is questionable, it does help reduce the unexplained variation in the equation. The R^2 value also increases due to the inclusion of the SERVICES factor. The variable will therefore remain within the equation.

The calculated F for the equation at this third stage is 7.50, while the expected F at 3 and 14 degrees of freedom at the .05 confidence level is 3.34, and at the .01 confidence level is 5.56. Therefore the significance of the over-

all equation in explaining growth at this third step is confirmed at both confidence levels using the independent variables EASTWEST, DEMOGRAP and SERVICES.

4.5.v Variables Entered on Step Number 4

The parameters for the final equation are, as seen previously,

$$y = 2.47.39 + 121.96 X_3 - 114.51 X_1 + 51.78 X_4 - 17.85 X_2,$$

where X_2 is the MANUFACT factor. T-tests again were performed for each independent variable to test for their significance and an F test was used to test for the significance of the overall equation.

The calculated t's for both the EASTWEST and DEMOGRAP factors, which are 3.21 and 3.0, are both significant at the .05 and .01 levels of confidence. On the other hand the calculated t's for the SERVICES and MANUFACT factors, which are 1.36 and 0.47 respectively are not significant at either confidence levels. The addition of the final variable MANUFACT, however, does reduce the overall residual error of the equation from 152.27, as was seen in the third step, to 150.69. The R^2 value also increases from step 3 to step 4 with the inclusion of the MANUFACT variable. Therefore the MANUFACT variable will remain within the equation.

The calculated F for the equation, at this final step is the regression analysis, is 5.36. The expected F with 4

and 13 degrees of freedom at the .05 confidence level is 3.18, and at the .01 confidence level is 5.74. Therefore, the significance of the overall equation in explaining growth at the fourth and final step confirmed at both confidence levels, using the independent variables EASTWEST, DEMOGRAP, SERVICES, and MANUFACT. Due to the fact that the standard error of the equation has decreased from step one through to step four and due to the fact that the overall equation has been determined to be significant, all four independent variables remain within the equation.

The equation has thus been determined to be statistically significant and it can therefore be accepted that approximately sixty-two percent of the total variation of prairie urban growth (Y) is explained by the regression of Y on the four independent variables. It must be kept in mind, though, that all the factors responsible for growth have not been considered in the regression analysis, and that the proportion of growth explained by the equation varies from city to city within the region. It is useful, therefore, to analyze the variation in the accuracy of the prediction for each city, for the residuals may suggest further factors that could be related to growth. One method of analysing the residuals is to map them to determine which cities experienced more growth than predicted and which less growth. The distribution of the residuals can be found in Figure 4.2. According

to the diagram, urban northern Alberta, except for Edmonton, as well as cities in Manitoba, with the exception of Flin Flon, experienced more growth than that predicted by the equation. On the other hand urban southern Alberta and most of urban Saskatchewan experienced less growth than predicted. The cities whose observed growth varied greatly from the predicted growth, according to the equation, are Red Deer, Lethbridge, Winnipeg and Grande Prairie, with residuals of 390.53, -262.17, 140.53, and 96.78, respectively. The patterning of these residuals could be due to the problems discussed earlier regarding the normality of the data (Table 4.3), which affect the results of the principal components analysis. Perhaps the variables would have been distributed differently in the group of factors seen in Table 4.7 had the variables indeed been transformed to exhibit normal distributions. This would then affect the results of the regression analysis and the pattern of residuals. For example, the EAST/WEST factor ranked third in strength in the principal components analysis, (Table 4.7), yet it accounted for the greatest dimension of growth according to the regression. This could be one reason which would account for the over prediction of growth in the western edge of the region and the under prediction of growth as seen in the eastern edge of the region.

Also from the short examination of the residuals it can be realized that factors have been ignored in the study. In some cases, for example Red Deer, the isolation of these factors could be significant to the explanation of urban growth of individual cities. A discussion of the missing factors will take place in the following and concluding chapter.

