INDUSTRIAL STRUCTURE AND URBAN GROWTH

INDUSTRIAL STRUCTURE AND URBAN GROWTH
OF CANADIAN CITIES 1951-1961

by

KEVIN O'CONNOR, M.COMM

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AUTHOR: Kevin O'Connor, M.Comm. (Melbourne University, Australia)

SUPERVISOR: Dr. L. J. King

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This dissertation proposes that employment in cities can be classified into one of three categories - national, regional and local industries. A method of classifying industries into these groups is developed. However, a clear discrimination between classes is difficult to achieve. There is overlap between national and regional and regional and local industries.

These groups of industries are then analysed separately. Three general relationships are identified: for a majority of cities, employment change in national industries is related to city infrastructure and metropolitan status; regional industry employment change is related to a city's location in relation to larger cities, the population of its trade area and its role in a regional hierarchy; finally local industry employment change is associated with a city's metropolitan influence and its total income. However in all three industry groups particular cities have employment changes not commensurate with these general relationships.

Furthermore, analysis of employment change in subgroups of industries shows change in employment in individual industries does not

correspond to the general relationship identified for the aggregate of which it is a part.

It is clear that the general relationships found for each employment group do not necessarily apply to individual cities nor to individual industries. Analysis of growth in one city or one industry requires a different strategy to that adopted here.

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CHAPTER ONE

SURVEY OF LITERATURE

This dissertation attempts to find the factors which affect the economic growth of Canadian cities. Many previous studies have examined Canadian urban growth or have attempted to model the urban growth process. These two strands of work are now reviewed.

1. URBAN GROWTH IN CANADA

The evolution of Canadian urbanisation has been documented by Stone (1967), Weir (1968) and Lithwick (1970). These authors have used historical data to show that the present urban pattern was established in response to forces that operated in the world economy, and was conditioned by the gradual evolution of transport technology. Each staple industry in the past economic growth of Canada (fish, fur, lumber, wheat, and minerals) has had an impact on the size and distribution of cities (Paquet, 1968).

This impact depended upon the demand that each staple industry placed upon services provided by urban areas. The contrast in the spatial impact of the fishing and wheat industries exemplifies this point. The fishing industry did not need many urban facilities for it to prosper in the Maritime Provinces, whereas the wheat industry required equipment and transport, together with international commercial relationships, before it was able to establish itself in the Prairie

Provinces. Consequently the wheat industry stimulated urban development not only on the Prairies, but also in the industrial and commercial provinces of Ontario and Quebec (Paquet, 1968). For these reasons the Maritime Provinces had less urban development than Ontario or Quebec; the contrast became more obvious once the fishing industry slipped in importance in the Canadian economy.

Two important elements have emerged in research on the growth of individual cities. The first was the significance of metropolitan development and the second was the regional differentiation within the country.

Stone (1967) has shown that 48% of the national population lived in 18 Principal Regions of Metropolitan Development and Kerr (1968) investigated the dominance that these metropolitan areas exercised in the functioning of the Canadian economy. He made clear the tendency for secondary and tertiary industry to concentrate in a few cities, particularly Montreal and Toronto. Gray et al. (1968) have shown that these two cities accounted for 38% of manufacturing value added, 87% of the assets of financial institutions and 64% of all cheques cleared in 1966, when at the same time they together held only 23% of the Canadian population. Such evidence demonstrates that the economic impact of the metropolitan areas in Canada was greater than their size alone would suggest. Recognising the disproportionate impact metropolitan areas had upon past urban growth in Canada, Lithwick (1970) was confident in projecting future Canadian urban population just in terms of the growth of twelve metropolitan centres. These were Calgary, Edmonton, Hamilton, London, Montreal, Ottawa, Quebec, Regina, Toronto, Vancouver, Windsor and Winnipeg.

The second major dimension that emerged in the past studies was the sharp regional differentiation in Canada. Merrill (1968) partitioned Canada into 5 regions - the Atlantic Provinces, Quebec, Ontario, Prairie Provinces and British Columbia - and provided evidence on the economic differences, such as income per head, that existed between these regions. He shows, for example, that Personal Income per capita in the Atlantic Provinces has persistently been only 75% of the Personal Income per capita for all of Canada, while Ontario incomes have generally been 125% of the national average. These economic contrasts are paralleled by contrasts in urban development, and both Stone (1967) and Weir (1968) have tabulated numbers of urban places and growth in urban settlement for the major regions in Canada, showing clear contrasts between regions. For example, Ontario has had the greatest share of total number of urban places and the highest proportion of population classified as urban since 1871.

The evolution of the Canadian urban system over time and, in particular, the performance of cities in the Atlantic Provinces, the Prairie Provinces and Ontario, provides a useful summary of the effect of regional differences upon urban development (Simmons and Simmons, 1969). St. John's, Saint John and Halifax were the fourth, fifth and sixth largest cities in Canada in 1851. By 1966 they had fallen in national rank as the Ontario cities (Hamilton, Windsor, Ottawa and London) and the Prairie cities (Edmonton, Calgary) and also Vancouver replaced them. These changes in the national urban hierarchy were the result of a large number of factors, though one important one was the economic conditions in the regions in which each city was located. Cities in the Atlantic Provinces lost ground relative to the others as the level of economic development there lagged behind that of Ontario and the Prairie Provinces.

The effect that regional differences have had upon urban development has been stressed in many different research efforts. For example, when cities were grouped according to their scores on the principal components among 52 social and economic variables (King 1966), most of these groupings had a strong tendency toward regional clustering, although all metropolitan areas were members of one group, irrespective of their regional location. This principal components analysis was performed for 1951 and 1961 data and the components identified were similar, although the regional differentiation and metropolitan dimensions were even stronger in the 1961 data set. Furthermore in a factor analysis of 84 social and economic variables, Ray (1971) interpreted 8 factors, of which four had an element of regionalism. Finally, a discriminant analysis on social and economic variables measured for Ontario and Quebec cities statistically identified two groups of cities - those that had increases in population on the one hand, and those that experienced decreases in population on the other (King 1967). This discrimination was, however, overshadowed by the regional differentiation between Ontario and Quebec; the King (1967) study concluded that further urban growth modelling would need to take account of the impact regional subsystems of cities had upon the economic growth of urban areas.

The Ontario and Quebec urban system has in fact been the subject of detailed research. Some studies produced findings that supported the general observations made above about Canada. The effect of economic differences between Ontario and Quebec has been stressed (King 1967) while Bourne and Gad (1972) found that as cities get larger their growth rates tended to converge on the system average and very few non-metropolitan areas in Ontario and Quebec experienced above average growth. However, the Ontario-Quebec studies identified two important additional elements in the study of Canadian urban growth. These were the city's location relative to other cities and its industrial structure.

Several studies found location relative to metropolitan areas was important to city growth. Differential accessibility (Barber 1972), location in a regional metropolitan area (Bourne and Gad 1972) or in a cluster of small centres (Hodgson 1972) and location on the periphery of the urban system (Bunting 1972) all featured prominently in different analyses of the growth of Ontario and Quebec cities. These studies suggested there was a strong linkage effect between cities and that urban growth was likely to be most rapid in cities that were close to the major urban centres of the sample. This phenomenon was further investigated by an attempt to estimate in-migration separately to satellite cities (those within 60 miles of an Ontario metropolis) and independent cities (those located further than 60 miles from an Ontario metropolis) (Siegel 1971). Results showed these two types of cities had in-migration for different reasons; the satellite city attracted migrants due to manufacturing industry growth, whereas in the independent city the growth of the service sector was the most important element in generating in-migration. These studies established that location relative to a large city was an important factor in urban growth in Ontario and Quebec.

The impact of proximity to a larger city on urban growth has also been analysed for Saskatchewan trade centres by Hodge (1965). There, proximity to a large city was detrimental to a trade centre's growth, as consumers bypassed the centre in favour of the larger city nearby. This finding differed from the Ontario results because of the different employment structures involved. The Ontario analysis was of manufacturing industry, and here proximity to a large city meant ready access to markets and suppliers. Proximity to a larger city was beneficial to Ontario cities as it allowed them to develop inter-industry linkages with the larger centre; the Saskatchewan trade centre suffered due to proximity as consumers bypassed it and there was no opportunity to benefit from inter-industry linkages. In summary, proximity to a large centre appears to be important to a city's economic growth, though the direction and strength of the relationship in question depends upon the type of industry involved.

The industry-mix in a city was the second variable stressed in the Ontario and Quebec studies. This was generally measured by the proportion of the workforce in manufacturing or other major employment sectors. The proportion of the workforce in manufacturing, for example, has been found to be a discriminator between fast and slow growth cities, (Barber 1972) while an analysis of growth rates and industrial structure found specialised cities had variable growth rates - some, such as Oshawa, were growing quickly while others, such as Timmins, were growing slowly (Bourne and Gad 1972). The difference was due in part to the type of industry - the automobile industry in Oshawa was growing faster than the mining industry in Timmins - but one cannot discount the effect that proximity to Toronto had on this comparison.

Hartwick and Crowley (1973) have taken the emphasis on industrial structure a step further and investigated city growth and industrial activity for a sample of Canadian cities. They found cities that grew rapidly usually had a broad range of industries which all developed at approximately the national average rate. The oft repeated notion that cities grow rapidly due to concentration of a particular industry was not supported by the data in that study.

The above survey of research on Canadian urban economic growth has stressed the importance of metropolitan areas and the differences between regions in the growth of Canadian cities. Furthermore, the Ontario and Quebec studies in particular introduced the important dimensions of industrial structure and proximity to larger cities, and it is clear that any future analysis of urban economic growth needs to incorporate these factors. It is necessary to find a modelling strategy that can incorporate these elements.

2. INDUSTRIAL STRUCTURE AND URBAN ECONOMIC GROWTH

Models of urban economic growth have a long history. The industrial structure approach to urban analysis was developed by Thompson (1965) who suggested that there are two ways of looking at urban economic growth - from the demand side and from the supply side. The present survey follows this classification.

A. Demand Analysis of Urban Economic Growth

The analysis of demand investigates the effect of export activity on the growth of a city. The empirical justification for the importance attributed to export production in overall city activity is sound; analyses of the flows of goods and services in major metropolitan areas such as Stockholm (Artle 1965) and Philadelphia (Karaska 1969, and Isard and Langford 1971) have shown that external demand accounts for up to 50% of total metropolitan area expenditure. Put simply, export base models were developed as follows:

$$\Delta E = \Delta E_x + \Delta E_s$$

where the change in employment, ΔE is seen as having two components: ΔE_x, the change in export employment, and ΔE_s, the change in service employment. The change in export employment, in turn, was related to $X_1, X_2, \ldots, X_n$, a set of exogeneous forces. For example, in a steel industry city such as Hamilton the national demand for steel may be used to estimate change in export employment. Hence,

$$\Delta E_x = f_x(X_1, X_2, \ldots, X_n)$$

The model was then completed by making the service sector dependent upon the export sector. Thus,

$$\Delta E_s = f_s(\Delta E_x) \quad .$$

The change in export employment and the change in total employment are related by an export multiplier similar to that found in models of income determination of a national economy (Shapiro 1970). Over a time period, a change in demand for the output of the export industry was reflected in the city economy by an increase in factor payments. These were either spent on the output of the service sector and hence circulated around the city economy multiplying the original increase in income, or they leaked out of the city to be spent elsewhere. The development of the service sector was then critical to future city growth as it was needed to contain the leakages in order to realize the maximum benefit from the increased export demand.

Applications of models with this general structure can be found at both the urban and regional scale. The size of the export-base multiplier was estimated by Hildebrand and Mace (1950), and also by Tiebout (1960, 1962) and Pfouts (1957). Ratios between export industries and service industries in Canadian cities have been calculated by Gray (1969). However, there has been disagreement on the scale of area and time for which export base models were appropriate. North (1955, 1956) has presented an export base approach to regional development over a long period of time, whilst Tiebout (1956) and more recently Mattila (1973) have argued the export base model was really a short run income determination model. Similarly there has been disagreement about what were the basic industries, how they changed over time and what was their particular role in different size cities (Andrews 1953 A,B,C; Blumenfeldt 1956). Gray's (1969) study, for example, has shown that the role of the basic industry in Canadian cities becomes weaker as cities grow.

There are two fundamental weaknesses associated with the simple export base model outlined in research cited above. The first is in the assumption that a change in demand for export industries leads directly to a change in total employment. The second is that the service sector responds endogeneously to changes in export employment. These two elements in the model have been the lines of substantive research.

The problem of the relationship between change in demand for exports and change in regional (or city) employment has been analysed by Borts and Stein (1964). They introduced the labour market into the analysis, similar to macro-economic modelling of national growth, where the change in output in the product market affected wages and employment in the labour market. This had the effect of complicating the impact that a change in employment in an export industry had upon a city economy. In the simple models it was assumed that a change in export industry employment led directly to a change in total employment. However, in the Borts and Stein (1964) model a change in demand for export industry output affected wages and employment in particular industries through its impact on the labour market. They argued that in an urban area, particularly where the labour market was open (in the sense that it is affected by inter-urban migration), the change in export demand could influence total employment in several different ways. If a change in demand for exports boosted money wages in export industries the labour market could react in three ways. There could be first, immigration, boosting total employment; second, intersectoral shifts within the city, not altering total employment; and third, a reduction in unemployment in the city as unemployed labour filled the vacancies created. The essential point was that the change in total employment that a city experienced would depend on the labour market conditions of each industry involved in export activity - some industries may have labour shortages whilst others may have surpluses.

Thus, the Borts and Stein (1964) analysis established that export base theory was too aggregative and had overlooked the working of the labour market. Mattilla (1973) also addressed the problem of excessive aggregation. He estimated a multi-sectoral export base model for the several basic industries within the Detroit Metropolitan Area. Mattilla's results made it clear that the export base model could estimate metropolitan income more accurately when structured in this fashion than when a single export base was used.

Two studies have attempted to estimate the dynamic nature of an open urban labour market. Muth (1968) and Greenwood (1973) have both undertaken research in this area, concentrating on the impact of migration on labour force growth. Muth (1968) set out to test hypotheses from Borts and Stein (1964), but he modified them slightly in order that urban growth and migration were simultaneously determined. His model had an export base framework, with urban employment divided into export and service activity, although the emphasis was really on labour market variables such as wages, employment and migration. Muth's results were inconclusive and he attributed this to the oversimplification of the export-service dichotomy in the export base framework. He stressed the need for a different classification of industry to make his analysis more sensitive to actual conditions in city economies. Further research by Greenwood (1973) showed that the simultaneous interaction between output levels, employment and migration, under the influence of the money wage rate in each industry group was critical to employment growth in urban areas.

A second serious question raised of the export base models referred to the behaviour of the service sector. Mattila (1973) showed this element of urban employment had a high degree of autonomy within the economy of Detroit, and converse to the expectations of the export base model the service sector did not change solely in response to changes in export employment. Searching for the role the service sector played in employment growth in Canadian cities, Harvey (1974) estimated the relationship between the change in service industry employment, ΔE_s, and the change in export industry employment, ΔE_x. He used a model as below

$$\Delta E_s = \alpha + \beta \Delta E_x$$

and hypothesised that α would not be significantly different from zero. This hypothesis was developed directly from the export base model, i.e., when the change in export employment was zero there should be no change in service employment. However, he found α to be significantly different from zero for a sample of 39 Canadian cities. Thus, like Mattila (1973), Harvey (1974) established that the service sector did not simply follow the export industries, but responded to forces that gave it some independence from the export sector. An attempt has been made to identify the forces that influence the service sector. For example, Polzin (1974) has shown that service sector employment growth was related to city population, income per capita and the city's geographic setting, that is its location with respect to other cities in the urban system.

The research of Mattila (1973), Harvey (1974) and Polzin (1974) has established that models which incorporate endogeneous determination of change in employment in the service sector oversimplify the analysis of the urban growth process. The growth of the service sector has been shown to depend in part on the export sector, but also on many other factors, especially the city's size, its position in a spatial system and the character of its export industries.

B. Supply Analysis and Urban Economic Growth

The supply side of urban growth analysis has stressed the availability of factors of production - land, labour and capital - as the principal determinant of growth. Theories of this type suggest that some cities grow faster than others because they have more to offer in the way of factors of production. These factors include the availability of services - transport, finance and other infrastructure - and supply oriented models of urban growth have stressed the role of the service sector in urban growth (Blumenfeldt 1956). This approach assumed that the availability of services within a city was a major reason why new industries would locate there and, furthermore, these service industries allowed externally generated income to circulate around the city economy with its consequent multiplier benefits. The strength of the local service sector was inversely related to the leakage of income from the city economy and hence the supply factors were ascribed a major role in urban growth.

The supply models suggested that cities grow when firms see advantages in spatial juxtaposition; the essence of the problem, then, was to identify when proximate location was an important locational force for firms and industries. Czamanski (1971) has addressed the problem of identifying the major inter-industry linkages in urban areas. He investigated the hypothesis that in an urban agglomeration various ancillary links with suppliers of technical, commercial or financial services ("links due to spatial juxtaposition") are more important than links based on flows of raw materials, basic production ingredients or outputs. Locating the strongest linkages in several input-output tables led him to conclude that "links due to spatial juxtaposition take precedence over those due to technical affinity ... for plants attracted to urban agglomerations, the very existence rather than the nature of the numerous and manifold links is a prime consideration" (Czamanski, 1971, p. 149). Furthermore, Streit (1969) has used correlation analysis to test the degree to which spatial associations reflect sectoral linkages, and the statistical relationship he found, although positive, was weak.

Research into the supply side of urban growth has stressed that city economies have complex internal flows of production and income, which together make an important contribution to economic growth. These internal flows are strongest between sectors not necessarily using related inputs and outputs, but between manufacturers and a range of tertiary services. Consequently, the complexity of the local sector was an important parameter in a city's growth.