4.6 Summary

In this chapter the theories presented in Chapter 2 along with the tentative hypotheses, derived from the deductive descriptive analysis of the region presented in Chapter 3, were tested for their significance using multivariate analysis. The four hypotheses tested, which were formally presented earlier in the chapter, relate to the petroleum industry, growth inducing manufacturing industry, community characteristics and the demographic characteristics of the cities

under study. Before proceeding on to the analysis, a study of the growth patterns of the individual cities took place. Those growth paths were examined using the percentage growth from 1941 to 1971 for each city, and also using the allometries of the individual cities. It became evident, upon examination of these data, that the cities in the province of Alberta experienced most growth, during the period, while cities in Saskatchewan experienced less growth, and the Manitoban cities least growth. This pattern of differing rates of growth is interesting, especially if one keeps in mind that at the beginning of the study period, the regional economics and the cities within the region were dependent upon agriculture, with the exception of Manitoba due to the presence of Winnipeg.

In the following section the variables chosen to summarize or represent the hypotheses to be tested, were presented and used in a principal components analysis in order to reduce the data dimensions and eliminate the problem of spatial autocorrelation for the regression test. The four factors, which were used in the regression model as independent variables, describe the demographic and income characteristics, the manufacturing characteristics, the east-west dimension and the service characteristics of the cities. The regression coefficients of the final regression equation, and the equation itself were determined to be statistically

significant to explain the urban growth paths of the region; the coefficient of determination states that the equation explains almost sixty-six percent of the variation of this growth. The factors listed in order of most to least explanation are the EASTWEST dimension, the DEMOGRAP (demographic/affluence) characteristic, the SERVICES characteristic, and the MANUFACT characteristics. The results are summarized in Table 4.11. The interpretation of the equation as well as the interpretation of the residuals will take place in the following chapter.

Table 4.11 SUMMARY TABLE FOR THE STEPWISE REGRESSION MODEL

Step	Included Variables						Variables not Included		
	Variable	R	Standard Error (of B)	R ²	Increase	Regression Coefficient	Standard Error	Variables	Partial Correlation Coefficient
1.	X ₃	.55 _Δ	46.69	.30 _Δ	.30	b ₃ = 121.96 _Δ	192.53	X ₁ X ₂ X ₃	-.61 -.90 .28
2.	X ₁	.75*	38.10	.50*	.26	b ₃ = 121.96* b ₁ = -114.51*	157.09	X ₂ X ₄	-.12 .35
3.	X ₄	.78*	36.93	.62*	.05	b ₃ = 121.96* b ₁ = -114.51* b ₄ = 51.78 _§	152.26	X ₂	-.13
4.	X ₂	.79*	38.00	.62*	.01	b ₃ = 121.96* b ₁ = -114.51* b ₄ = 51.78 _§ b ₂ = -17.85 _§	150.69		

X₁ = Demographic/AffluenceX₂ = ManufacturingX₃ = East/WestX₄ = Services

* = Significant on the 99 percent level

 Δ = Significant on the 95 percent level

§ = Not Significant

FOOTNOTES FOR CHAPTER 4

¹One of the problems encountered in research relates to the lack of suitable data, and it often results in restricting the type of research to be done. Because of this, care must be taken to realize the data limitations of various projects and to set up the study accordingly. For the purposes of this study, cities with populations of 10,000 and above in 1971 were chosen, the reason being that their 1941 populations were also to be used in the study, and the equivalent 1941 data for cities with populations under 10,000 in 1971 are not available. Data restrictions are also encountered when choosing the independent variables for each of the individual cities; for most types of information required for this paper, the 1971 data are not available for cities with populations under 10,000. Therefore, it must be kept in mind that even though this study deals with the prairie urban system, the results are restricted to the upper levels of the hierarchy, even though it would have been preferable to include cities with 1971 populations as low as 5,000.

²The factors derived from the principal components analysis are to be used as the independent variables in the multiple regression test. One of the requirements or assumptions for multiple regression analysis is that the independent variables are independent of each other; otherwise the test will yield spurious results (Yeates, 1974). Therefore the varimax rotation, which ensures orthogonal results, is used in the program. The varimax rotation also ensures absorption of the maximum variance within the data.

³Principal components analysis and factor analysis are, in fact, two separate techniques; however, for the remainder of the study the terms principal component and factor will be used synonymously to imply the principal component.

⁴The cut-off point for the factors were determined separately for each factor. This was done by viewing the results and visually determining a numerical break in the loadings which explained or described the principal components or factors.

⁵These distances were calculated as the average distance of the mid-point of each city to the mid-point of all the principal oil and gas fields in 1976; these mid-points were chosen visually.