The foregoing survey of both the demand and supply approaches to urban growth has stressed three major themes. The first is that the export and service industry dichotomy is too broad and that if the demand approach is used it may operate more successfully with a different classification of industries. The second theme is that of the autonomous nature of service industry employment in cities, and the third has been the role of labour market dynamics. It is not possible to handle all three themes simultaneously and in the present study only the first two will be taken into consideration. It is suggested that a different classification of employment would prove more useful and that recognition need be given to the autonomous nature of service industry employment. Furthermore, the industrial classification that is decided upon will need to admit both the influence of metropolitan areas in the Canadian urban system, and the important role that the regional economy plays in each city's growth. It was clear that a simple export base framework would not allow analysis of this type. As a result the emphasis of the research shifted toward a search for an alternative classification of industry.

3. AN ALTERNATIVE CLASSIFICATION OF INDUSTRY

A first attempt at a more sensitive classification of urban employment was made by Czamanski (1964, 1965). He formulated a three sector model and estimated it both for four city size groups at one point in time and for one city, Baltimore, over time. He proposed three groups of industries = (i) "Geographically Oriented" - industries with particular locational requirements such as oil refining; (ii) "Complementary" - industries influenced by agglomerative forces, representing the impact of input-output linkages; and (iii) "Urban" - industries such as retailing, shown to be dependent on city population. The Czamanski models have been able to successfully predict urban growth; their predictions of population size have been checked against available data and the results were accurate (Czamanski 1965). This accuracy indicated that a three sector framework with a demand orientation was likely to be a successful modelling strategy. This approach was used in the preliminary analysis in the present study, but the industrial classification did not lend itself to incorporating the role played by a regional economy in the growth process. Furthermore in the Czamanski models the service sector ("urban industries") depends directly upon the other sectors and so they are out of step with the recent research on service sector autonomy.

It was decided to use a model framework that allowed for analysis of both the regional economy and the local service sector. This objective could be achieved by using a three group classification of industrial employment in cities - national, regional and local industries. This was a departure from the export base approach for two reasons. In the first place, it admitted that the city had three separate sources of demand rather than one, and secondly, it allowed the service sector - satisfying both regional and local markets - to have an autonomous role in the model structure. Muth (1968) has commented that this distinction could be useful in urban analysis. He found the export-and service dichotomy to be oversimplified as he believed there were two types of industries involved in export activity - those selling on national markets with exogeneously given prices on the one hand, and firms facing finitely elastic regional demand schedules on the other.

Furthermore, there was strong empirical evidence that the distinction between national and regional markets was a legitimate one. In his analysis of growth in New York, Vernon (1960) identified national and regional market area industries, and this distinction was also used by Duncan (1960) in research on metropolitan growth. Regional markets and subsystems of cities have been identified by Mattila and Thompson (1960), King, Casetti and Jeffrey (1969) and Borchert (1972) in the U.S., and by Bourne and Gad (1972) in Ontario and Quebec. Thus there appeared to be theoretical and empirical justification to use national, regional and local industries as a framework to analyse urban growth. Consequently, it was used in the present study to analyse employment growth in Canadian cities.

CHAPTER TWO

STATEMENT OF RESEARCH OBJECTIVES

It is proposed that employment in Canadian urban areas can be classified into three categories - national, regional or local industries - depending on the market area for the industries' products. The objective of the dissertation is to identify the industries that are in these categories, and then to attempt to predict employment change in each group. The basic contention of this dissertation is that different economic forces account for changes in urban area economic activity in each of these industry groups. In simple terms, a city's national industries are seen as being conditioned by national forces, its regional industries by regional forces and its local industries by conditions in the city's local economy. A major concern is over the identification of these forces; the research seeks to isolate the components of the spatial and economic system that influences change in each of these groups of industries in Canadian cities.

1. RESEARCH METHODOLOGY

The most straightforward technique to analyse change in these groups is to use a regression model which relates changes in group employment to some hypothesised spatial and economic variables. The regression model enables a statistical assessment to be made of both the strength of the relationship and the significance of the parameters in the relationship.

There are several alternative ways in which regression analysis can be performed in the study of industry groups in urban areas. The first possible regression structure of relevance here is one that is applied in the temporal domain. This would involve estimating parameters in a model where the dependent variable, ΔE_g - change in employment in industry group g - is related to independent variables either measured at the same time period, or at an earlier point in time. Hence

$$\Delta E_g = f_1(\Delta X_1, \Delta X_2, \ldots, \Delta X_n) \quad (1)$$

or

$$\Delta E_g = f_2(X_1, X_2, \ldots, X_n) \quad (2)$$

The first model relates changes in employment to concomitant changes in the independent variables and effectively represents an analysis of the evolution of the system under study. The second model relates changes in employment to conditions in the system at the start of the time period.

However, neither of these approaches directly measures an important element in urban analysis. This is the effect of space and the existence of an autocorrelation effect between the growth rates of cities in an urban system (Cliff and Ord 1971). In simple terms the temporal regression can be cast in a spatial domain when the dependent variable in city i, ΔEg_i is related to activity levels, X, in other cities j, ..., n. Hence,

$$\Delta E_{gi} = f_3(X_j, \ldots, X_n) \tag{3}$$

Cliff and Ord (1971) have shown how a model of this form can be estimated for a regular lattice, where n, the number of cells adjoining cell i equals four. How this same strategy could be used for a system of irregularly spaced cities is less clear. For a start one needs to specify a set of weights that measure the interdependencies between cities, reflecting, for example, inter-city distances. Furthermore, Ord (1972) has shown a model that modifies maximum likelihood estimators is necessary to achieve unbiased estimators.

The regression format in (3) above is essentially a spatial forecasting model (Curry 1970). It allows for the prediction of employment change in city i, given activity levels in other cities. If a separate regression could be performed on each industry group in every city, the results would provide detailed information on industry group growth. However, the empirical estimation of such a model for each city requires time series data; these are not available at the required level of spatial and sectoral resolution for Canadian cities.

Consequently, one is left with the temporal regression format in which the inclusion of the spatial dimension is only implicit. This involves, for example, the use of independent variables such as distance to a larger city or other distance measures, to estimate the influence that space has upon the growth of cities. This approach however does not incorporate the spatial dimension in the explicit sense as suggested by Cliff and Ord (1971). These authors' models estimate the relationships between activity levels in cities and hence admit directly the spatial dependency that exists between activity levels in cities.

The implicit incorporation of the spatial element can be achieved by a regression of the form:-

$$\Delta E_g = f_4(X_1, X_2, \ldots, X_n) \qquad (4)$$

Parameter values in this model can be estimated from two separate data sources. The first is to treat the regression as a time series analysis for a single city. This provides information about industry group behaviour in that city. If regressions are then performed for several cities, the general behaviour patterns of industry groups would become clear. However as commented above, time series employment data that can be analysed separately for national, regional and local industries are not available for Canadian cities. Thus a cross-sectional approach is necessary. This involves obtaining data at two points in time for a sample of cities and performing the regression on these data. This approach suits the present research as it provides a commentary on the behaviour of industry groups as aggregates in all cities, and it can also be structured in a predictive framework.

The research proposes that total employment change in a city, ΔE, has three components:

$$\Delta E = \Delta E_N + \Delta E_R + \Delta E_L$$

where the subscripts N, R and L refer to national, regional and local industries. It is proposed that each group of employment has identifiable forces $X_1, X_2, \ldots, X_p$ that are related to employment change in each group.

$$\Delta E_N = f_N(X_1, X_2, \ldots, X_i)$$

$$\Delta E_R = f_R(X_j, X_k, \ldots, X_l)$$

$$\Delta E_L = f_L(X_m, X_n, \ldots, X_p)$$

The problem is to identify the $X_1,\ldots,X_p$ variables. For each group specific hypotheses about the variables relevant to change in employment are tested with correlation and stepwise multiple regression analysis.

2. THE DEPENDENT VARIABLES

An important assumption in the research is that the economic growth experienced by a national economy is translated into demand for the production of national, regional and local industries in cities. It is assumed further that this demand is not allocated equally to all cities in the system. The real problem then is to suggest the factors that might condition a city's ability to share in this demand. Hence the research attempts to isolate a city's ability to satisfy national, regional and local demand in competition with other cities in the system. A dependent variable has been developed for each industry group that measures this effect. It is assumed the change in employment has two components — the first depends on the national average change all cities experience, while the second reflects each city's unique industrial growth. This second component is the dependent variable used for each industry group and is basicially city employment change after a national average change has been removed.

This variable is in fact the shift component in the language of shift-share analysis (Dunn 1960; Perloff et al. 1960). To calculate this component it is assumed there is a known national average change in employment in each industry group over a time period. It is assumed further that each city at least experiences this amount of growth and hence an *expected* change in employment for each industry group is calculated for each city over the time period. The actual change can be found from published data. The difference between the actual and expected change is the shift component and this is the dependent variable in the regression models developed in this research. The method of calculating the dependent variable for one city, for regional industries, is shown in Table 1; the calculations for all cities, for all three industry groups, appear in Appendix Five.

TABLE 1

CALCULATION OF DEPENDENT VARIABLE

TORONTO - REGIONAL INDUSTRIES

Regional Industry Employment 1951	Expected Change in Regional Industry Employment 1951-1961	Actual Change in Regional Industry Employment 1951-1961	Dependent Variable ΔE^*_R
(1)	(2)	(3)	(4)
236201	96776	112487	15711

In Table 1, columns (1) and (3) record data available in published statistics. Column (2) records the expected change in regional industry employment in Toronto had it grown at the national average rate of 40.97% between 1951 and 1961. Column (4) records the change in regional industry employment in Toronto in excess of the national average change. It is denoted ΔE^*_R. This symbol is used with different subscripts to identify the dependent variables in the regressions in this study.

This particular dependent variable emphasises the explanation not of absolute changes in industry group employment (which are highly correlated with population) but of changes relative to the national average. It means that the analysis to follow represents attempts to predict not simply employment change in national, regional and local industries, but change in employment after an assumed national average change has been removed. Thus, if there is some industrial growth that is shared by all cities, and some that is unique to each city, the dependent variable described above attempts to capture this second component. This approach sharpens the focus of the study on individual cities and their industrial growth by measuring how each city performs vis-a-vis the national average.

Admittedly, Alonso (1972) has criticised the use of this type of variable. His contention is that cities do not have an equal ability to satisfy demand for an industry's output, because proximity to another city can increase or decrease the share of demand - in a word, economic activity is spatially autocorrelated in a system of cities. Consequently, Alonso (1972) believes a better method to obtain an estimate of a city's expected growth is to fit a spatial autocorrelation function to data on employment growth in cities. This function would identify a residual for each city representing that city's growth in excess of the expected value, given its spatial location. However, estimation of a precise spatial autocorrelation function for a set of irregularly spaced cities is a vexing problem. Indeed if this were possible, the Curry (1970) and Cliff and Ord (1971) approaches to spatial forecasting would be used and regression models formulated on the basis of the known spatial autocorrelation between employment growth in Canadian cities. It is precisely because Alonso (1972) is unable to specify the form such a function should take that this present research used the national average method to filter out a component of growth assumed to be shared by all cities.

3. THE DATA

This research requires data on urban employment, disaggregated into a sufficient number of sub categories to allow for classification into three groups of industries. The data need to be available for cities that have similar boundary definitions for two separate years, and furthermore definitions of the economic activity contained in each industry group need to be similar for both years. In summary, data have to be available for spatial units and an industrial classification that have consistent definitions at two points in time.

The definitions both of the spatial units and employment groups for which published census data are reported have changed between censuses. Consequently, a transformation of published data is needed. This has been done by Grossner (1970) who produced data for similar industrial groups and comparable spatial units for 46 Canadian cities in 1951 and 1961. Hence these data satisfied the major requirements of the study. Ideally it would be better to have employment change data for time periods less than ten years; a ten year time period introduces the possible influence of a very large number of forces. This is reflected in big employment changes in some cities, well in excess of the regression models' predictive abilities. However shorter time period data were not available, so the study uses the Grossner (1970) data. The data appear as an Appendix to Grossner (1970) and also to Hartwick and Crowley (1973).

4. SUMMARY

Broadly the research strategy is to take change in employment relative to a national average change in national, regional and local industries in 46 Canadian cities 1951-1961, and to identify variables measured in 1951 that can predict these changes. The research attempts to identify the independent variables $X_1, \ldots, X_p$ in the three regression models as shown below:-

$$\Delta E_N^* = f_N(X_1, X_2, \ldots, X_i)$$

$$\Delta E_R^* = f_R(X_j, X_k, \ldots, X_l)$$

$$\Delta E_L^* = f_L(X_m, X_n, \ldots, X_p)$$

and use these models to analyse urban growth in Canadian cities. The following propositions are tested:-

(i) Employment in national, regional and local industries responds to different economic forces;

(ii) Growth in these industry groups can be predicted from knowledge of certain key variables at the start of a time period; which implies

(iii) This classification of industries is a useful one to analyse employment change in an urban system.

CHAPTER THREE

A CLASSIFICATION OF INDUSTRIES

A first step in the research was to develop a means of classifying industries into three groups - national, regional and local industries. Several authors have classified industries for various purposes and their efforts are reviewed below.

1. A SURVEY OF CLASSIFICATIONS OF INDUSTRY

Groves (1971) has summarised previous attempts to classify industries. He observed that other authors have used a combination of several of the following criteria to arrive at their classifications;

(i) Locational Pattern
(ii) Market Area Served
(iii) Plant Characteristics
(iv) Transport Media Used
(v) Nature of Product and/or Raw Materials
(vi) Communication Requirements

The present research needed a classification based on the second criterion - market area served.

The three group classification - national, regional and local industries - has been used before in urban and regional research. Vining (1946) used it in a study of regional business cycles, Isard (1953) in a regional input-output table, and Duncan (1960) and Vernon (1960) in analyses of metropolitan areas. Mennes et al. (1969) have used a similar three group classification - international, national and regional industries in a spatial growth model of Mexico. In all the studies the classifications were based on the assumption that some goods (e.g., iron and steel and automobiles) were only produced in a few locations for economic or technical reasons, and that these industries supplied the national market from their few locations. A second group of industries, such as the food industry, were located in several cities in an urban system and supplied their products to sub-national or regional markets. A third group of industries produced and sold all their output in each city and the best example of these local industries was retailing. This classification depended solely on location and the implied market area served. Other characteristics, such as corporate structure, were not considered. Many firms in the food industry, for example, breweries, were national companies with headquarters in a major metropolis and a market extending across the nation. However, they operated a branch plant production system and their branches supplied regional markets and so this industry was classified as "regional".

Both Vining (1946) and Isard (1953) came to grips with the problem of how the market area of an industry could be measured without precise data on sales and distribution. Vining (1946) measured the tendency for industries to localise using State Labour Force data. The classification focussed on the proportion of State j's labour force, LF, in industry i:

$$\frac{LF_{ij}}{LF_j}$$

relative to the share that industry i had in the national labour force (LF_N).

$$\frac{LF_i}{LF_N}$$

The index:

$$\frac{\dfrac{LF_{ij}}{LF_j}}{\dfrac{LF_i}{LF_N}}$$

was computed for each state and calculations made of the number of states that had an index greater than unity. National industries were those that were highly localised - i.e., a few states had indices greater than unity, representing concentrations of the industry. An array of industries was produced with national industries such as automobile production as the most concentrated through to retail trade as the least concentrated.

Isard (1953) steered away from the localisation measure and made a direct attempt to measure output and sales for each industry in each state. He estimated Production and Consumption for an industry in each state, and was then able to calculate the surplus or deficit for each state. He defined a national industry as one which had a large number of states in deficit and a few in surplus (i.e., a concentrated pattern) and a local industry as one which had had only small surpluses or deficits in all states. This approach was preferable to that adopted by Vining but its data requirements prohibited its use in the present research. Isard produced a list of industries similar to that produced by Vining, and both are tabulated in Appendix 3, along with the Mennes et al. (1969) classification. Mennes et al. (1969) produced their classification by what the authors describe as an "ad hoc strategy" where industries were allocated to classes solely on what markets Mennes et al. believed to be appropriate, based on the knowledge the authors had of the distribution of industry in Mexico.

These classifications produced arrays of industries with national, or most spatially concentrated, industries at one end and local industries at the other. None had an analytical method to separate the regional category; and the only operational method was an ad hoc selection strategy. Isard found two large gaps in his array of industries and defined these as the borders of the regional class. Both Vining and Isard found the level of disaggregation of industry employment data to be critical to the allocation to a class. If there were employment data on Metal Fabrication alone, for example, the high degree of concentration in the iron and steel industry (a sub-category in metal fabrication) would be lost and the industry may appear to be a regional industry. Thus, the greater the disaggregation the more sensitive was the classification system used.

This survey of previously developed classifications has shown that in the absence of precise estimates of the market area of industries, classification has generally depended on the locational characteristics of an industry. Both Vining and Isard assumed that the locational pattern had reflected market area forces and overlooked any industrial inertia or other inefficiency in the working of the spatial system. They assumed further that all firms within an industry had a similar market area for their products, irrespective of size, age and relative efficiency. Although these two critical assumptions were probably violated by the data, there seemed no other way to effectively disaggregate industries into market area groups.

An alternative strategy was to estimate the tendency for industries to be distributed in accordance with the distribution of population. It was expected the location of the retailing industry in an urban system would bear a close correspondence to the distribution of population in that system. Conversely, the iron and steel industry was not expected to be located in any way similar to the pattern of population distribution. Hence, the example of retailing was one of a local industry, whilst that of iron and steel was an example of a national industry. Hartwick and Crowley (1973) have provided some data that could be used to classify industries in this manner. They used least squares regression to estimate the parameters A_i and B_i in the following model:

$$LF_{ij} = e^{A_i} \, CIPO_j^{B_i} \cdot \varepsilon$$

where LF_{ij} was the Labour Force in industry i in city j, and $CIPO_j$ was the population of city j. The R^2 values obtained for estimates of this model for each industry were reported. The R^2 value measures the proportion of variance in labour force shares in a given industry that is associated with city populations in the sample. Consequently an industry with a high R^2 value in this model has the variance in its shares of cities' labour force closely associated with the variance in cities' populations. On the other hand an industry with a low R^2 value in this model has its variance in labour force shares not closely related to cities' populations. These two values were interpreted as typical of a local industry in the first instance (a high R^2) and a national industry in the second case (a low R^2). The R^2 values obtained by Hartwick and Crowley (1973) are listed in Table 2: they have been presented in ascending order.

Table 2 shows a range of industries similar to that produced by Vining (1947) and Isard (1953), with national market area industries, like iron and steel and textiles, at the top of the scale and local industries, such as retail trade, at the bottom. However, there is no means of clearly identifying the midway category - regional industries - though it is likely they are clustered around the group "Provincial Administration". To achieve the discrimination of regional industries attention in the present study focussed on the distribution of industries among cities in an urban system, rather than on the relationship between industrial employment and population.

2. A METHOD OF CLASSIFYING INDUSTRIES

A modification of the Vining technique was used to classify industries into national, regional or local industry groups. These

TABLE 2

PROPORTION OF VARIANCE IN CITY LABOUR FORCE IN AN INDUSTRY GROUP ASSOCIATED WITH CITY POPULATION (R^2)

46 CANADIAN CITIES 1951

Industry Group	R^2
Services-Recreation	.02
Textiles	.08
Rubber	.17
Agricultural Implements	.20
Non Ferrous Metal Smelting	.23
Hosiery	.23
Forestry	.24
Iron and Steel	.27
Mining	.27
Tobacco	.28
Pulp and Paper	.33
Fishing and Trapping	.36
Petroleum	.39
Electrical Appliances	.40
Leather	.46
Transport Equipment	.47
Metal Fabrication	.47
Chemicals	.54
Other Machinery	.57
Administration - Provincial	.59
Non Metallic Mineral Products	.60
Miscellaneous Manufacturing	.63
Administration - Federal	.64
Clothing	.67
Agriculture	.69
Furniture	.72
Liquor and Beverages	.72
Lumber	.73
Electicity, Gas and Water Supply	.78
Food	.80
Services - other	.80
Transportation	.81
Services - Religion	.81
Wholesale Trade	.83
Services - Health and Welfare	.87
Printing	.89
Insurance, Real Estate	.90
Services - Food and Lodging	.91
Services - Business	.91
Administration - Local	.91

Continued...

Table 2 Continued...

Services - Repair	.93
Services - Education	.94
Construction	.94
Retail Trade	.95
Services - Personal	.96

Source: Hartwick and Crowley (1973), Table 2.1.

three industry groups were first defined in terms of their tendencies in locating among the cities in Canada. A national industry was defined as one whose labour force was concentrated in a few cities; a regional industry was one whose labour force was dispersed among subsets of cities in a sample, with a weaker tendency to concentrate; and a local industry was dispersed among all cities in relatively equal proportions, without any tendency to concentrate. The following variable was used to measure the concentration of industries in cities. Let LF_{ij} be the labour force in industry i in city j, LF_j the total labour force in city j and LF_i the total labour force in industry i. Following Vining (1946) the variable

$$\frac{LF_{ij}}{LF_i} .$$

measures the share of employment in industry i that is located in j. This was the first variable used to measure the tendency to concentration, and it identified cities that held large shares of industry i. However, it quickly became obvious that the Canadian metropolitan areas held large shares of most industries - employment in the Transport Equipment industry in Montreal was larger than that in Windsor in 1951, but this group employed only 4% of Montreal's labour force while it employed 33% of Windsor's labour force. Thus the share of each industry's employment would not capture the concentration tendency believed to be important to this research. It seemed essential to capture the impact of high concentration of industries in particular cities such as the transport equipment category in Windsor. In effect, some means was needed to compensate for city size.

Attention therefore turned to a second variable:

$$\frac{LF_{ij}}{LF_j}$$

which measures the share of city j's work force occupied by industry i. The focus of this variable is on the tendency for some industries to absorb large proportions of a city work force. This changes the emphasis of the classification. A national industry is now an industry which has large shares of the city labour force in a few cities. A local industry has similar shares of the labour force in most cities and the regional industries are once again a midway category. A method to discriminate industries into groups is used that identifies the number of cities that have large concentrations of their work force in a particular industry. This is done by constructing frequency distributions for each industry showing the share of the city labour force in each of the 46 cities in the sample. These distributions are made comparable by using the same six class intervals for each frequency distribution. The class intervals are determined by using multiples of LF_i^*, the labour force share of industry i in total employment in the sample. This is calculated as below

$$LF_i^* = \frac{\sum_{j=1}^{46} LF_{ij}}{LF}$$

where LF was the total labour force of the 46 cities. The following six classes were used:

(i) Greater than $5(LF_i^*)$

(ii) $2(LF_i^*) \rightarrow 5(LF_i^*)$

(iii) $LF_i^* \rightarrow 2(LF_i^*)$

(iv) $1/2(LF_i^*) \rightarrow LF_i^*$

(v) $1/5(LF_i^*) \rightarrow 1/2(LF_i^*)$

(vi) Less than $1/5\ (LF_i^*)$

A frequency distribution is constructed for each industry and industries are allocated to categories according to the following criteria:

(i) A national industry is one with a bi-modal frequency distribution. The two modes arise from the two groups of cities within the distribution - those with very large labour force shares in the industry at one end of the frequency and those with very small shares in the industry at the other end. This is typical of a national industry as it has large concentrations of employment in a few cities - the mining and iron and steel industries are examples of this pattern.

Regional and local industries do not have bi-modal frequency distributions as they do not concentrate sufficiently to dominate the employment structure of several cities. Hence this first step in the classification filtered out the national industries. To separate regional and local industries a measure of dispersion around the industry share in total employment (LF_i^*) was used.

(ii) A regional industry is one with frequencies recorded in 4 or more classes. This means that regional industries could have up to

5 times LF_i^* (in major regional centres such as Winnipeg or Saskatoon), or as little as $^1/5$th LF_i^* (in cities like Timmins or Sydney which have sparsely settled hinterlands), but the majority of cities have shares close to the industry's share in total employment.

(iii) A local industry is one with frequencies recorded in no more than 3 classes. Because the distribution of a local industry is expected to be similar to the distribution of population the share that local industries have in each city work force is expected to be relatively similar from city to city. This means all cities are expected to have shares in their labour force close to the industry's share in total employment.

Thus the classification is based first on the existence of a bi-modal frequency distribution (reflecting the concentration in a few cities and absence from many others), and second on the dispersion of a distribution about a central value - the industry share in total employment. This classification routine produces the groupings of industries, shown with their respective frequencies in the six classes specified earlier, in Table 3. This classification was compared to those developed by Vining (1946), Isard (1953) and Mennes et al. (1969). (See Appendix 3). The allocation of industries to groups was similar. Furthermore, the variance in labour force shares associated with city populations (produced by Hartwick and Crowley (1973) from the same industries - see Table 3) was paired with the allocation that the classification routine made for each industry. These two arrays are shown in Table 4.

Ideally the R^2 values for all national industries should be in one range, for example, .01 to .50, the regional industries in a second

TABLE 3.

FREQUENCY DISTRIBUTIONS OF

INDUSTRY LABOUR FORCE SHARES IN CITIES, 1951

	$<\frac{1}{5}(LF_i{*})$	$\frac{1}{5}(LF_i{*})$ – $\frac{1}{2}(LF_i{*})$	$\frac{1}{2}(LF_i{*})$ – $LF_i{*}$	$LF_i{*}$ – $2(LF_i{*})$	$2(LF_i{*})$ – $5(LF_i{*})$	$>5(LF_i{*})$
National Industries						
Forestry	23	5	7	3	3	5
Iron and Steel	32	5	5	–	–	4
Mining	29	8	4	–	1	4
Textiles	19	8	3	3	9	4
Non Ferrous Metal Smelting	37	2	2	1	1	3
Hosiery	25	4	3	4	7	3
Transport Equipment	21	6	7	7	2	3
Chemicals	8	19	8	6	2	3
Rubber	32	1	3	5	3	2
Fishing	31	5	3	2	3	2
Petroleum	31	2	4	4	3	2
Agricultural Implements	33	4	4	1	2	2
Tobacco	40	2	–	1	2	1
Pulp and Paper	15	10	6	7	7	1
Leather	35	2	2	3	3	1
Clothing	25	5	7	8	–	1
Regional Industries						
Electrical Applicances	23	7	5	5	4	2
Furniture	17	16	6	6	1	–
Other Machinery	11	16	7	7	5	–
Metal Fabricating	9	12	9	9	7	–
Miscellaneous Manufacturing	6	12	12	10	4	2
Agriculture	6	13	12	11	3	1
Non Metallic Minerals	6	11	14	9	6	–
Administration – Federal	2	19	9	10	4	2
Lumber	2	19	18	4	3	–
Liquor and Beverages	2	6	29	12	5	1

Continued.

Table 3 Continued...

	$<\frac{1}{5}(LF_i^*)$	$\frac{1}{5}(LF_i^*)$	$\frac{1}{2}(LF_i^*)$	LF_i^*	$2(LF_i^*)$	$5(LF_i^*)$	$>5(LF_i^*)$
Regional Industries							
Administration - Provincial	1	13	18	6	6		2
Electricity, Gas & Water Supply	-	4	23	14	4		1
Transportation	-	1	15	22	8		-
Food	-	8	18	17	3		-
Services - other	3	12	13	17	1		-
Services - Religion	-	6	6	28	6		-
Services - Business	1	13	23	9	-		-
Services - Health & Welfare	-	3	21	20	2		-
Wholesale Trade	-	1	11	29	5		-
Local Industries							
Printing	-	11	30	5	-		-
Services - Repairs	-	-	16	28	2		-
Services - Education	-	-	26	19	1		-
Finance, Insurance	-	-	3	37	6		-
Services - Recreation	-	2	30	14	-		-
Services - Personal	-	1	25	20	-		-
Retail Trade	-	-	12	34	-		-
Construction	-	-	24	22	-		-
Administration - Local	-	-	28	18	-		-
Services - Food, Lodging	-	-	26	20	-		-

TABLE 4

INDUSTRY GROUP MEMBERSHIP AND LABOUR

FORCE VARIANCE ASSOCIATED WITH POPULATION 1951

Industry	R^2	Group Membership
Recreation	.02	Regional
Textiles	.08	National
Rubber	.17	National
Agricultural Implements	.20	National
Non Ferrous Smelting	.23	National
Hosiery	.23	National
Forestry	.24	National
Iron and Steel	.27	National
Mining	.27	National
Tobacco	.28	National
Pulp and Paper	.33	National
Fishing and Trapping	.36	National
Petroleum	.39	National
Electrical Appliances	.40	Regional
Leather	.46	National
Transport Equipment	.47	National
Metal Fabrication	.47	Regional
Chemicals	.54	National
Other Machinery	.57	Regional
Administration - Provincial	.59	Regional
Non Metallic Mineral Products	.60	Regional
Miscellaneous Manufacturing	.63	Regional
Administration - Federal	.64	Regional
Clothing	.67	National
Agriculture	.69	Regional
Furniture	.72	Regional
Liquor and Beverages	.72	Regional
Lumber	.73	Regional
Electricity, Gas & Water Supply	.78	Regional
Food	.80	Regional
Services - other	.80	Regional
Transport	.81	Regional
Services - Religion	.81	Regional
Wholesale Trade	.83	Regional
Services - Health & Welfare	.87	Regional
Printing	.89	Local
Insurance, Real Estate	.90	Local
Services - Food and Lodging	.91	Local
Services - Business	.91	Local

Continued...

Table 4 Continued...

Administration - Local	.91	Local
Services - Repair	.93	Local
Services - Education	.94	Local
Construction	.94	Local
Retail Trade	.95	Local
Services - Personal	.96	Local

range, for example .51 to .90 and local industries from .91 to 1.00. If this were so one could be confident there were three distinct groups of industry. A look at Table 4 shows the national and regional differentiation is blurred, though the regional and local distinction is clear. Four anomolies appeared - recreation, clothing, chemicals and electrical appliances. The Recreation industry has a very low R^2 in the regression with population, due no doubt to its tendency to disperse to areas with little population, not in any way inconsistent with its designation as a regional industry. The industry category clothing has an R^2 value more consistent with other regional industries, but the frequency distribution of labour force shares suggested it should be classified as a national industry.

The Clothing, Chemicals and Electrical Appliance industries indicated the classification did not handle the discrimination of national and regional industries as clearly as was expected. It was thought the bi-modal distributions would stand out but there was a gradual transition from the obvious bi-modal pattern associated with the iron and steel industry to that of the pulp and paper industry, which is not very different from the positively skewed distribution associated with the electrical appliances industry. The distinction between regional and local industries is more obvious, although this classification allocated some Services - Religion, Business, Health and Welfare - to the regional industry category, when they were expected to be local industries. A look at the data showed that these industries do have some cities with both high and low labour force shares, while most cities have close to the all city average share, which is the characteristic of the regional industry.

It is clear that positive identification of regional market area industries can only be made with precise specification of flows of products from cities. But in the absence of these data the relatively crude classification scheme devised above has to be used. The classification is listed in Table 5 in conventional Standard Industrial Classification order.

3. NATIONAL, REGIONAL AND LOCAL INDUSTRIES IN CANADIAN CITIES

When the total labour force of the 46 cities in the sample is allocated to the three categories they have employment totals and proportionate shares as shown in Table 6. The industries with the largest employment in each category are Transport Equipment (largely automobiles) in national industries, Wholesale Trade and Transportation in regional industries, and Retail Trade in the local industry category.

In absolute terms, the largest employment in each of these categories is in the metropolitan areas, which is the expected pattern. Tables 7, 8, and 9 show the cities with the highest shares in each industry group; only ten have been tabulated. In relative terms, the shares of the labour force occupied by national, regional and local industries provides a commentary on the industrial structure of some Canadian cities.

Table 7 shows the shares of city work force taken by national industries in 1951. Cities with the largest labour force concentration in national industries are the small textile cities in Quebec (Drummondville and Granby) and the specialised mining and iron and

TABLE 5

NATIONAL, REGIONAL

AND LOCAL INDUSTRIES IN CANADIAN CITIES

National Industries

- Forest and Logging
- Fishing and Trapping
- Mining
- Manufacturing
  - Tobacco
  - Rubber
  - Leather
  - Textiles
  - Hosiery and Knitwear
  - Clothing
  - Pulp and Paper
- Metals and Machinery
  - Primary Iron and Steel
  - Non Ferrous Smelting
  - Agricultural Implements
- Petroleum Refining
- Chemicals
- Transport Equipment

Regional Industries

- Agriculture

Continued...

Table 5 Continued...

Manufacturing

Food

Liquor and Beverages

Lumber and Wood

Furniture

Metals and Machinery

Metal Fabrication

Other Machinery

Electrical Appliances

Non Metallic Mining

Miscellaneous Manufacturing

Electricity and Gas

Transportation

Wholesaling

Administration

Federal

Provincial

Services

Health and Welfare

Religion

Business

Other

Local Industries

Manufacturing

Printing and Publishing

Continued...

Table 5 Continued...

Retail Trade
Finance Insurance and Real Estate
Construction
Services
Food
Recreation
Personal
Repair
Education and Related
Administration
Local

TABLE 6

INDUSTRY GROUP SHARE OF TOTAL LABOUR FORCE

1951

Industry Group	Labour Force	%
National Industries	444,000	17.15
Regional Industries	1,150,085	44.45
Local Industries	993,704	38.40

TABLE 7

PROPORTION OF LABOUR FORCE IN NATIONAL INDUSTRIES

1951

City	% of Labour Force
1. Drummondville	.49
2. Timmins	.48
3. Sydney	.47
4. Valleyfield	.49
5. Saulte Ste. Marie	.46
6. Sudbury	.45
7. Oshawa	.43
8. Welland	.42
9. Granby	.42
10. Cornwall	.42

TABLE 8

PROPORTION OF LABOUR FORCE IN REGIONAL INDUSTRIES

1951

	City	% of Labour Force
1.	Peterborough	.59
2.	St. Jean	.58
3.	Halifax	.57
4.	Guelph	.56
5.	Ottawa	.56
6.	Brandon	.55
7.	St. John	.54
8.	Moose Jaw	.54
9.	Belleville	.54
10.	Saskatoon	.53

TABLE 9

PROPORTION OF LABOUR FORCE IN LOCAL INDUSTRIES

1951

	City	% of Labour Force
1.	Lethbridge	.50
2.	Edmonton	.45
3.	Saskatoon	.45
4.	Victoria	.45
5.	Calgary	.43
6.	Regina	.43
7.	Moncton	.42
8.	St. John's	.42
9.	Toronto	.41
10.	Vancouver	.41

steel cities (Timmins, Sudbury, Welland, Saulte Ste. Marie and Sydney). These cities show up in later analyses of national, regional and local industry growth as they have distinctive patterns of employment changes.

Table 8 shows there are two types of cities that have concentrations of regional industry. On the one hand there are the regional market centres (Brandon, Saskatoon, Moose Jaw, Saint John and Halifax) and on the other, small cities located close to metropolitan areas which are regional manufacturing industry centres (Peterborough, St. Jean, Guelph and Belleville). This contrast highlights the distinction within the category regional industries between regional market service industries and regional market manufacturing industries. This distinction is important in the analysis of regional industry growth. Ottawa, of course, has a concentration upon regional industries as Federal Administration is classified as a regional industry.