CHAPTER 5

CONCLUSIONS

The analysis of prairie urban growth was presented in the previous chapters. The dependent variable (growth) was studied for each of the eighteen cities and it was noted that the more western cities in the region experienced greater percentage population growth during the period 1941 to 1971.

The east/west variable explained the greatest variation in the growth performance of the urban centres, thus implying that there is a relationship between prairie urban growth and the petroleum industry. Care must be taken, though, in interpreting the results because distance to the oil and gas fields was used only as a proxy for the petroleum industry. Nonetheless, the results of the analysis become much stronger when substantiated with similar conclusions from other studies (Smith, 1972; Stabler, 1969).

The other variable which contributed significantly to the explanation of urban growth was the demographic characteristic of the cities studied. Chapter three demonstrated that the prairies' dependence on agriculture has changed

since 1941 to a greater dependence on industrial, urban related activities. Much of the industry that has developed in the prairies since 1941, though, is related to mineral extraction whose labour inputs require a high male to female ratio. The cities, which, in fact have experienced high percentage growth during the three decades under study are those with high male to female ratios and those in proximity to either the petroleum activities or the frontier, resource extraction towns. The other demographic characteristics which are associated with growth, according to the study, are a younger population, which would seem to imply a population of young families, and higher per capita incomes. The latter characteristic seems to describe the income level received for employment in the resource primary industries.

The inclusion of the services and manufacturing characteristics helped increase the coefficient of determination of the regression equation and reduce the standard error of the equation, but the results of the t-test indicate that the relationships between the variables and the independent variable-growth are not significant. The services component as derived from the principal components analysis did not yield a consistent pattern of urban characteristics. The variables that had significant loadings on this component were the per capita expenditure on utilities, per capita expendi-

tures on transportation and a change in the manufacturing activities. This component did not include all the services provided to cities. One would assume that the services would all fall under one component, presenting a more consistent and a more statistically valid factor. Perhaps, the weakness of this component is responsible for the weaker contribution to the equation of the services variable.

The manufacturing variable, on the other hand was a statistically strong component, but did not provide a statistically strong relationship with the dependent variable. However the data presented in Table 4.9 does illustrate that there is a strong rank correlation between the factor scores for manufacturing and population size in 1971; this demonstrates the significance of absolute size, with its threshold and agglomeration economy implications.

With reference to the hypotheses presented in Chapter four, the results of the analysis satisfy only those pertaining to the petroleum industry and to the demography of the urban areas. The hypotheses regarding community characteristics and growth inducing economic activities are not satisfied by the results of the regression equation. According to the analysis, it can therefore be inferred that the petroleum industry provided a strong stimulus to the regional economy and was the predominant factor underlying the urban growth

that took place within the region. As a result the "... region has become an important supplier of fuel and raw materials to Canadian and American manufacturers, and the prairie economy has become polarized around the Edmonton-Calgary corridor and the Winnipeg metropolitan area" (Barr, 1972, p.65). The petroleum industry became a major employer and was largely responsible for the increase in per capita income. In-short, it can be stated that an industrial complex developed after the discovery of oil, whereby local and non-local multiplier linkages came into being to stimulate the urban economies. However, because the main area of activity was restricted to Alberta, it was predominantly the Albertan cities that were affected.

It was not the purpose of this study to illustrate the step by step manner in which the mineral discoveries of the forties altered the urban region of the prairies, during the study period, because the data and money required for such a study were not available. The purpose was to illustrate simply that a relationship does exist between the urban regional development of the prairies and the mineral discoveries that have been developed since 1941. The theories of urban growth describe the manner in which these industrial complexes develop to stimulate urban and regional development. One of the problems with the theoretical literature on urban growth, nonetheless, is that it is very specialized for

highly industrialized regions and nations, being preoccupied with manufacturing and the quaternary sectors of those economies. It fails to recognize the manner in which other less dynamic regional economic activities also behave to stimulate urban economies, as was the situation in the prairies. The prairie urban and regional economy has been shown to be developing towards an advanced industrial society as shown by the decline in the importance of agriculture and the growth of cities, with their non-agriculturally oriented economic activities. It should be kept in mind though, that a large portion of the non agricultural economic activities which are providing many jobs and increasing the per capita income are still greatly confined to the primary and secondary sectors of the economy. Very little of Canada's manufacturing industry is located in the prairies. Central Canada still has a virtual monopoly on this industry. The economic activities that have in fact stimulated the urban prairie region are those in the primary and secondary sectors related to mineral extraction of oil, potash, coal, nickel, etc. (Barr, 1972, p.67). These are not often recognized as dynamic stimulants to regional and urban development. One could therefore state that regarding the urban growth and development that has taken place in the prairies since 1941, the theories of urban growth discussed in Chapter two provide a limited explanation. Nonetheless,