Finally, local industries have large shares of the work force in metropolitan areas (Edmonton, Calgary, Toronto and Vancouver) and in Prairie and Maritime Provinces' cities, as shown in Table 9.

The next step in the research is to estimate the change in employment in each of these three industry groups in the sample of Canadian cities.

CHAPTER FOUR

CHANGE IN EMPLOYMENT IN NATIONAL INDUSTRIES

A national industry is one that is located in a few cities in an urban system and which supplies the national market from these few cities. There were two major subgroups of industries within this category in 1951. The first comprised industries tied to a few locations due to technical factors. Examples of this type were Mining, Paper, Non Ferrous Metal Smelting and Iron and Steel Production, which had large shares of employment in a few Canadian cities because of particular requirements such as a weight-loss raw material, a hydroelectric power supply or port facilities. The second subgroup was industries such as textiles, clothing, transport equipment (especially automobile production), which were concentrated in metropolitan areas or smaller centres such as Drummondville (textiles) and Oshawa (automobiles).

1. RESEARCH HYPOTHESES

This study tests four hypotheses about the change in employment relative to a national average change in national industries. These are that employment change in the sample of cities is conditioned by (a) city infrastructure; (b) national market accessibility; (c) the city's metropolitan influence; and (d) the present size of the city's national industry sector.

(a) Employment change in national industries is expected to be greater than (less than) the national average change in a city the greater (less) the infrastructure in that city.

Infrastructure is understood in a general sense to mean the availability of a range of services and industrial supplies which generate urbanisation economies. Czamanski (1971) proposed that local infrastructure interpreted in precisely this manner is important for industrial growth, because it generates external economies. These were shown to be relevant in national industry growth by Vernon (1960) and Darwent (1970). External economies are savings in production costs that an industry experiences because of conditions in the spatial economy outside its own influence. Such savings arise, for example, because of access to a skilled labour pool or existing transport facilities. Vernon (1960) and Darwent (1970) both showed that fast growth industries (their example was the radio industry in its early development in New York City) were dependent upon external economies available in the city. The Vernon (1960) research established that many industries are constrained to the metropolitan regions by the need for these infrastructure externalities in their production technology. Consequently, national industry growth is likely to be greater in those cities with the more sophisticated infrastructure.

Infrastructure can be measured indirectly by the total population of a city (on the assumption that larger cities have better developed city economies that can supply necessary services) or more directly by a measure of the development of other industries in a city, which is indicated by employment in regional and local industries. Following

Czamanski (1971) it is suggested that it is the service industries that supply the important infrastructure to national industries and so this second measure may be more appropriate. Both measures were correlated with the dependent variable; the variable that measured total regional and local employment had the strongest correlation with the dependent variable. It is used as the measure of the Infrastructure of a city and is designated E_{R+L}.

(b) Employment change in national industries is expected to be greater (less) than the national average in a city the greater (less) its accessibility to the national market.

This hypothesis is developed logically from the definition of a national industry - one that serves the national market from few locations in the urban system. It follows that the city with the greatest accessibility is likely to be one with the strongest gains in national industry employment. Different interpretations placed on the concept of accessibility led to several different measures being used to estimate the importance of the variable. A first measure of accessibility follows the formulation of Harris (1954) which estimates market potential as a surrogate for accessibility. It is assumed the city with the highest market potential has the greatest national market accessibility. The following computation is used to estimate M_i, the market potential of city i

$$M_i = \sum_{j=1}^{n} \frac{P_j}{D_{ij}} \qquad (n = 45)$$

where P_j is the population of the jth city, and D_{ij} is the distance between it and city i. Note that the population of city i is excluded from this measure. This is because the effect of the population of city i is included in the infrastructure variable. The calculations suggested that the cities with greatest accessibility were those on the fringes of Montreal and Toronto; this pattern arose because of the arithmetic impact of large populations associated with small distance measures. This measure of accessibility was used in some preliminary investigations and had a correlation with the dependent variable of -.02. Furthermore, this variable was tried in step-wise regression models but was found to have weak partial correlation coefficients with the dependent variable, and no values obtained for parameters on various forms of this variable were statistically significantly different from zero. Several different forms of the calculation were tried, using different exponents on the distance measure, but the one specified above had the strongest association with the dependent variable. Because the parameter values were found to be not statistically different from zero, and because of the weak simple correlation coefficient between this variable and the dependent variable, attention turned to other measures of accessibility. One is the interaction measure, I_{ij}, where I_{ij} was determined by populations of i and j and the distance separating them

$$I_{ij} = \sum_{j=1}^{n} \frac{P_i P_j}{D_{ij}} \qquad (n = 45)$$

Here it is assumed the city with the highest level of interaction with all other cities had the greatest national market accessibility. This however, was effectively the market potential measure with the individual city population included. As the first hypothesis - that to do with infrastructure - allowed for the city size influence in the model it was decided to avoid accessibility measures that included city population.

If one assumes the heart of the Canadian market lies in the Toronto-Montreal corridor, then a city's accessibility to the national market should be inversely related to its distance from Montreal or Toronto whichever is the closest. The distance was calculated for all cities in the sample and the variable had a correlation coefficient with the dependent variable of .09. Both these measures of accessibility - the Harris formulation and distance to Montreal or Toronto - had very weak simple correlations with the dependent variable, and parameter values in multiple regression statistically not significantly different from zero. Hence these results prompted rejection of the hypothesis that market accessibility of a city was positively associated with city employment changes greater than the national average growth in national industries.

(c) Employment change in national industries is expected to be greater (less) than the national average in a city the greater (less) its metropolitan influence in the system of cities.

As noted earlier past research on Canadian urban economic growth has stressed the role that metropolitan influence has played in the rapid growth of the larger Canadian cities (Lithwick, 1971; Kerr, 1968).

This has generally involved illustrating that the concentration of economic activity in metropolitan areas is disproportionate to their size, and they are presumed to exert a powerful influence on the functioning of a national economy.

The objective was to find a measure of the relative degree of metropolitan influence of each city in the sample. It was decided to concentrate upon one particular metropolitan function - employment in the occupational category stock and bond brokers. Although this activity is in fact a regional industry - it is a member of the category Business Services - it was deemed appropriate to use in an index of metropolitan influence as stock exchange activity tends to be concentrated in major metropolitan areas. Employment in this activity is large in metropolitan areas, and it is assumed that this is so for two reasons. On the one hand, the large market within the city itself explains part of the employment, whilst on the other hand, the role of the metropolis within the national system of cities explains the balance. It is this second component that is regarded as an index of the city's metropolitan influence in the system of cities. In effect, then, it is assumed the metropolitan influence of any city can be measured by the employment in stock and bond broker activity that is not associated directly with the city's population.[9] A strategy that allowed the seperation of employment into these two parts was used to calculate an index of metropolitan influence. This was believed to be superior to a simple index such as stock broker employment per capita as it was a direct attempt to calculate employment that, on average, was not related with local city employment. This component is estimated by using a simple linear regression of employment in stock broker activity against population for each city. The regression provides the average relationship between the two variables and given this relationship it is possible to estimate an expected level of employment for each city once its population is known.

The model used is shown below. The employment in stock and bond brokerage, S_i, was hypothesised to have a linear relationship with Population, P_i, with an error that could be estimated as the residual, ε_i.

$$S_i = \alpha + \beta P_i + \varepsilon_i$$

ε_i is interpreted as stock broker employment not related to the population of city i, and this provides the estimate of ε_i, the index of the metropolitan influence of the city within the national system of cities. The following values were obtained for this model for employment in the stock and bond brokers occupational group and population in 1951:

$$S_i = -27.4 + \underset{(.00005)}{.0007}\, P_I$$

(The figure in parentheses is the standard error of the estimate of the parameter β)

$$R^2 = .81$$

The values for cities in the sample are tabulated in Appendix 6. This shows Toronto was the dominant metropolis in Canada in 1951, but it is likely that the index underestimated the influence of Montreal, as it appears with a negative residual, meaning it has less employment than expected given its population. Another index was constructed (using bank employment in a similar strategy) but this produced a comparable pattern, with Montreal having a negative value on the index. Clearly the index used in this analysis, estimated from stock broker employment, was not a totally adequate one to measure metropolitan influence in Canada, but is adequate for the purposes of this study. This is because it is easily incorporated into the analysis of employment change in the national, regional and local sectors. Thus it gives a direct estimate of the influence that metropolitan areas have on employment change in these three groups. Its role in the regional and local industry sectors is made clear in subsequent chapters. The simple correlation between this index, to be designated METRO, and the dependent variable in the national industry model was .43.

(d) Employment change in national industries is expected to be greater (less) than the national average in cities with large (small) national industry employment sectors at the start of the time period.

This hypothesis is developed from the particular definition of a national industry - one that had large concentrations of employment in a few cities. In these circumstances new growth is expected primarily in cities that already have national industries. Expansions in employment in national industries are most likely in cities which already have existing national industry employment because of the influence of industrial inertia and uncertainty about the effect of locating in a less developed city. This variable is measured simply by taking employment in national industries at the start of the time period, designated E_N.

2. A MODEL OF EMPLOYMENT CHANGE IN NATIONAL INDUSTRIES

These three hypotheses are tested using three variables as predictors in a multiple regression model. The variables are Infrastructure (E_{R+L}), Metropolitan Influence (METRO) and present National Industry Employment (E_N).

The correlations between these variables and the dependent variable ΔE_N^*, and their intercorrelations were calculated and appear in the correlation matrix in Table 10. The most important element in this matrix is the high intercorrelation between the two employment measures - Infrastructure and National Industry in 1951. This is not surprising as it is expected national industries are well developed in cities with well developed infrastructure. This level of collinearity (.92) in the estimating variables would affect the standard errors of the parameter estimates and it is worthwhile considering ways in which this can be removed prior to final model estimation. Further justification of this strategy is that the two employment variables are obviously measuring the same effect in the urban economic growth process. Thus it was decided to take the logarithm of the variable E_N; this has the consequence of compressing the variance in the variable, because the influence that large values exercise in the estimation procedure is reduced.

The impact of this strategy, found by recalculating the correlation and intercorrelations, is shown in Table 11. The

TABLE 10

CORRELATION MATRIX - NATIONAL INDUSTRY MODEL

	ΔE_N^*	E_{R+L}	METRO	E_N
ΔE_N^*	1.00	.53	.43	.39
E_{R+L}		1.00	.24	.92
METRO			1.00	.09
E_N				1.00

TABLE 11

CORRELATION MATRIX - NATIONAL INDUSTRY MODEL II

	ΔE_N^*	E_{R+L}	METRO	LOG E_N
ΔE_N^*	1.00	.53	.43	.09
E_{R+L}		1.00	.24	.65
METRO			1.00	-.04
LOG E_N				1.00

correlation between the measure of present national industry employment (LOG E_N) and the dependent variable was reduced along with the intercorrelation between it and the infrastructure measure E_{R+L}.

It is hypothesised that the four variables in the correlation matrix are linearly related; consequently the contribution of the three independent variables to estimation of the dependent variable ΔE_N^* is found by estimating a model as below:

$$\Delta E_N^* = \alpha_1 + \beta_1 E_{R+L} + \beta_2 \text{ METRO} + \beta_3 \text{ LOG } E_N + \varepsilon$$

where ε is the error term.

Stepwise ordinary least-squares regression is used to obtain estimates for the parameter values in this model for national industry employment change in 46 Canadian cities 1951-1961. The results are as follows:

$$\Delta E_N^* = 5417.75 + \underset{(.004)}{.02}\, E_{R+L} + \underset{(4.23)}{8.64}\text{ METRO} - \underset{(764.30)}{1759.35}\text{ LOG } E_N$$

(The figures in parentheses are the standard errors of the estimates of the parameters)

$$R^2 = .44$$

$$\overline{\Delta E_N^*} = 51.21 \qquad \sigma_{\Delta E_N^*} = 2730.12$$

$$\sigma_\varepsilon = 2107.01$$

The positive values of the parameters on the Infrastructure measure

(E_{R+L}) and on the variable measuring metropolitan influence does not prompt a rejection of the hypothesised relationships between these variables and the dependent variable. Change in employment relative to the national average is greater in cities the larger the infrastructure and the greater its metropolitan influence in the national system of cities. However, these values show a negative relationship between the dependent variable and the transformed variable measuring existing national industry, the opposite to the expected relationship. The reason for this was investigated and is found in the collinearity between E_{R+L} and LOG E_N. The effect of this collinearity was traced through the stepwise routine of the multiple regression algorithm (Dixon 1973). The variables are entered into the estimating algorithm in the order shown in Table 12.

The model enters the variable E_{R+L} first and when its effect is accounted for the partial correlation coefficient of the variable LOG $E_{N_{1951}}$ is negative. Consequently, the positive effects of the present size of a national industry sector on a city's national industry growth are absorbed in the collinearity with the infrastructure measure.

The model indicates that 44% of the variance in the dependent variable is associated with the co-variation of the three independent variables. Over half this "explained" variance is accounted for by the infrastructure variable, effectively a measure of city size. Employment growth in national industries is sensitive first and foremost to city size and in general, cities with better developed infrastructure have the greater gains in national industry employment.

TABLE 12

STEPWISE ROUTINE – NATIONAL INDUSTRY MODEL

Step Number	Variable Entered	R^2	ΔR^2	Variables not in Equation	Partial Correlation Coefficients	F Value to Enter or Remove
1	E_{R+L}	.28	.28	LOG E_N	-.40	7.95
				METRO	.37	6.74
2	LOG E_N	.38	.10	METRO	.30	4.17
3	METRO	.44	.06			

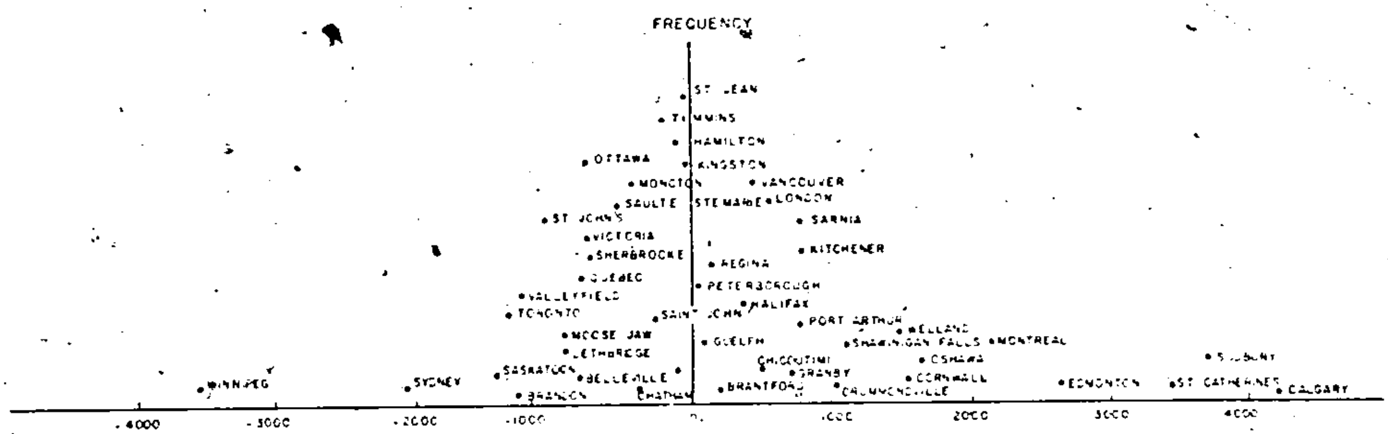
3. THE MODEL'S PERFORMANCE FOR INDIVIDUAL CITIES

An indication of the model's predictive ability is obtained by a close examination of the residuals of the regression model. These are the differences between the model's predictions for employment change 1951-1961, and the actual changes that occurred in each city. This is done in two stages, first by studying a plot of residuals for all cities and, second, by comparing the actual and predicted employment change for each city. These lines of analysis have two objectives. The first is to isolate any systematic tendency the model had toward error, and the second is to probe further into the urban growth of particular Canadian cities.

The residuals for each city are plotted on the first graph. The model accurately predicted change for a wide range of cities - small regional centres such as St. Jean and Kingston, and national industry centres such as Brantford and Hamilton. It underestimated change in some metropolitan areas, for example, Calgary, Edmonton and Montreal, and over estimated change in others, such as Toronto, Winnipeg and Ottawa. Thus it does not appear to have a systematic bias in predicting employment change in metropolitan areas. Furthermore, there did not seem to be any spatial clustering of high or low residuals.

The model's predictions are in essence based on the effect of city size and metropolitan influence on national industries. If a prediction is inaccurate there is some force, other than infrastructure or metropolitan influence at work on national industries in the city. A study of the predicted and actual changes in employment is undertaken to help explain individual city performance. These data are plotted on Graph 2.

GRAPH I : PLOT OF RESIDUALS NATIONAL INDUSTRY MODEL

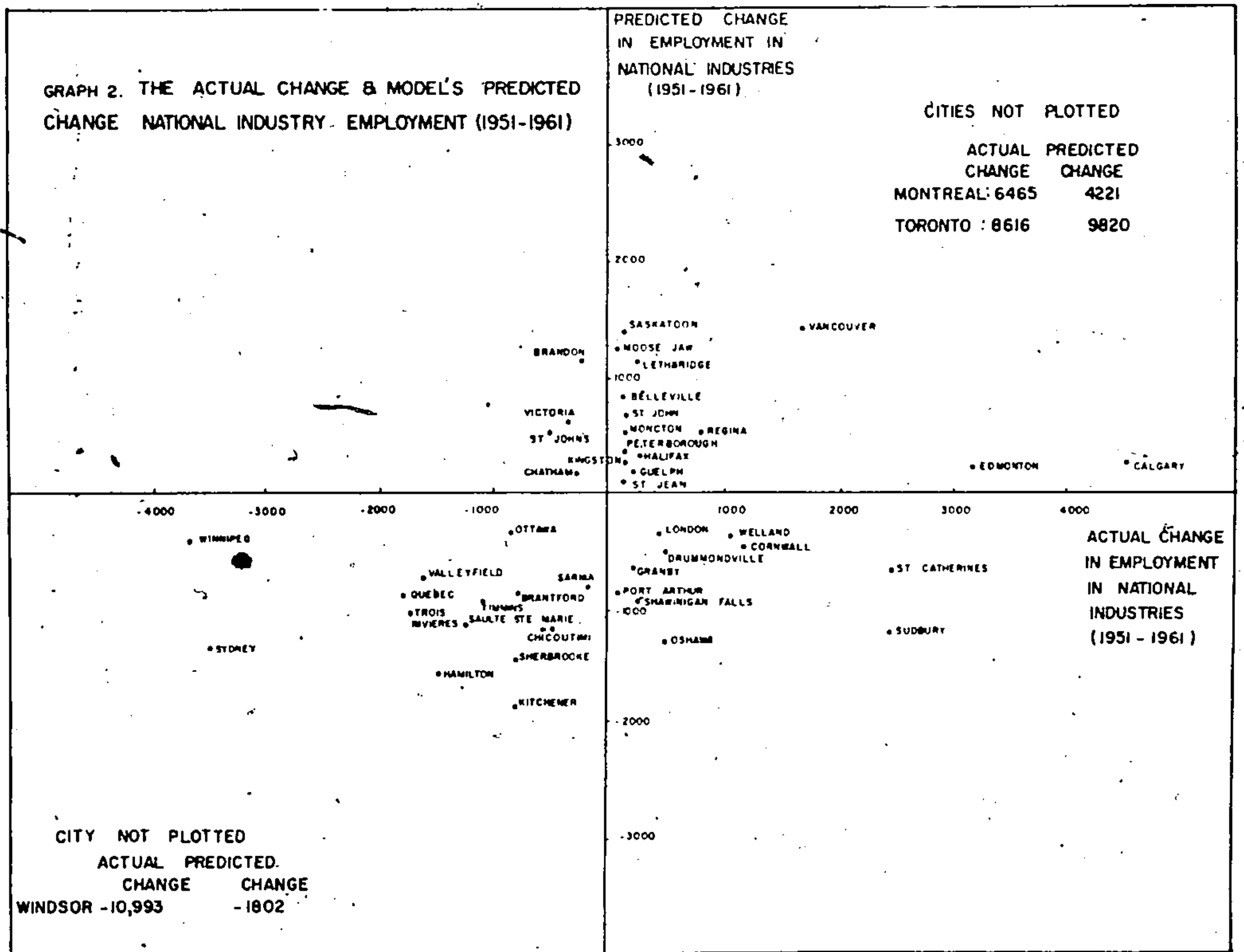


ERROR IN MODEL'S ESTIMATE OF EMPLOYMENT CHANGE 1951 — 1961

CITY NOT PLOTTED

WINDSOR

ERROR — 9190



GRAPH 2. THE ACTUAL CHANGE & MODEL'S PREDICTED CHANGE NATIONAL INDUSTRY EMPLOYMENT (1951-1961)

The model predicted the direction of change incorrectly for 14 cities in the sample. These are identified on the graph as those cities in Quadrants 2 and 4. For 10 cities (those plotted in Quadrant 4) the model inaccurately predicted that the change in employment was less than the national average. Apart from London, all of these cities were highly specialised national industry centres in 1951; seven of them had more than one-third of their workforce in national industries, and usually just in one particular national industry. These were Drummondville, Granby and Cornwall (textiles), Welland (iron and steel), Sudbury (mining), Shawinigan Falls (paper) and Oshawa (automobiles). Largely because of the competitive strength of the particular industries in these cities they were able to generate employment changes greater than the national average change. A study of the predictions for other small cities with large national industry employment (for example, Brantford, Timmins and Trois Rivièrs) shows they had employment change close to that predicted by the model. Consequently, the model's inaccuracy in predicting change in several small national industry specialised cities is not strong evidence of a systematic underlying weakness, but rather the grouping of these cities reflects the growth of their particular industries. A shift-share analysis by Crowley (1971) found that several of these cities had strong positive "growth effects", or employment change above average due to rapid growth of particular industries. Analysis of the regional industry model that follows shows similar inaccurate predictions of employment change associated with these cities. This suggests that this group - and in particular Sudbury, Cornwall, Drummondville and Granby - had growth unique to themselves in this period.

Clearly, the aggregation of industries into one category "national industries" tended to be insensitive to particular industries in particular cities, although short of separate models for each industry group it is difficult to structure a general model to accurately predict change in each city.

The model is inaccurate in its predictions of the direction of change for four other cities - Chatham, St. John's, Victoria and Brandon. Chatham's inability to match the national average change in employment was due to a large fall in the employment in its automobile industry between 1951 and 1961. This could be related to the unusual conditions in the Canadian automobile industry at this time. These involved serious decreases in demand and consequent cuts in production, which had a major impact on Windsor and Chatham (Beigie, 1970, Dykes, 1970). The model's inaccurate predictions for St. John's and Victoria can be traced to the particular industrial activities in these two cities. In both St. John's and Victoria, regional industries (particularly federal and provincial administration) had a large share of city employment in 1951. The model interprets this employment as infrastructure for national industries, but both cities had a small amount of employment in national industries in 1951.

For all other cities in the sample, the model predicted the direction of change correctly. There are, however, several substantial errors, due in large part to particular features of the industries in each city. The most serious errors are those associated with the prediction of change in Windsor and Winnipeg.

Windsor had a major fall in national industry employment between

1951 and 1961 as employment in the automobile industry fell by 50%. As Windsor is one of the Canadian metropolitan areas it has well-developed infrastructure and the model took account of this in predicting a change in employment a little less than the national average change. This, however, proved very inaccurate. It would seem appropriate to regard this as a unique event and to treat Windsor as a special case in the data set.

The underestimation of change in Winnipeg was due to the lack of national industries in that city in 1951. It had only one large national industry (transportation), and hence a totally different industrial structure compared to the other major metropolitan areas. Given Winnipeg's infrastructure and accessibility in 1951, the model predicted the change in national industry would be a little less than the national average. However, the lack of a broad national industry sector in the city meant that it was unable to capture national industry growth forces and it fell well below the national average change in employment.

The model is not able to predict change in Prairie cities with great accuracy. This is because it interpreted the large regional and local industry employment in cities such as Saskatoon, Moose Jaw, Lethbridge and Brandon as "infrastructure" and so predicted relatively large gains in national industry employment. However, these cities lacked national industries, and the large regional and local employments in 1951 reflected their respective roles as regional centres, not their ability to attract and foster national industry. None of these cities had more than 5% of their work force in national industries, and all had over 45% in regional industries in 1951. Regina did a little better and was able to match the model's predictions because it had larger national industry employment, mainly in the petroleum industry.

Edmonton and Calgary were not typical of Prairie city growth in this time period. Both had substantial growth in national industry sectors (mining in Calgary, chemicals in Edmonton) which boosted their growth in employment above the model's predictions. The error in the estimation of change in Calgary was very large; this was because the mining industry doubled its share of Calgary employment between 1951 and 1961. Consequently, Calgary's growth was generated in large part by elements operating external to the model. In summary, there are two reasons why Prairie cities employment changes are not accurately predicted by this model. First, the model misinterprets the large regional and local industry employment as infrastructure conducive to national industry growth. Secondly, the Prairie cities (with the exception of Calgary and Edmonton) lack well developed national industry sectors.

Another major error in the model is the estimate of employment change in Sydney. This city, along with Windsor, had an absolute decrease in national industry employment between 1951 and 1961. This was brought about by the collapse of the steel industry in Sydney in this period, and this change explained the poor estimate for Sydney. Looking at other Maritime cities the model appears to be relatively accurate, apart from the estimate for St. Johns commented upon earlier.

The model's inability to accurately estimate change in Montreal and Toronto was due to the influence of the variable METRO. To recall, this measure of metropolitan influence was calculated from a regression of stock broker employment against population. Due largely to the concentration of stock exchange activity in Toronto in 1951 this index provided a very high estimate of metropolitan influence for Toronto and a low estimate for Montreal. When this was used in the model, employment change in Montreal was underestimated, and in Toronto was overestimated. The sensitivity to this measure was found by experimenting with different values for the index for these two cities. The measure did not adequately capture the influence of metropolitan areas on national industries, even though it had played a useful role as an estimator of variance in the dependent variable. Any future development of models along these lines will need to develop a more sensitive measure of metropolitan influence than that used here.

4. THE MODEL'S SENSITIVITY TO SAMPLE COMPOSITION

In this part of the research the model is tried with subsamples of the original 46 cities to test the strength of the relationship under different circumstances. Two substantive issues are probed. The first is whether the relationship found in the first esimation of the model is really a reflection of large city employment growth patterns. The second is the degree to which the relationship is sensitive to a few unique cases in the data.

The first issue is investigated by estimating the model for a a subset of 36 cities, excluding the 10 largest cities in 1951. The results of this subset are as follows:

$$\Delta E_N^* = \underset{}{715.66} + \underset{(.02)}{.01}\, E_{R+L} + \underset{(12.31)}{14.61}\, METRO - \underset{(499.41)}{296.60}\, LOG\, E_N$$

(Figures in parentheses are standard errors of the estimates of the parameters)

$R^2 = .08$

$\overline{\Delta E_N^*} = -86.42 \qquad \sigma_{\Delta E_N^*} = 1136.81$

$\sigma_\varepsilon = 1140.27$

These results show the relationships specified in the first model were not statistically significant for this particular sample. It is clear that the hypothesised relationships, and the values obtained for the parameters, are dependent upon large cities in the sample.

To test the strength of the relationships in large cities the model was calibrated for a 30 city sample, where all cities had a population greater than 30,000 people in 1951. The following results were obtained:

$$\Delta E_N^* = 8913.75 + \underset{(.006)}{.02}\, E_{R+L} + \underset{(5.14)}{7.39}\, METRO - \underset{(1203.19)}{2797.71}\, LOG\, E_N$$

(The figures in parentheses are the standard errors of the estimates of the parameters)

$R^2 = .50$

$\overline{\Delta E_N^*} = 60.20 \qquad \sigma_{\Delta E_N^*} = 3357.88$

$\sigma_\varepsilon = 2511.93$

These results confirm a stronger relationship in larger cities, though the particular value of the variable METRO is not significantly different from zero. This suggested that this variable is not as important in this sample of larger cities and that their national industry growth is dependent upon infrastructure and consequently their own size.

Finally, the model is estimated for a 43 city sample, after 3 cities are excluded. These are Windsor and Sydney, two cities which had large drops in national industry employment between 1951 and 1961, and Calgary, whose national industry employment doubled over the same time period, a change greatly in excess of the estimating power of the model. The estimates for this 43 city sample were as follows:

$$\Delta E_N^* = 1733.61 + \underset{(.003)}{.02}\, E_{R+L} + \underset{(2.68)}{8.13}\, METRO - \underset{(516.30)}{614.95}\, LOG\ E_N$$

(The figures in parentheses are the standard errors of the estimates of the parameters)

$$R^2 = .61$$

$$\overline{\Delta E_N^*} = 288.46 \qquad \delta_{\Delta E_N^*} = 2061.97$$

$$\delta_\varepsilon = 1330.05$$

Dropping three cities from the sample lifts the level of explained variation by 27% and also provides a standard error 5 times larger than the average ΔE_N^* - the original model estimate had a standard error 40 times the average size of the dependent variable. These results suggest that there is a strong underlying relationship between both infrastructure and metropolitan influence and the change in national industry employment. Together, these two variables account for 60% of the variance in the dependent variable for the sample of 43 cities. Presumably, a model with a more sensitive measure of metropolitan influence would offer an even higher level of explained variance.

5. THE BEHAVIOUR OF SUBGROUPS OF NATIONAL INDUSTRIES

The research has analysed the behaviour of national industries as though they comprise an homogeneous group, assuming implicitly that all the member industries react to urban growth forces in a similar way. The analysis of individual city growth has, however, placed an emphasis on the role of specific industries in certain cities in the decade 1951-1961. The automobile industry, for example, was found to be important to Windsor, and the mining industry to Calgary, Edmonton and Sudbury. It was clear that the growth of these industries followed a different path to that of the aggregate of all national industries. Consequently this stage of the research addresses the question of whether subgroups of national industries behave in the same manner as the pattern that has been identified for the aggregate national industry group.

Two subgroups were analysed: (a) national industries that are directly related to resource extraction and processing; and (b) national manufacturing industries. The first group comprise mining, forestry, pulp and paper, primary iron and steel, non-ferrous metal smelting and petroleum. These are treated as a subgroup because the industrial location decisions of firms in these industries are clearly influenced by the need for either cheap power, a port facility or access to a raw material only found in a few locations. The second subgroup comprises the following industries: clothing, textiles, agricultural implements, transport equipment, chemicals, tobacco, rubber, leather, hosiery, and fishing. These industries do not have their locational pattern influenced by raw material or power requirements but rather by market accessibility and the importance of external economies.

The essence of the present investigation is to establish whether these subgroups respond to the same forces that are important in the analysis of national industries as an aggregate. Consequently, separate analyses are performed on employment changes in both these subgroups, national mining industries on the one hand, denoted by ΔE^*_{MINE} and national manufacturing industries, denoted by ΔE^*_{MFG}, on the other. In both cases the dependent variables are analogous to those in the model of national industries - they represent change in employment in industry groups after a national average change has been removed - and these dependent variables are regressed against the independent variables in the aggregate model. This step provides the following results:

$$\Delta E^*_{MINE} = 2132.75 + \underset{(.002)}{.01}\, E_{R+L} + \underset{(2.47)}{1.08}\, METRO - \underset{(447.62)}{678.02}\, LOG\ E_N$$

$$R^2 = .20$$

$$\Delta E^*_{MFG} = 4661.51 + \underset{(.003)}{.02}\, E_{R+L} + \underset{(3.53)}{5.79}\, METRO - \underset{(638.79)}{1547.81}\, LOG\ E_N$$

$$R^2 = .48$$

These results show the two subgroups do not both behave in the same manner as was established for the aggregate. In the mining subgroup the infrastructure variable is the only one that has a parameter value significantly different from zero at the 95% confidence level; the low level of explained variance in this model suggests there are factors not presently included that influence employment change in the mining and similar resource or power oriented industries. On the other hand the national manufacturing industries subgroup behaves in a similar manner to the aggregate. Estimates for this same model are shown below for a 45 city sample, where Windsor is excluded for reasons discussed earlier.

$$\Delta E^{*}_{MFG} = 1745.85 + \underset{(.003)}{.02}\, E_{R+L} + \underset{(2.32)}{5.74}\, METRO - \underset{(437.66)}{633.41}\, LOG\ E_N$$

$$\bar{R}^2 = .64$$

This result shows the Infrastructure and Metropolitan variables both have parameter values significantly different from zero at the 95% confidence level, and these two variables accounted for 62% of the "explained" variance in the dependent variable.

Values for parameters and the level of explained variance differ from one subgroup to the other. It is clear that the commentary on national industries refers primarily to manufacturing industries, and not to the resource and power oriented industries. The concept of national industries within the analysis of urban growth is obviously an oversimplification as there are two subgroups within this category, only one of which behaves in a manner similar to that of the aggregate of which it is a member.

6. CONCLUSIONS

It is shown above that the national industry group is not an homogeneous group and thus conclusions need to be made for the two subgroups. Change in national industry manufacturing employment, even after a national average change in national industries was removed, is very sensitive to city size. It is clear that national manufacturing industries grow most rapidly in large cities, particularly metropolitan areas, due to the infrastructure these cities offer. The analysis also makes clear that a subgroup of national industries (those associated with primary resource extraction and processing) do not behave in the same predictable manner. Consequently, detailed knowledge of industrial structure and the growth determinants of each industry are necessary to predict growth in cities with concentrations of these industries.

Apart from a concentration of growth in a particular city size group the model also detects a functional and spatial clustering in national industry growth. Apart from mining towns such as Sudbury, the only small cities that achieved growth greater than this model's predictions were specialised cities in the Ontario-Quebec urban system, generally those close to Montreal or Toronto. Significantly the Prairie city, unless it had a substantial employment in mining, petroleum or chemicals was unable to achieve national industry growth between 1951 and 1961 commensurate with its size in 1951. In summary, national industry employment growth was most rapid in some metropolitan areas (Calgary, Edmonton, Toronto and Vancouver) and specialised mining or manufacturing centres such as Welland, St. Catharines, Cornwall and Sudbury.

CHAPTER FIVE

CHANGE IN EMPLOYMENT IN REGIONAL INDUSTRIES

Regional market area industries such as Food Production, Wholesaling and Administration are the subject of the next stage of the analysis, and the aim is to determine elements in the spatial system that are associated with employment change in these industries. Once again a national average growth rate is assumed and the following problem is posed: "What elements in the spatial and economic environment of a city condition regional employment changes above or below the national average change of regional industries in all cities in the sample?" The dependent variable, ΔE^*_R is computed as the difference between the actual change in regional industry employment for cities in the sample and the expected change for those cities had their regional industries grown at the national average rate.

1. RESEARCH HYPOTHESES

It is expected that employment change is closely related to regional market characteristics. Three hypotheses are tested.