the mechanisms incorporated in the theories, such as the multiplier, and backward and forward linkages, have in fact been operative to provide the momentum for growth, but in the primary and secondary sectors of the economy. The urban and regional economy has expanded its economy to include the tertiary and quaternary sectors, but the economy is still very dependent upon its resources - agricultural and mineral. At some point the urban and regional economies will have to expand and diversify into more growth generating activities in order to continue the growth trend that has been taking place in the thirty years studied. Another disadvantage of the region's dependence on resources is that the extraction and development of these resources is very much dependent upon exogenous demand: oil is more and more satisfying domestic Canadian demand, wheat is dependent upon world markets and potash is dependent upon North American markets. If the economy is to continue to prosper it must further the economic diversification that was initiated by the petroleum discoveries. It has been said that

Economic reorganization, however, has not been a complete panacea for previous uncertainty and instability. Regional prosperity is restrained by surplus wheat crops and competition from other regions in marketing raw materials and attracting new investment capital. Regional development problems are increasingly manifest in the need to apply governmental incentives and assistance to promote industrial investment within the region.

(Barr, 1972, p.67)

Thus, once diversification of the economy is initiated, the urban growth paths will be similar to those described in the latter part of Chapter two. The mechanisms for growth - the multiplier, agglomeration economies, backward and forward linkages will come into action and provide the momentum for further growth.

The hypothesis pertaining to the demography of the cities under study is related, to a certain extent, to the hypothesis concerning the petroleum industry; it pertains to the labour force of the region. It seems logical that since the petroleum industry has been responsible for a great deal of the regional growth, the labour force characteristics would also be important. The cities that did in fact experience growth were those cities whose demographic characteristics corresponded well to the labour force requirements of the petroleum industry.

The east-west differences in the degree of the prairie urban development become apparent when noting the highly localized nature of petroleum related activities. The Albertan cities experienced the greatest growth from 1941 to 1971 compared to Manitoba and Saskatchewan. If one were to rank the provinces in order of most urban growth to the least urban developed, Alberta would be number one, followed by Manitoba and then Saskatchewan. This ranking would be followed by

that for industrial development (most to least industrialized),

Winnipeg's continued growth could be due to its role as a regional service centre for the eastern part of the region as well as to its state of development. The agglomeration economies are available which makes the city suitable for industrial activity. In fact, as seen earlier, it has the highest proportion of manufacturing activity of all the prairie cities. According to the results of the regression its population should not have increased to the extent it did over the thirty year period; the predicted population for 1971 was 227,420.

Figure 4.2 illustrates that Brandon and Portage la Prairie experienced more growth than that predicted by the regression model. This could perhaps be due to their proximity to Winnipeg. Thompson's growth, on the other hand, was clearly due to its function as a frontier mineral extraction centre.

No ready explanation can be given for the urban development experiences of Moose Jaw and Yorkton, and North Battleford, but Saskatchewan's still greater dependence on agriculture can be associated with the negative residual resulting for all the other Saskatchewan cities (Figure 4.2).

All the growth experiences for the Albertan cities can be associated with the petroleum industry. New reserves of oil have been discovered in northern and north western Alberta. As a result it is suggested that Grande Prairie is functioning as the regional centre or gateway for these northern based activities, and it has experienced much population and physical growth and development because of this. Edmonton and Calgary are maintaining their positions as provincial leaders in the urban system because of the mineral discoveries and also because of their role as gateway to the west in British Columbia and the world market (Burghardt, 1971). No explanation, however, can be given for Calgary's less than expected growth; perhaps there is a relation between its slower growth and the passing of the peak of the oil boom. Finally, the urban growth experience of Red Deer could be said to be due to its location in the "main street" between Edmonton and Calgary; it could be deriving much of its stimulus from both these large centres.