(a) The change in employment in regional industries is expected to be greater (less) than the national average change, the greater (less) the number of consumers in the regional market area surrounding the city.

This hypothesis is formulated on the grounds that cities with large trade area populations have access to external economies and supply goods and services not available in trade areas with small populations. Consequently, cities with large trade area populations are expected to have growth in regional industries well above the national average change in employment in these industries. An attempt to make this hypothesis operational runs up against the difficulty of specifying the market area for the product of regional industries. This is a problem because there is a broad range of manufacturing and service industries within this category; the market area for food production is likely to be very different from that of, say, electricity. Hence, it is necessary to envisage a typical regional industry. The behavior of this typical regional industry along with the available data is then used to estimate trade area populations. The two categories within the regional industry group that have the largest employment are Transportation and Wholesale Trade; they together constitute over 1/3 of the total employment in the group, and these are used as models of the typical or average regional industry.

The trade area variable is designed to measure the demand for regional industry products *outside* the city. Hence, the number of consumers included in a trade area did not include the population of the city but only the population living outside of the city. The decision on the size of trade areas for the typical regional industry was guided by previous attempts to estimate this type of data for Ontario (Dean 1969; Ray 1967), Saskatchewan (Government of Saskatchewan 1957; Hodge 1965), and for Mid-West States in the U.S. (Berry 1968). Business directories of Canadian cities (Hamilton 1952), provided information on the population of wholesale trade sales areas. The size of trade areas was decided upon after examining these various sources in the light of data available in 1951.

The major regions specified by Provincial Governments (usually as Planning Areas or Economic Regions) were tried first as a source of regional industries' trade area information. These regions provided a good source of subprovincial data; to obtain some idea of their size, there were ten such regions in both Ontario and Quebec. A test of the usefulness of data at this scale found that the relationship between ΔE_R^* and this measure of trade area population was a weak one, and the simple correlation coefficient between the two was -.06.

Theoretically, it is expected that smaller trade areas are better estimators of regional employment change. The reason is that typical regional industries such as transportation and wholesale trade are generally represented in each city and so small trade areas are necessary to capture the demand these industries satisfy. Consequently the trade area statistics used to test the hypothesis are generally groups of contiguous counties or census Divisions that surround a city in the sample. A judgment based on estimated interaction between cities was made about the location of the border between one city's trade area and that of its neighbour. The areas used are plotted on maps and the counties in each trade area are listed in Appendix 7. These trade areas do not exhaust the map because the sample of cities does not exhaust the urban system. This variable is denoted TRADE AREA POP and the correlation between this measure of trade area population and the dependent variable ΔE_R^* was .35.

The model uses demand from the trade area measured solely in terms of population, with the implicit assumption that although there is inter-trade area variation in income, this is not sufficient to be associated with inter-city differences in regional industry employment change.. This assumption was investigated further in a routine manner by using several measures of trade area income. None was useful in the sense of adding to explained variance.

(b) The second hypothesis tested is that the change in employment exceeds (is less than) the national average change if the city has few (many) competitors in its regional market.

This hypothesis attempts to isolate how important is sharing the market area to the performance of regional industries in cities. Two variables are used here. The first measures distance to the closest larger city and the second is an index of the importance of a city in a regional hierarchy.

Distance to the closest larger city is used because larger cities normally have trade areas that include smaller cities. Consequently, the further a city is from a larger city the greater regional industries are expected to develop in that city. Proximity to other cities has been found to be important in previous research on Canadian urban growth (Hodge 1965; Hodgson 1972) and this particular hypothesis investigated the importance of this factor in the employment change in regional industries. The distance to the closest larger city was measured by the straight line distance in miles. For Montreal, there is no larger city: Toronto was used as the next largest city in this study.

The other variable used to test this second hypothesis is an index of a city's role in a regional hierarchy of centres. This strategy was adopted to incorporate into the analysis the impact on regional industry growth of established regional centres, some of which have substantial market area influence, perhaps even disproportionate to their size. London, Ontario, is a case in point. London was three-quarters the size of Windsor and less than one-half the size of Hamilton in 1969, yet it has a considerably larger market area of wholesale trade than both of these centres (Dean 1969, Map 52). Furthermore, it is necessary to take into account the role of provincial capitals, whose market areas for some regional industry goods extend over whole provinces. Consequently, an index of regional hierarchy leadership is needed to capture some of this effect. Ideally, the analysis requires a precise specification of a regional hierarchy with details on the trade area of each city for several different goods. Data of this type are not readily available so an alternative strategy is used. It was assumed that a city's role in a regional hierarchy was measured by its metropolitan influence, and this has already been measured by the variable "METRO", constructed from a regression of stock broker employment on city population. This strategy enabled the inclusion of the metropolitan dimension into this model in a straightforward manner.

(c) The third hypothesis to be tested is that change in employment in regional industries is greater (less) than the national average change, the better (less) developed the national industries in a city.

The essence of this hypothesis is the importance of internal circulation of income within the city to the performance of regional industries in that city, resulting from inter-industry linkages. This was tested by correlating employment in national industries with the dependent variable. The correlation coefficient of the relationship is -.103, so that the relationship is not only very weak, but also negative. Consequently the hypothesis concerning the role of national industries as an important estimator of regional industry employment change is rejected at this stage. This result suggested that the behaviour of regional industries is related more to the character of the regions in which industries are located than to the cities' industrial structures.

2. A MODEL OF EMPLOYMENT CHANGE IN REGIONAL INDUSTRIES

Three variables are used to test the hypotheses outlined above. These are:-

(i) Trade Area Population, designated as TRADE AREA POP in the analysis below;

(ii) Distance to closest Larger City, designated as DCL; and

(iii) Index of influence in a Regional Hierarchy designated as METRO.

The correlations between these three variables and the dependent variable, and the inter-correlations between them, are given in Table 13. Because a city's trade area depends in large part on the proximity of a larger city it is not surprising that there was some positive inter-correlation between DCL and TRADE AREA POP; other independent variables have only weak intercorrelations.

It was hypothesised that the change in employment in regional industries relative to a national average change ΔE_R^* could be modelled in the following form:-

TABLE 13

CORRELATION MATRIX - REGIONAL INDUSTRY MODEL

	ΔE_R^*	TRADE AREA POP	DCL	METRO
ΔE_R^*	1.00	.35	-.38	.65
TRADE AREA POP		1.00	.38	.13
DCL			1.00	-.13
METRO				1.00

$$\Delta E^*_R = \alpha + \beta_1 \text{ DCL} + \beta_2 \text{ METRO} + \beta_3 \text{ TRADE AREA POP} + \varepsilon$$

and stepwise least squares regression analysis was used to estimate the parameters in a model of this form. The following estimates were obtained for a 46 city sample:

$$\Delta E^*_R = -1457.65 - \underset{(1.22)}{6.53} \text{ DCL} + \underset{(5.01)}{29.98} \text{ METRO} + \underset{(.005)}{0.24} \text{ TRADE AREA POP}$$

(Figures in parentheses are standard errors of the estimates of parameters)

$$R^2 = .70$$

$$\overline{\Delta E^*_R} = -137.09 \qquad \sigma_{\Delta E^*_R} = 4532.19$$

$$\sigma_\varepsilon = 2581.89$$

This particular estimate of the model provided parameters that were clearly significantly different from zero, as their standard errors were all small in relation to the parameter estimates. This model also provided information on some aspects of the behaviour of regional industries. The negative estimate for the parameters α and β, meant that cities with small trade area populations and low metropolitan indices (i.e., those cities without an important role in a regional system of cities) had employment change less than the national average. A large trade area population or a strong regional hierarchy influence was essential to generate employment changes above the national average.

This generalisation holds with even greater force for cities that are distant from other large cities. The negative sign for the parameter on DCL indicates that regional industry employment change is greater than the national average the less the distance to the closest largest city. This result confirmed that a city's position vis-a-vis larger cities in a regional spatial system was an important constraint on regional industry performance. However, an important qualification is necessary here. It will be recalled that research on the role of distance from a larger city produced conflicting evidence: Hodge (1965) found that proximity hindered growth whilst Hodgson (1972) and Bourne and Gad (1972) found the opposite relationship. The finding in the results above support the Hodgson (1972) and Bourne and Gad (1972) opinion. It is felt that this is due to the preponderance of Ontario cities in the sample, particularly those with strong regional manufacturing industries (Peterborough, Guelph, Belleville, Kitchener, St. Catharines and Welland). Had there been more Prairie cities in the sample, or had the regional industry category been comprised solely of service industries, this result may have been different. This problem of interpretation draws attention to the possible differences between regional manufacturing industries and regional service industries; this question is addressed in section five of this chapter.

The results show that 70% of the variance of the change in regional industry employment relative to a national average was associated with a linear combination of the three hypothesised variables. The stepwise routine, shown in Table 14, indicates the relative contribution of the three variables to this level of "explained" variance.

TABLE 14

SUMMARY OF STEPWISE ROUTINE - REGIONAL INDUSTRY MODEL

Step Number	Variable Entered	R^2	ΔR^2	F to Enter
1	METRO	.42	.42	31.81
2	DCL	.51	.09	8.21
3	TRADE AREA POP	.70	.19	25.57

The change in explained variance (measured by ΔR^2), indicated all three variables made an important contribution to the model's explanatory power. Metropolitan influence is clearly the most powerful estimator as it contributes over half the explained variance. This shows that a city's role in a regional hierarchy (measured by its metropolitan influence) is the critical element in Canadian cities' regional industry growth.

Another element worthy of comment in this table is the contribution of the variable TRADE AREA POP to the level of explained variance. The table shows that even though this variable enters the regression last, it contributes more than the second variable, DCL, to the explained variance. The reason for this is found in the partial correlation coefficients of each variable with the dependent variable. Once the first two variables have entered the regression, the partial correlation coefficient between TRADE AREA POP and the dependent variable doubles; hence its strong contribution to explained variance. In essence this means that if all cities had equal influence in a regional hierarchy and were all located the same distance from larger cities (i.e., both these variables are held statistically constant) then the population of the trade area assumes critical importance to a city's regional industry growth.

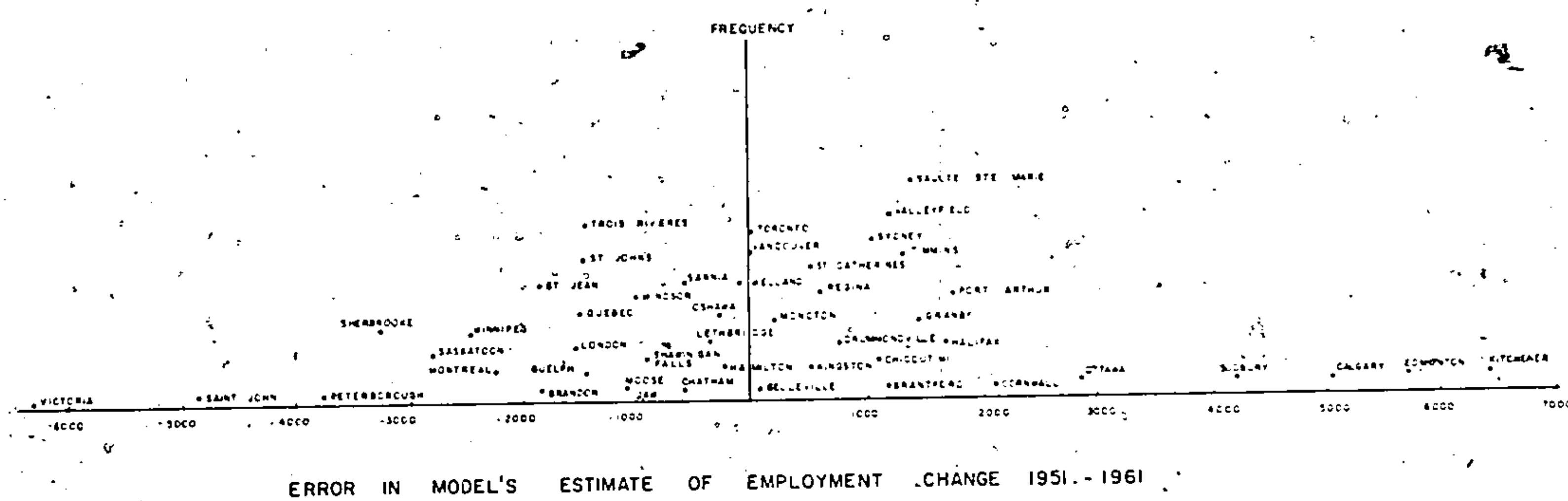
Employment change in regional industries is greater than the national average the greater the number of consumers in the market area, though the analysis suggested that regional hierarchy leadership was a more important element in regional industry employment change. A second hypothesis - that employment change exceeds the national average where the city has a few competitors - is rejected in the light of the negative value for the parameter on the variable DCL. The results show that change in employment is greater than the national average the closer the city is to a larger city. Consequently, the spatial distribution of cities is important to regional industry performance, with proximity to a large city and position in a regional hierarchy both critical to growth. This much is clear from the general structure of the model; to obtain greater understanding about regional industries it is necessary to study how well the model estimated change in individual cities.

3. THE MODEL'S PERFORMANCE FOR INDIVIDUAL CITIES

The emphasis in this part of the research shifted to the individual city and the change in its regional industries in the 1951-1961 period. This focus is obtained by concentrating on the error terms in the predictions of the model - the situations where the model over - or under - predicts employment change given a city's particular values for the independent variables.

The residuals from the model's predictions are presented graphically (Graph 3). A careful study was undertaken to detect whether there is any systematic patterns in these error terms. Three particular patterns were sought - where the model under- or over-predicted for a size group, for a regional or provincial cluster, or for a group of functionally similar cities. The ten SMSA's in 1951 are scattered throughout the residuals, varying from 5084 for Calgary to -2493 for Winnipeg, and the model is accurate for Toronto, Hamilton and Vancouver.

GRAPH 3: PLOT OF RESIDUALS — REGIONAL INDUSTRY MODEL

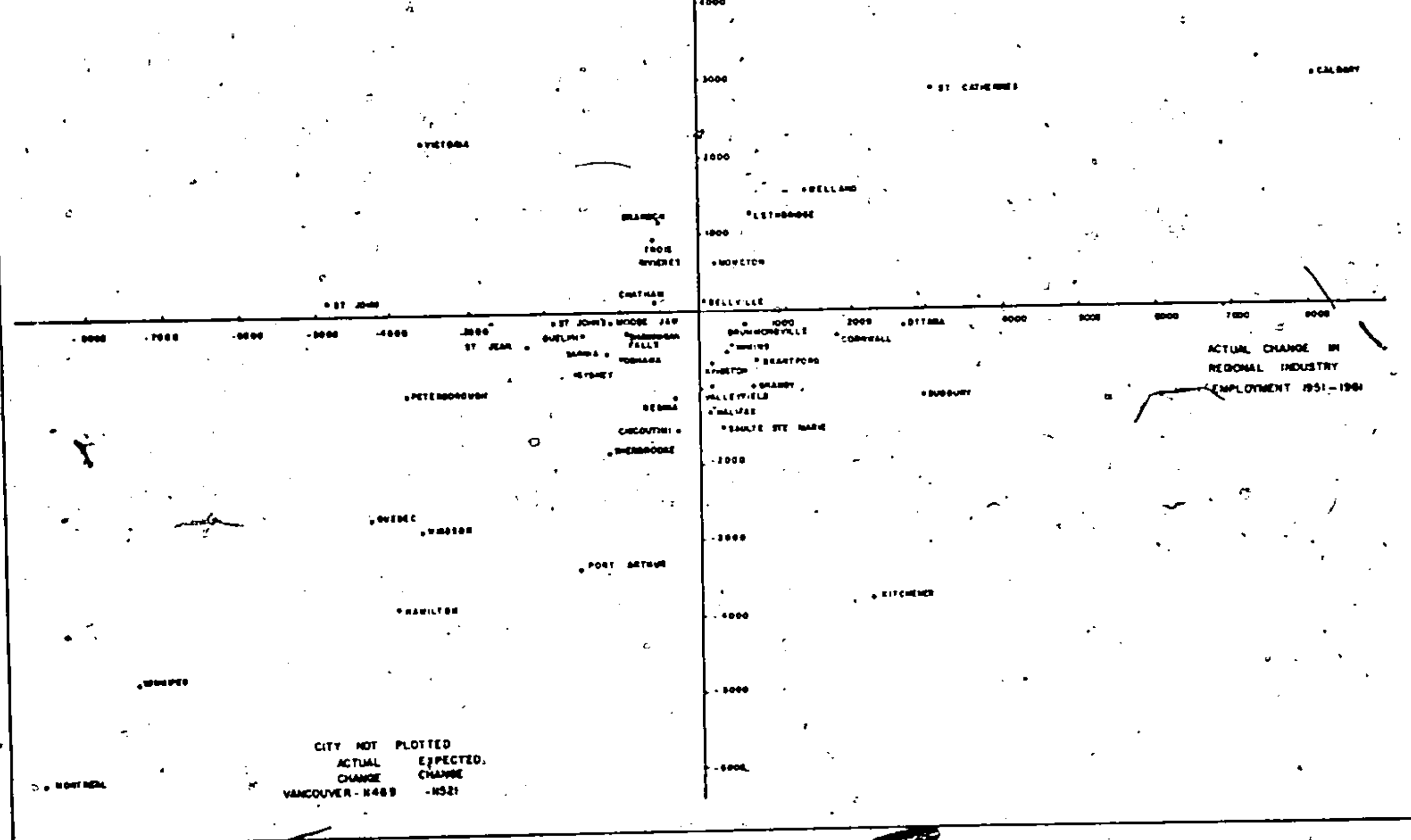


Maritime cities record both positive (Sydney and Halifax) and negative (Saint John, St. John's) values, as do cities on the Prairies (Regina, positive, and Saskatoon, negative). The extreme cases - Edmonton, Calgary, Sudbury, Victoria, Kitchener and Saint John - do not seem to be subject to the working of a systematic factor that requires inclusion in the model. Finally, the model was accurate for a variety of cities: Hamilton, Vancouver, Welland and Moncton.