The economic experiences of the three provinces were quite different - Manitoba's more diversified economy is dependent to some extent upon the performance of Winnipeg, Saskatchewan's economy is still greatly dependent upon agriculture, and Alberta's economy is greatly dependent upon the petroleum industry. Of the three provinces the growth of Saskatchewan's urban areas was the slowest, while the

Manitoban cities grew more than expected according to the model. It seems apparent that there is a relationship between the urban and regional economic base and the urban growth performances. One could therefore predict from the above results, that unless new economic developments take place, the prospects for the region will not be very different from the present situation; the intraregional disparity of population and industrial growth will continue and probably increase.

Small service centres, dependent upon resource extraction, will continue to dot the landscape, particularly in the mid-north, but production of most prairie commodities will remain dependent on extra-regional demand. The region is similar to many others in that domestic governments cannot guarantee stability in the price of export commodities. Prairie developments related to potash, coal, tar sand, wood pulp, and agricultural processing, however, suggest that the federal and provincial governments will play an increasingly strong role through a variety of financial incentives in assisting individual producers to increase their ability to offer primary commodities at competitive prices in world markets.

However,

The major function of the prairie economy - to supply raw materials to manufacturing regions - will not change until natural population increase provides sufficient markets to support major secondary manufacturing establishments in the region, or until resources become depleted. (Barr, 1972, p.82)

As a result, one can see why the intraregional disparity of urban populations and urban and industrial growth will continue.

CARLETON UNIVERSITY

COBOL STATEMENT

APPENDIX - RAW DATA -

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CARLETON UNIVERSITY

DATE		PUNCHING INSTRUCTIONS	GRAPHIC PUNCH	PAGE OF	
FORTRAN STATEMENT					
Pop. Density	Pop. Growth Rate 1941-1971	Pop. Growth Rate 1961-1971	Percent of Pop. Under 15	Percent of Pop. Over 65	Sex Ratios
Adults-1946	Immigrants as % of Total Imm.	Total Imm. - % of Total Population	Estimated Value of Construction	Median Housing Value	Level of Protection Utilities Index
University Degree	Recreation Percent	Cultural Labour in Manufacturing	Transportation Labour in Retail	Wholesale Labour in Finance	Public Admin
Number of S.C. Functions	Change in Manufact. Employment	Percent Labour in Petroleum	Average Dist. to Oil Fields	Average Distance to Gas Fields	Average Farm Size
Degree Days	Frost Free Days	Mean Jan. Temp.	Precipitation	Sunshine Hours	Latitude Longitude
COBOL STATEMENT					
PROGRAM I.D.					

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CARLETON UNIVERSITY

PROGRAM		DATE		PUNCHING INSTRUCTIONS		GRAPHIC PUNCH	
PROGRAMMER							
STATEMENT NUMBER	FORTRAN STATEMENT						
	BRANDON	31150.00	3580.46	56.73	9.60	25.70	
		33.10	9.90	54.09	12.20	356.30	
		26.13	13.73	9.80	10.09	16.06	
		35.00	23.00	98.50	2.68	579.60	
		476.51	2750.00	112.00	-0.60	18.76	
	CALGARY	403319.00	2588.36	127.75	36.40	30.50	
		24.20	14.20	28.29	20.50	970.23	
		27.27	35.73	12.06	8.34	12.47	
		510.00	97.00	138.30	22.54	332.00	
		1058.92	2000.00	106.00	11.00	17.00	
	EDMONTON	495702.00	4038.27	136.34	31.80	30.70	
		27.80	12.10	31.14	18.30	796.78	
		19.47	30.37	12.59	9.17	13.20	
		587.00	99.00	129.30	9.69	276.80	
		1058.92	2150.00	107.00	6.00	18.64	
	FLINFLON	11201.00	1989.46	200.00	-13.60	30.00	
		35.90	6.50	60.00	11.00	85.26	
		49.58	6.26	9.83	4.60	11.44	
		6.00	5.00	85.30	0.00	549.60	
		653.00	1900.00	121.00	-6.90	17.00	
SEQUENCE	A MARGIN	B MARGIN		COBOL STATEMENT			

SEQUENCE

A MARGIN

B MARGIN

COBOL STATEMENT

CARLETON UNIVERSITY

DATE		PUNCHING INSTRUCTIONS	GRAPHIC PUNCH	PAGE		OF	
FORTRAN STATEMENT							
3580.46	56.73	9.60	25.70	11.90	95.00	8993.00	
9.90	54.09	12.20	356.30	14777.00	29.22	40.19	
13.73	9.80	10.09	16.06	5.78	3.79	11.60	
23.00	98.50	2.68	579.60	629.60	663.32	2649.03	
2750.00	112.00	-0.60	18.76	2129.00	49.55	99.57	
2588.36	127.75	36.40	30.50	6.30	99.00	10943.00	
14.20	28.29	20.50	970.23	22461.00	26.27	76.76	
35.73	12.06	8.34	12.47	5.88	5.93	7.61	
97.00	138.30	22.54	332.00	152.80	912.70	3112.32	
2000.00	106.00	11.00	17.00	2166.00	51.06	114.01	
4038.27	136.34	31.80	30.70	6.00	101.00	10460.00	
12.10	31.14	18.30	796.78	23665.00	23.77	62.06	
30.37	12.59	9.17	13.20	5.87	4.81	11.50	
99.00	129.30	9.69	276.80	156.80	419.54	1154.83	
2150.00	107.00	6.00	18.64	2203.00	53.33	113.30	
1989.46	200.00	-13.60	30.00	6.70	105.00	9543.00	
6.50	60.00	11.00	85.26	10013.00	38.36	26.61	
6.26	9.83	4.60	11.44	1.74	1.87	5.85	
5.00	85.30	0.00	549.60	535.20	676.68	1621.30	
1900.00	121.00	-6.90	17.00	2067.00	54.46	101.51	
COBOL STATEMENT							PROGRAM ID

CARLETON UNIVERSITY

PROGRAM		PROGRAMMER		DATE		PUNCHING INSTRUCTIONS		GRAPHIC PUNCH	
STATEMENT NUMBER	Cont	FORTRAN STATEMENT							
		GRAPRAIRI	13079.00	1791.64	153.41	42.60		33.	
			30.20	9.70	52.23	13.40		948.	
			48.00	37.09	10.85	8.28		15.	
			19.00	15.00	246.40	0.91		416.	
			1270.70	2000.00	108.00	3.10		17.	
		LETHBRID	41217.00	1901.15	95.20	14.30		27.	
			30.70	11.20	46.32	23.10		1064.	
			46.15	39.86	15.44	8.10		16.	
			76.00	34.00	166.00	0.19		398.	
			1023.62	2750.00	120.00	18.00		17.	
		MEDICAT	28773.00	1246.15	92.52	7.50		27.	
			41.70	6.90	62.05	19.50		1175.	
			23.70	38.73	19.62	10.53		15.	
			48.00	25.00	89.10	0.30		352.	
			917.73	3200.00	125.00	14.00		14.	
		MOOSEJAW	31854.00	1873.76	42.20	-8.00		25.	
			39.00	8.30	68.66	15.00		607.	
			16.41	21.42	8.47	10.96		14.	
			38.00	22.00	62.00	17.55		408.	
			705.94	2800.00	117.00	6.00		14.	

SEQUENCE	A MARGIN	B MARGIN	COBOL STATEMENT

DATE		PUNCHING INSTRUCTIONS	GRAPHIC PUNCH							PAGE	OF
FORTRAN STATEMENT											
1791.64	153.41		42.60	33.50	6.60	104.00	9520.00				
9.70	52.23		13.40	948.31	18443.00	65.73	49.02				
37.00	10.85		8.28	15.58	6.80	3.94	10.75				
15.00	246.40		0.91	416.80	308.80	676.71	1666.57				
2000.00	108.00		3.10	17.27	18.75	15.11	118.15				
1901.15	95.20		14.30	27.00	10.70	99.00	10171.00				
11.20	46.32		23.10	1064.46	18989.00	29.64	62.59				
39.86	15.44		8.10	16.60	5.73	4.61	9.01				
34.00	166.00		0.19	398.00	220.80	1861.33	4989.70				
2750.00	120.00		18.00	17.23	2384.00	59.38	112.48				
1246.15	92.52		7.50	27.50	12.00	96.00	8423.00				
6.90	62.05		19.50	1175.89	14608.00	25.68	52.56				
38.73	19.62		10.53	15.03	3.93	3.03	9.38				
25.00	89.10		0.30	352.80	243.20	1256.90	2906.88				
3200.00	125.00		14.00	14.29	2208.00	50.01	110.43				
1873.76	42.20		-8.00	25.70	14.00	95.00	8344.00				
8.30	68.66		15.00	607.77	11552.00	21.50	55.37				
21.42	8.47		10.96	14.89	3.30	3.89	15.93				
22.00	62.00		17.55	408.40	390.80	917.57	5263.69				
2800.00	117.00		6.00	14.94	2283.00	50.23	105.34				
COBOL STATEMENT											
											PROGRAM
											END