To further investigate the model's ability to explain change in individual cities, an analysis of actual change in employment and the model's predictions for each city was undertaken (see Graph 4). The model is able to predict the direction of change correctly for 29 cities, a general comment on its accuracy. Cities such as Windsor, Quebec, Hamilton, Oshawa, Peterborough and Port Arthur had less than national average change in regional industry employment due in part to the character of their trade area and their roles in their respective regional hierarchies. On the other hand, the model's explanation accounts for above average growth in Toronto, London, Saskatoon, St. Catharines, and Welland.

In Quadrant 4 there is a group of cities the model incorrectly predicted would expand regional industry employment by an amount less than the national average. These cities (including those close to the axis in Quadrant 3, i.e., Chicoutimi, and Regina) have important elements in common. They are relatively small, and in several of them national industries are the major employers. In Drummondville, Sault Ste. Marie and Timmins, for example, national industry employment accounts for more than 45% of the workforce. In fact, the model inaccurately predicts

GRAPH 4: THE ACTUAL CHANGE & MODEL'S PREDICTED CHANGE IN EMPLOYMENT IN REGIONAL INDUSTRIES 1951 — 1961



change in regional industry employment for the majority of small specialised cities in the sample. Furthermore, four cities - Drummondville, Cornwall, Granby and Sudbury - have the direction of change predicted incorrectly for both their national and regional industry employment; these four cities are among the ten most specialised national industry cities in Canada.

This observation is critical of the logic underlying the regional industry model. It is predicated on notions of central place theory, i.e., trade area population and the structure of the regional hierarchy are used as the explanatory variables. This approach suits the service industries but may not adequately account for the behaviour of regional manufacturing industries. In summary, this analysis overlooks the small cities with small trade areas; however, these cities have attracted regional industries, due in large part to their strong national industry sectors. In all likelihood these regional industries - such as Metal Fabricating, Transport, Public Utilities, Wholesaling, and Services - supply each city's national industries in close input-output linkages. This particular attribute was originally hypothesised to be important for the whole sample but the simple correlation between the dependent variable and a measure of national industry employment was weak. However, the persistent inaccuracy of the model as developed here suggests that in input-output effect is important at least in small cities with large national industry sectors.

This assertion is tested for a subsample of cities - for 16 cities with populations less than 30,000 in 1951. The dependent variable ΔE_R^* in these cities was hypothesised to be linearly related to employment in national industries in 1951 (E_N) as follows:

$$\Delta E_R^* = \alpha + \beta E_N + \varepsilon$$

The estimates for α and β were as follows:-

$$\Delta E_R^* = -817.84 + \underset{(.11)}{.23} E_N$$

(The figure in parentheses is the standard error of estimate of the parameter β)

$$R^2 = .14$$

Although the parameter value is significantly different from zero at the 95% confidence level, the low level of variance in the dependent variable that is associated with co-variation in the independent variable suggests this particular factor is not closely associated with the change of employment in regional industries in the cities in this subsample.

A second group of cities for which the model predicted an incorrect direction of change were those located in Quadrant 2 of the graph. It is not likely that these five have anything in common that suggests a systematic error. The inaccuracy with respect to Victoria probably reflects a lack of a regional manufacturing sector and the proximity of Vancouver. In this situation the model interpreted proximity to Vancouver as likely to generate a large employment change, but apart from Provincial Administration, Victoria lacks a large regional industry sector that can take advantage of this proximity.

In this situation, the straight line distance between Victoria and Vancouver is not an accurate estimate of the cost of moving goods between these cities. It is clear that other cities in the shadow of major metropolitan areas (for example, Hamilton and Oshawa close to Toronto) do not fall behind the national average as much as does Victoria. These cities, of course, have strong national industry sectors. The error associated with Saint John does not indicate any tendency towards systematic error in estimating change for Maritime cities, but is due to the fortunes of particular industries in that city. Both Wholesale Trade and Transportation declined over this period in Saint John, bringing total regional employment change well below the national average.

A comment on the model's inaccuracy is needed in reference to Calgary and Edmonton. It is clear that growth in these cities surpassed the national average, well in excess of the model's estimating ability. The rapid growth in Calgary and Edmonton is noted in the national industry analysis and it is likely that rapid national industry growth in Alberta generated substantial demand for regional industry output and hence regional industry growth is much greater than the national average in Calgary and Edmonton. It will be argued later that it is reasonable to regard these two cities as special cases in light of their sudden oil and mineral based growth. The model is an attempt to estimate an average relationship between some hypothesised independent variables and the change in employment relative to a national average; Calgary and Edmonton have so exceeded the national average change, for reasons unique to themselves, that they hinder the estimation of the average relationship between the variables.

Kitchener also has a substantial error associated with its estimation. It had growth in regional industries well above the national average due to expansion in food and electrical appliances industries, yet the model interprets the small trade area and low metropolitan status of Kitchener as a reason to expect less than national average growth. However, the expansion in the two industries named above gave Kitchener above average growth; also the trade area population of Kitchener was underestimated, as it was calculated from Waterloo county data, and the Kitchener urban area occupies a large portion of this county, but given the data available that was the only value that could be used.

Apart from the model's demonstrated inaccuracy with one group of cities, there did not seem to be any other serious tendency for it to err in a predictable manner for particular size or spatial groups. Consequently the model was an appropriate one to measure change relative to a national average.

4. THE MODEL'S SENSITIVITY TO SAMPLE COMPOSITION

Two problems are posed in an assessment of the sensitivity of the model's estimates to changes in sample composition. These are first, are similar results likely from a sample of (a) large cities and (b) small cities? Second, are parameter estimates and the proportion of explained variance sensitive to a small number of special cases - that is to say, cities for which a reasonable argument is made that their past growth has been conditioned by certain unique features? These two problems are addressed in turn.

Two sub-samples are obtained to test the impact of city size on the parameter estimates of the model. The first, a sample of 30 cities, is obtained by excluding all cities with populations less than 30,000 in 1951. The second, a sample of 36 cities is obtained by excluding the 10 Standard Metropolitan Statistical Areas in 1951. The model is estimated for both sample groups generating the following results:

For 30 cities (excluding small cities)

$$\Delta E_R^* = -1507.62 - \underset{(1.51)}{6.65}\text{ DCL} + \underset{(6.18)}{29.93}\text{ METRO} + \underset{(.006)}{.024}\text{ TRADE AREA POP}$$

(The figures in parentheses are the standard errors of the estimates of the parameters)

$R^2 = .72$

$\overline{\Delta E_R^*} = -168.63 \qquad \sigma_{\Delta E_R^*} = 5587.68$

$\sigma_\varepsilon = 3143.32$

For 36 cities (excluding large cities)

$$\Delta E_R^* = -544.88 - \underset{(2.28)}{2.66}\text{ DCL} - \underset{(18.65)}{22.19}\text{ METRO} - \underset{(.004)}{.009}\text{ TRADE AREA POP}$$

$R^2 = .14$

$\overline{E_R^*} = -169.05 \qquad \sigma_{\Delta E_R^*} = 1989.09$

$\sigma_\varepsilon = 1932.61$

A study of these results shows that removing small cities from the sample adds a little to explained variance (no more than 2%) and does so at the cost both of greater standard errors on the parameter estimates, and a large increase in the standard error of the estimate. In general, removing 16 small cities has no substantial impact on the estimates. The results for the second subsample supports the model's big city bias. Dropping the 10 SMSA's from the sample reduces explained variation by 56% and increases standard errors for the parameter estimates. Clearly the hypothesised relationships between dependent and independent variables do not hold for small cities, which is another reason why several small cities have employment change estimated incorrectly. The logical step is to try to find variables that serve as useful estimators for this 36 city sample. However this sample held only 21% of total regional industry employment in 1951; a concerted effort to explain variance in this sample would offer only a little further information about regional industries as a group.

The second problem is the question of how sensitive the model's estimating ability is to one or two extreme cases in the sample. There are two reasons to regard some cities' experience as exceptional. The first is that they had error terms in this model much larger than other cities in the sample. Second, there are known features in the past development of three cities (Victoria, Edmonton and Calgary) that suggests their regional industry behaviour is exceptional. Victoria has grown in the shadow of Vancouver, and Calgary and Edmonton have proportional changes in regional industry employment up three times greater than other cities their size. The problem becomes one of finding the impact that removing these cases might have on the model's present estimates – which are that 70% of the variance in the dependent variable is associated with three independent variables, and the model's predictions have a standard error of 2809, over 20 times the mean value of the dependent variable. The same model calibrated for 43 cities (excluding Calgary, Edmonton and Victoria) provides the following estimates:

$$\Delta E_R^* = -930.76 - \underset{(1.03)}{5.82}\ \text{DCL} + \underset{(4.06)}{30.83}\ \text{METRO} + \underset{(.005)}{.016}\ \text{TRADE AREA POP}$$

(Figures in parentheses are standard errors of the estimates of parameters)

$$R^2 = .75$$

$$\overline{E_R^*} = -535.05 \qquad \sigma_{\Delta E_R^*} = 4004.75$$

$$\sigma_{\varepsilon} = 2075.87$$

This strategy achieves a small increase in the level of explained variation and reduces the size of the standard error.

5. THE BEHAVIOUR OF SUBGROUPS OF REGIONAL INDUSTRIES

This stage of the research seeks to establish whether the relationships found between three independent variables and the aggregate of regional industries employment change also hold for changes in employment in subcategories of regional industries. Two separate industry groups are selected for analysis; one, Food Production, as an example of a regional manufacturing industry and two, Wholesale Trade as an example of a regional service industry. The thrust is to study how well the model used for an aggregate of all regional industries performs when estimating changes in employment in two groups within that aggregate.

A manufacturing industry and a service industry were chosen because it was expected these two groups may indeed respond to different forces. The manufacturing industry, on the one hand, may have greater growth in cities that are close to larger cities because this proximity generates greater demand through inter-industry linkages. Conversely, the service industries may grow faster in a relatively isolated city because the greater the distance to a rival the less competition a city's service industry will face. These issues are addressed in the analysis below.

Two regression models are estimated using the same independent variables that enter the regional industry model. In the first regression below, the dependent variable, ΔE^*_{FOOD}, is change in employment in the food industry after the national average change in that industry has been removed. In the second regression, the dependent variable, $\Delta E^*_{WH.TRD.}$, is the change in employment in wholesale trade after the national average change has been removed. The results are as follows:

$$\Delta E^*_{FOOD} = 73.78 - .83\ \underset{(.15)}{DCL} + .94\ \underset{(.63)}{METRO} + .001\ \underset{(.0005)}{TRADE\ AREA\ POP}$$

$$R^2 = .45$$

TABLE 15

SUMMARY OF STEPWISE ROUTINE - FOOD INDUSTRY MODEL

Order of Entry	Variable	R^2	R^2	F to Enter
1	DCL	.37	.37	25.878
2	TRADE AREA POP	.42	.05	4.09
3	METRO	.45	.03	2.21

$$\Delta E^{*}_{WH.TRD.} = 46.23 - \underset{(.27)}{.97}\ DCL + \underset{(1.12)}{7.54}\ METRO + \underset{(.001)}{.002}\ TRADE\ AREA\ POP$$

$$R^2 = .62$$

There are important differences first, between these results and those achieved for the model of the aggregate of regional industries, and, second, between the two regressions themselves. In the first place neither of these models offers the high level of explained variance found in the aggregate model (.70); the change in employment in the food industry obviously depends on variables not included in the model as the three independent variables are able to explain only 45% of the variance in the dependent variable. A second contrast to those results achieved for the aggregate model is in the contribution of each independent variable to explained variance. For all regional industries as a group the metropolitan influence variable dominates explained variance in the dependent variable, but this particular variable makes only a weak contribution to the explained variance of employment change in the food industry. Indeed, it not only has a small contribution to explained variance but furthermore has a parameter value not significantly different from zero (at the 95% confidence level). On the other hand, the wholesale trade sector mirrors the behaviour of all regional industries - the metropolitan influence variable has the major contribution to explained variance in this particular regression. These results highlight a difference between regional manufacturing and regional service industries. In addition, they show that the results obtained for the

TABLE 16

SUMMARY OF STEPWISE ROUTINE - WHOLESALE TRADE MODEL

Order of Entry	Variable	R^2	R^2	F to Enter
1	DCL	.51	.51	46.67
2	TRADE AREA POP	.60	.09	9.17
3	METRO	.63	.03	2.85

aggregate of regional industries really reflect the behaviour of the service industries. It is clear for example, that the regional manufacturing industries are conditioned by variables not presently included in this model and certainly trade area population and metropolitan influence make only a weak contribution to explaining employment changes in these industries. This is quite the contrary to the role these variables play in estimating employment change in the regional service industries and the aggregate group of all regional industries.

However, there is one important similarity between all the results considered above. Both subgroup regressions have negative values for the parameter of the variable DCL. Thus general statements about the effect of proximity to a large city upon the employment growth in regional industries do in fact apply to both subgroups studies' here. In essence, employment change in both the manufacturing and service components of regional industries is likely to be greater the closer a city is located to a larger city.

6. CONCLUSIONS

The change in city employment in regional industries is sensitive to the character of the spatial system in which the city is located. Trade area population, distance to closest larger city and the city's role in a regional hierarchy together explain 70% of the variance in all regional industry employment change. It is clear however, that this relationship is due primarily to the influence of regional service industries; change in employment in regional manufacturing industries is not as closely related to these explanatory variables. The model as currently structured correctly predicts the direction of change in employment in two-thirds of the cities in the sample and provides some valid reasons why some cities, e.g., Toronto and St. Catharines, had changes in employment greater than the national average whilst others, for example, Quebec and Hamilton, fell behind the national average.

CHAPTER SIX

CHANGE IN EMPLOYMENT IN LOCAL INDUSTRIES

Employment change over time in local industries is expected to be closely associated with the economy of a city. This should be so because local market area industries - typically retailing, construction, finance, insurance and real estate - are defined on the basis of a single city market. The general hypothesis is that future changes in employment relative to a national average can be predicted from knowledge of the present state of local city economy. The dependent variable in this analysis - ΔE_L^* - is the change in employment in local market area industries after a national average change was removed.

1. RESEARCH HYPOTHESES

The research proposes that the growth of local industries depends upon (a) local city income and (b) the extent to which metropolitan functions are developed in a city.

(a) One hypothesis tested is that change in employment in local industries is greater (less) than the national average the greater (smaller) the purchasing power of the population in the local city economy.

The justification for this hypothesis is that larger markets allow economies of scale and the provisions of specialised services. Hence, the local industry sector is more likely to grow faster than the national average the larger is its market. This hypothesis also tests whether a local service sector reacts autonomously to particular forces in the city economy. Naturally this market, which comprises the population of the city, is influenced by many other factors, particularly the development of the national and regional industries in the city. However, instead of relating change in local industries to the change in other industries, the study relates change in local industry employment to the state of the city economy at the start of the time period.

Three measures were tried to estimate the strength of this hypothesised relationship. The first two were measures of the number of consumers, namely city population and the total city labour force. Both had relatively strong simple correlations with the dependent variable of .649 and .675 respectively. However, it is expected that a measure which includes an estimate of local city income would bear a closer relationship to the dependent variable. Direct measures of local city income were not available for 1951 so an approximation was used, developed from total income earned for counties. Using total income earned for counties and population of counties, it was possible to calculate per capita county income. This was multiplied by city population to obtain an estimate of total city income. Though not without flaws due to aggregation this particular measure of purchasing power - to be designated as CITY INCOME - has a simple correlation coefficient with the dependent variable of .736, and is used in the regression model below.

(b) The second hypothesis is that employment change in local industries is greater (less) than the national average the more (less) important the metropolitan functions in a city.

This hypothesis is proposed to test the influence metropolitan development has upon local industries. To a degree the metropolitan factor is included in the first variable, because metropolitan areas are those with largest total city incomes; simply the effect that the diversity of functions in a metropolitan area has upon local industries is measured here. This factor is represented in the index of metropolitan influence that has entered both the national and regional industry models earlier. The index - METRO - is included in the model below.

The correlations between these two variables and the dependent variable, and their inter-correlations are shown in Table 17. There is some correlation between total income and the metropolitan index but it is not strong. This is due to the particular technique used to construct the metropolitan index which has removed most of the effect of city size on the index values.

2. A MODEL OF EMPLOYMENT CHANGE IN LOCAL INDUSTRIES

As with national and regional industries these two hypothesised variables are assumed to have a linear additive relationship with the dependent variable and the model below is estimated with least squares multiple regression.

$$\Delta E_L^* = \alpha + \beta_1 \text{ CITY INCOME} + \beta_2 \text{ METRO} + \varepsilon$$

The data for this study were fitted to such a model and yielded the following estimates:

$$E^*_{L\,1951-61} = -103.42 + .017\ \text{CITY INCOME}_{1951} + 39.61\ \text{METRO}_{1951}$$
$$\qquad\qquad (.002) \qquad\qquad (6.70)$$

(The figures in parentheses are the standard errors of the estimates of the parameters)

$$R^2 = .75$$

$$\overline{\Delta E^*_{L}}_{1951-61} = 1589.36 \qquad \sigma_{\Delta E^*_{L}\,1951-61} = 6357.18$$

$$\sigma_\varepsilon = 3364.91$$

These results did not reject either of the hypotheses proposed, as both parameters have estimates many times larger than their standard errors, and the model offers a high level of explained variance.