2042

CARLETON UNIVERSITY

PROGRAM		PROGRAMMER		DATE		PUNCHING INSTRUCTIONS		GRAPHIC PUNCH	
STATEMENT NUMBER	Cont	FORTRAN STATEMENT							
		NORBATTL 15148.00 1089.96 104.58 2.70 28.							
		41.20 9.20 71.42 14.00 682.							
		19.31 22.82 5.31 8.44 76.							
		14.00 10.00 115.00 0.00 311.							
		847.13 2400.00 114.00 0.30 13.							
		PORPRATR 12950.00 1456.69 57.23 4.40 27.							
		45.80 6.50 51.30 11.50 758.							
		19.21 6.03 7.70 7.93 13.							
		15.00 13.00 102.90 0.00 660.							
		405.92 2950.00 127.00 2.30 19.							
		PRINCALB 28464.00 1170.39 77.88 16.30 30.							
		42.60 9.10 67.56 11.10 609.							
		17.17 20.48 13.04 8.90 15.							
		26.00 16.00 130.40 0.00 385.							
		758.89 2400.00 121.00 0.00 15.							
		REDDEER 27674.00 2099.70 161.77 34.10 29.							
		34.30 9.90 45.92 13.50 934.							
		32.12 21.36 6.58 7.85 12.							
		36.00 18.00 156.40 1.65 281.							
		1058.92 1900.00 79.00 7.80 21.							
SEQUENCE	A MARGIN	B MARGIN							

COBOL STATEMENT

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CARLETON UNIVERSITY

DATE		PUNCHING INSTRUCTIONS	GRAPHIC PUNCH									PAGE	OF
FORTRAN STATEMENT													
089.96	104.58		2.70		28.60		12.70		95.00		8281.00		
9.20	71.42		14.00		682.07	13477.00	30.33		32.50				
22.82	5.31		8.44		16.59		5.69		4.74		9.00		
10.00	115.00		0.00		311.20	258.80	787.99		2209.52				
400.00	114.00		0.30		13.71	2259.00	52.46		108.15				
456.69	57.23		4.40		27.10		11.10		97.00		8362.00		
6.50	51.30		11.50		758.37	12349.00	62.77		23.66				
6.03	7.70		7.93		13.33		2.30		4.60		20.80		
13.00	102.90		0.00		660.40	693.20	540.55		2605.54				
950.00	127.00		2.30		19.00	2150.00	49.58		98.18				
170.39	77.88		16.30		30.80		9.70		97.00		8956.00		
9.10	67.56		11.10		609.68	13997.00	17.46		44.86				
20.48	13.04		8.90		15.05		5.02		3.78		12.52		
16.00	130.40		0.00		385.60	371.20	560.93		2193.26				
400.00	121.00		0.00		15.75	2138.00	53.10		105.45				
2099.70	161.77		34.10		29.70		6.80		99.00		9894.00		
9.90	45.92		13.50		934.37	19117.00	26.91		51.92				
21.36	6.58		7.85		12.31		5.73		2.55		16.14		
18.00	156.40		1.65		281.60	125.20	587.64		1394.44				
900.00	99.00		7.80		21.44	20.94	52.16		113.49				
COBOL STATEMENT													PROGRAM I.D.

CARLETON UNIVERSITY

PROGRAM		PROGRAMMER		DATE		PUNCHING INSTRUCTIONS		GRAPHIC PUNCH	
STATEMENT NUMBER	CONT	FORTRAN STATEMENT							
		REGINA	1407	34.00	4727.76	82.91	21.20		2
				30.60	12.70	49.61	13.10		107
				37.01	20.35	10.28	9.79		1
				137.00	54.00	113.00	11.51		24
				670.65	2675.00	107.00	1.60		1
		SASKATOON	1264	49.00	3459.62	98.44	27.80		2
				32.00	14.40	51.07	13.90		101
				21.13	22.89	10.60	8.84		1
				142.00	53.00	111.40	2.68		35
				776.54	2600.00	109.00	1.00		1
		SWIFCURR	1541	5.00	2560.63	92.49	23.40		2
				37.00	9.00	71.87	12.80		107
				23.22	22.86	5.51	9.73		1
				23.00	15.00	100.40	3.07		36
				811.84	2750.00	114.00	8.90		1
		THOMPSON	1900	1.00	3166.83	200.00	130.90		3
				24.50	9.00	3.73	13.40		
				17.02	21.40	9.79	4.80		1
				2.00	2.00	98.90	0.00		67
				852.40	1750.00	112.00	-7.00		1
SEQUENCE	A MARGIN	B MARGIN							
COBOL STATEMENT									

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DATE		PUNCHING INSTRUCTIONS	GRAPHIC PUNCH	PAGE	OF
FORTRAN STATEMENT					
4727.76	82.91	21.20	29.50	8.20	96.00
12.70	49.61	13.10	1072.51	6443.00	25.45
20.35	10.28	9.79	15.57	5.37	6.25
54.00	113.00	11.51	248.80	426.00	783.55
2675.00	107.00	1.60	15.53	2266.00	50.26
3459.62	98.44	27.80	29.20	9.00	95.00
14.40	51.07	13.90	1010.99	17230.00	19.88
22.89	10.60	8.84	14.25	6.37	4.53
53.00	111.40	2.68	356.40	318.80	712.20
2600.00	109.00	1.00	13.86	2381.00	52.15
2560.63	92.49	23.40	28.00	11.90	97.00
9.00	71.87	12.80	1076.22	16349.00	32.42
22.86	5.51	9.73	16.54	6.37	4.39
15.00	100.40	3.07	362.40	318.00	928.68
2750.00	114.00	8.90	15.27	2281.00	50.17
3166.83	200.00	130.90	36.20	0.30	128.00
9.00	3.73	13.40		22601.00	10.77
21.40	9.79	4.80	10.73	2.15	2.90
2.00	98.90	0.00	678.80	695.20	676.68
1750.00	112.00	-7.00	18.00	2000.00	55.25
COBOL STATEMENT					
PROGRAM ID					

CARLETON UNIVERSITY

PROGRAM		PROGRAMMER		DATE		PUNCHING INSTRUCTIONS		GRAPHIC PUNCH	
STATEMENT NUMBER	Cont	FORTRAN STATEMENT							
		WINNIPEG	540262.00	8086.35	83.51	12.50	20		
			31.20	11.60	39.69	19.90	408		
			37.56	24.55	19.66	10.81	13		
			957.00	117.00	116.50	1.56	72		
			352.97	2950.00	115.00	0.10	20		
		YORKTON	13430.00	2356.14	82.63	29.30	27		
			43.60	9.00	75.19	12.90	987		
			22.45	10.69	9.57	8.35	16		
			22.00	17.00	144.20	0.00	48		
			600.00	2400.00	95.00	0.00	17		
SEQUENCE	A MARGIN	B MARGIN	COBOL STATEMENT						

CARLETON UNIVERSITY

DATE		PUNCHING INSTRUCTIONS	GRAPHIC PUNCH					PAGE	OF
FORTRAN STATEMENT									
0	80	86.35	83.51	12.50	26.50	9.50	95.00	9989.00	
0		11.60	39.69	19.90	408.39	17780.00	28.46	52.21	
6		26.55	19.66	10.81	13.54	6.66	5.70	8.84	
0		117.00	116.50	1.56	721.60	727.60	377.96	2297.18	
7	2950.00	115.00	0.10	20.35	2177.00		49.54	97.14	
0	2356.14	82.63	29.30	27.40	12.50	97.00	7760.00		
0	9.00	75.19	12.90	987.78	13831.00	37.23	28.38		
5	10.69	9.57	8.35	16.50	6.52	4.68	12.02		
0	17.00	144.20	0.00	481.20	488.00	557.71	1903.94		
0	2400.00	95.00	0.00	17.00	2271.00	51.16	102.28		
COBOL STATEMENT									
								PROGRAM	ID

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