This level of explained variance is dominated by the TOTAL INCOME variable, as shown in the stepwise routine in Table 18. When CITY INCOME is entered in the stepwise routine (i.e., all cities have statistically constant incomes) the relationship between METRO and the dependent variable does not change. This suggests that the Metropolitan influence is a strong element in employment change determination as even with statistically constant city incomes it has a strong role in the estimation. Consequently, metropolitan area economies contribute more than high income to the growth of local industries; the size and complexity of the metropolitan functions are together important predictors of employment change.

TABLE 17

CORRELATION MATRIX - LOCAL INDUSTRY MODEL

	ΔE_L^*	CITY INCOME	METRO
ΔE_L^*	1.00	.736	.665
CITY INCOME		1.00	.319
METRO			1.00

TABLE 18

SUMMARY OF STEPWISE ROUTINE

LOCAL INDUSTRY MODEL

Step Number	Variable Entered	R^2	ΔR^2	F to Enter
1	CITY INCOME	.54	.54	51.88
2	METRO	.75	.21	34.99

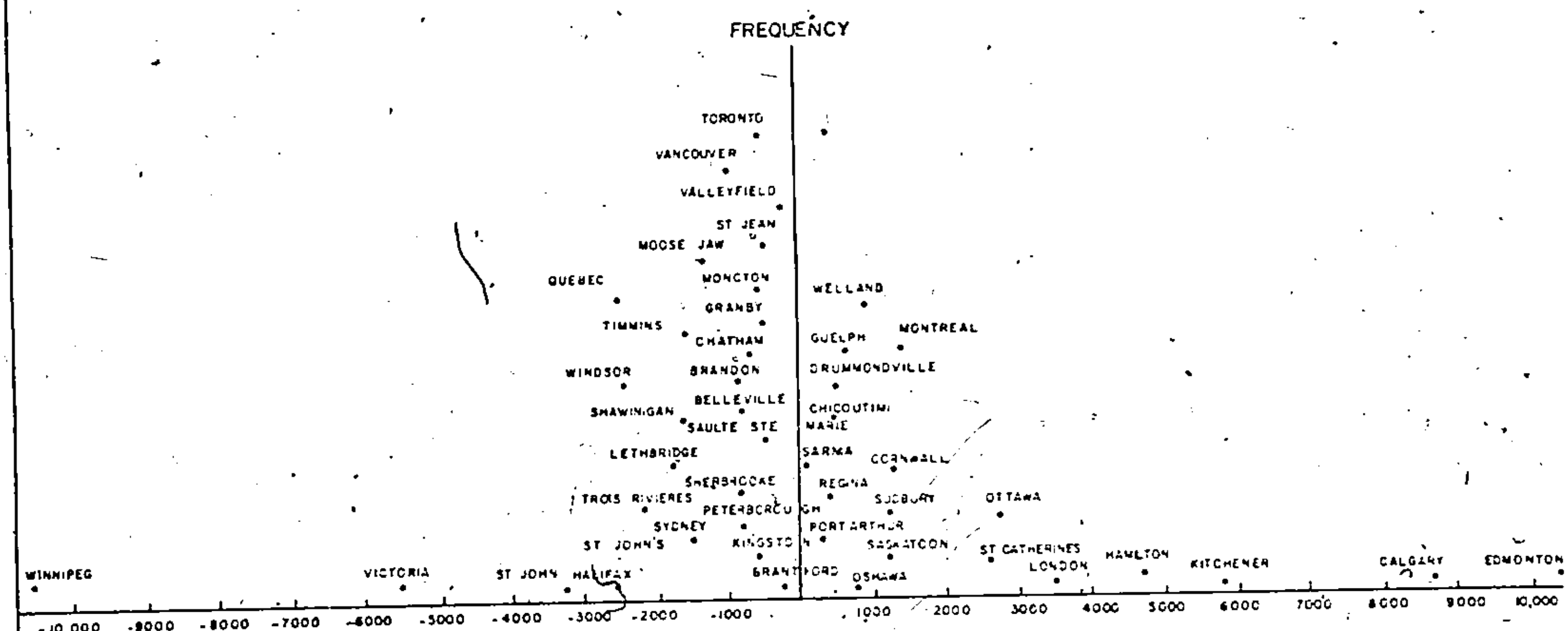
These results support the general contention that change in local industry employment relative to a national average change can be estimated by using a measure of economic conditions in a city economy at the start of a time period. Local industries satisfy local markets and their ability to grow at rates in excess of the national rate depends largely upon the level of income and metropolitan functions in their particular markets.

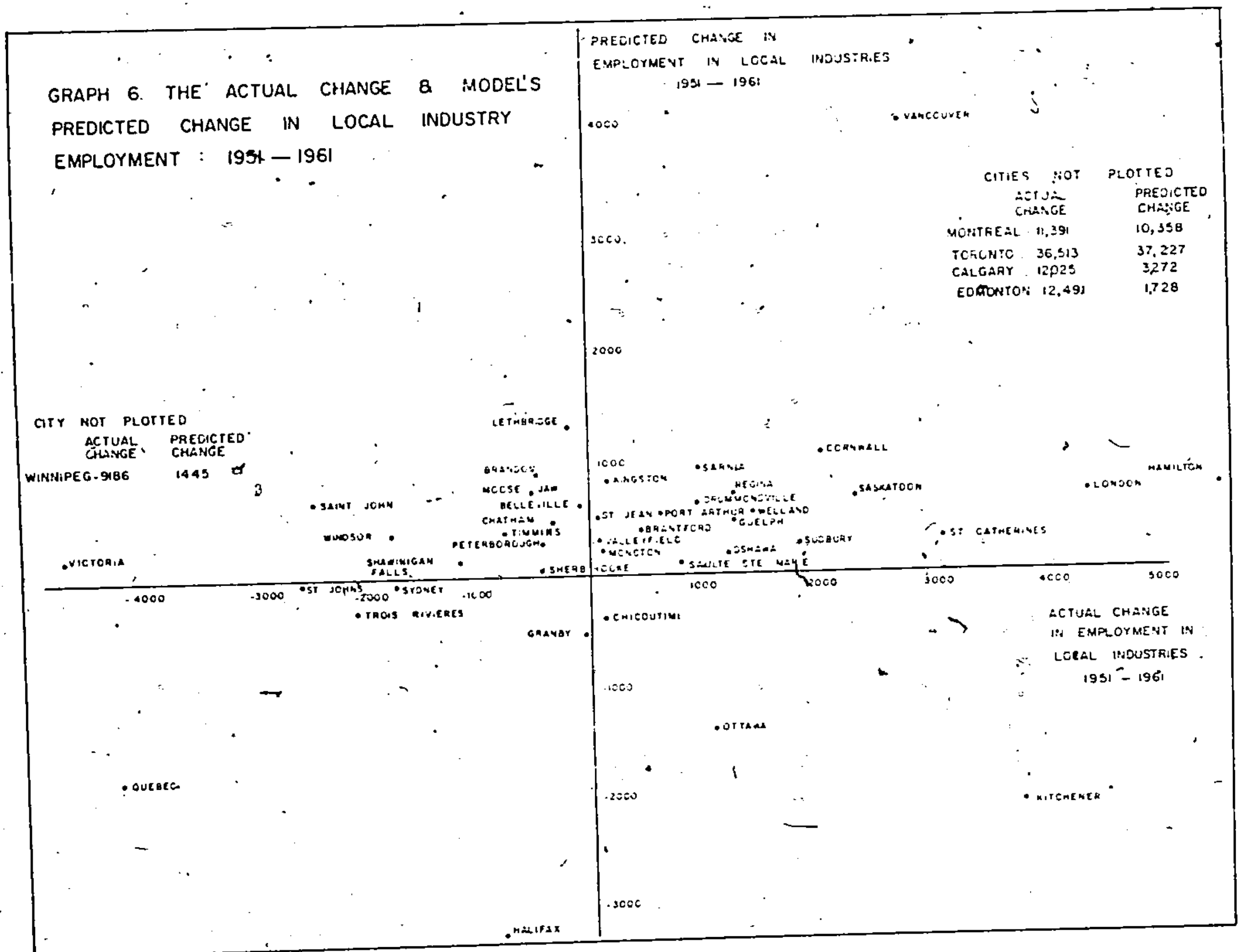
3. THE MODEL'S PERFORMANCE FOR INDIVIDUAL CITIES

An indication of how well this particular estimate of the model works for individual cities is obtained by studying its residuals. These are plotted on Graph 5. A study of this plot reveals the model has a tendency to underestimate employment change in Maritime Province cities. These errors imply that employment change in these locations is conditioned by forces not in the model but it is difficult to estimate how these could be integrated into the analysis. Apart from this problem there are no other obvious spatial or functional groupings in the data.

An examination of the actual and predicted values for each city is the next step taken (see Graph 6). The model accurately predicts the direction of change in 30 cities in the sample. For the majority of cities - those located in quadrants 1 and 3 - employment change in local industries from 1951 to 1961 is associated with city income and metropolitan functions in 1951. But for some cities in these quadrants (Edmonton, Calgary and Halifax) there were large errors involved such that it is likely other forces are involved.

GRAPH 5: PLOT OF RESIDUALS — LOCAL INDUSTRY MODEL





GRAPH 6. THE ACTUAL CHANGE & MODEL'S PREDICTED CHANGE IN LOCAL INDUSTRY EMPLOYMENT : 1951 — 1961

The model inaccurately predicted the direction of change for a large group of cities, those located in Quadrant 2 of the graph. More than half these cities have populations of less than 30,000 in 1951 and the inaccuracy in the estimation of local industry growth in these small cities is an important finding. This suggests that the local industry sector in a small city responds to economic forces different from those that influence the same industries in a larger city. Further evidence for this observation was the model's tendency to underestimate change in some larger cities such as London, Hamilton, Calgary, and Edmonton. It is clear that large cities with large markets are able to generate employment changes proportionately greater than those in small cities. This correlates with the earlier observation on the estimating power of the variable METRO; this variable has an important role in local industry employment change even when city incomes are held statistically constant.

There are several major errors in estimation shown on this graph - particularly for Winnipeg, Halifax, Kitchener, Calgary, Edmonton and Victoria. In the case of Calgary and Edmonton it has been argued previously that the rapid development of oil based national industries in Alberta influenced regional industries in these two cities; the combined growth of national and regional industries boosted local industry growth well above the national average. Victoria is regarded as a special case for reasons advanced in the previous chapter, while Winnipeg, Halifax and Kitchener deserve special attention. The model interprets the city income and metropolitan functions of Winnipeg in 1951 as a basis for above average employment change in local industries between 1951 and 1961. This was in error however, as Winnipeg's local industries were not able to grow faster than the national average rate in this time period. (This was typical of the general pattern of industrial growth in Winnipeg between 1951 and 1961 - in none of the employment groups was it able to expand employment beyond the national average rate. It was an example of a slow growth metropolitan area at this time.)

Both Halifax and Kitchener have employment changes greater than the model's predictions. Ottawa, too, is in this category. Growth in these three cities is due to very strong regional industry sectors - Government employment in both Halifax and Ottawa and manufacturing in Kitchener. These regional industries probably promote demands for local industry sectors not necessarily expressed in high city incomes or metropolitan functions and the model is not sensitive enough to catch this influence.

4. THE MODEL'S SENSITIVITY TO SAMPLE COMPOSITION

Again, to obtain some further information about the behaviour of local industries in different size cities, two separate runs of the model are made on two subsamples, the first with 30 cities and the second with 36 cities. The 30 city subsample is obtained by removing from the original 46 cities all those with populations less than 30,000 in 1951, and the 36 city subsample is obtained by removing the 10 metropolitan areas in 1951.

The following results are obtained:

30 city sample:

$$\Delta E_L^* = 200.82 + .017 \text{ CITY INCOME} + 40.62 \text{ METRO}$$
$$\qquad\qquad\quad (.003) \qquad\qquad\qquad (8.53)$$

(Figures in parentheses are the standard errors of the parameter estimates)

R^2 = .75

$\overline{\Delta E_L^*}_{1951-61}$ = 2332.43 $\quad \sigma_{\Delta E_L^*}$ = 8017.81

σ_ε = 4174.54

36 city sample:

$$\Delta E^*_{L\,1951-61} = -745.45 + .04 \text{ CITY INCOME} + 16.17 \text{ METRO}$$
$$\qquad\qquad\quad (.03) \qquad\qquad\qquad (22.55)$$

R^2 = .06

$\overline{\Delta E_L^*}_{1951-61}$ = 161.91 $\quad \sigma_{\Delta E^*_L\,1951-61}$ = 1878.17

σ_ε = 1879.33

Removing 16 cities from the sample has no effect on the model's level of explained variation, but does change the standard error of the estimate. Thus the model is really one of large cities, as they dominate the estimation procedure. This is further substantiated by the second subsample results - the model's explanatory power falls considerably when the ten largest cities in 1951 are removed.

In a manner similar to the analysis of regional industry employment a test is performed to find the sensitivity of the model's estimates to three special cases - Calgary, Edmonton and Victoria. The model's estimates for a 43 city sample are shown below:

$$\Delta E_L^* = -419.20 + \underset{(.002)}{.017}\text{ CITY INCOME} + \underset{(5.08)}{38.47}\text{ METRO}$$

(Figures in parentheses are standard erros of the estimates of the parameters)

$$R^2 = .84$$

$$\overline{\Delta E_L^*} = 1243.44 \qquad \sigma_{\Delta E_L^*\ 1951-61} = 6264.81$$

$$\sigma_\varepsilon = 2543.81$$

This strategy achieves a 10% increase in the level of explained variation and narrows the size of the standard error, confirming a strong underlying relationship exists between these variables.

5. THE BEHAVIOUR OF SUBGROUPS OF LOCAL INDUSTRIES

Here the research attempts to establish the degree of homogeneity within the group of local industries. This involves taking two subgroups within the aggregate and using the model developed in this chapter to estimate change in these subgroups.

Economic activities in cities can be ordered into a hierarchy, depending upon their technical complexity and the frequency of demand for their product. Retailing, for example, is a lower order service, whilst financial services are higher order activities. Thus there are broadly two types of activity within the local industry category. On the one hand there are higher order service activities that tend to develop to a greater degree in metropolitan areas, though they are present in all cities - an example is finance, insurance and real estate services. On the other hand there are lower order services - such as retailing. This present stage in the research tests whether the local industry model presented earlier does in fact work differently for finance, insurance and real estate services compared to its prediction of activity in retailing.

This comparison is performed by generating results for two regressions, the first for change in employment in finance, insurance, and real estate (ΔE^*_{FIN}) and the second for change in employment in retailing (ΔE^*_{RTL}). Both dependent variables are derived in a similar manner to the dependent variable in the aggregate model - they represent industry group changes after the national average change as been removed. The results of the regressions are as follows:

$$\Delta E^*_{FIN} = -25.02 - \underset{(.001)}{.006}\ \text{CITY INCOME} + \underset{(1.65)}{7.50}\ \text{METRO}$$

$$R^2 = .71$$

$$\Delta E^*_{(RTL)} = -49.11 + .001 \text{ CITY INCOME} + 6.02 \text{ METRO}$$
$$\qquad\qquad (.001) \qquad\qquad (2.89)$$

$$R^2 = .15$$

These results establish that the model commented upon for the aggregate of all local industries is not an accurate guide to the behaviour of these individual industries within the aggregate. In the first place it is clear that employment change in retail trade relative to a national average growth in retailing is not strongly related to the independent variables used here. Not only is the level of explained variance low but neither of the parameter values are significantly different from zero (at the 95% confidence level). In summary the model does not apply to employment changes in city retailing. It is likely that employment growth in retailing relative to the national average depends on particular local variables that have been missed in the variables METRO and CITY INCOME used here.

On the other hand, change in the finance category is closely related to the independent variables used. However, the regression result for this subgroup does show a negative value for the parameter on the variable CITY INCOME, which is different from the value obtained from the aggregate group regression. Apart from this discrepancy the finance industry provides a mirror image of the aggregate models results - the levels of explained variance and the contribution of independent variables to this variance are both similar.

The consequence of these results is that the local industry group regression is only an average relationship, one that does not necessarily hold for individual industries taken separately. In addition, there is some evidence to suggest that the aggregate relationship reflects the influence of industry groups such as the finance category investigated here. These activities are best developed in large cities and, to the extent that these influence the aggregate relationship, it seems this relationship principally applies to large cities.

6. CONCLUSIONS

The results obtained support the two hypotheses proposed. City Income in 1951 and an index of Metropolitan functions in 1951 provide an effective means of estimating change in employment in local industries in Canadian cities between 1951 and 1961. However analysis of two subgroups of local industries found this relationship did not hold for lower order services (for example retailing) although it did seem appropriate for higher order services such as finance, insurance and real estate. This result, along with the role played in the relationship by the metropolitan influence variable did suggest the local industry model developed here is primarily applicable to large cities. In these cities the local economy is able to generate greater growth due to external economies and the provision of specialised services.

CHAPTER SEVEN

INDUSTRIAL STRUCTURE AND URBAN GROWTH

The purposes of this chapter are to examine the changes in total employment in Canadian cities in the light of the changes in national, regional and local industries, to evaluate the models that were developed, and to summarize the conclusions of the research.

1. GROWTH IN EMPLOYMENT IN CANADIAN CITIES

This research has involved an empirical investigation of the changes in employment in Canadian cities. It has stressed the factors relevant to the growth of three groups of industry in a sample of 46 cities. The discussion now shifts to a consideration of changes in total employment in the cities. Certain patterns emerge when the percentage change in city employment is subjected to scrutiny; particular types of cities seem to have rapid growth and this can be explained in terms of the change in employment in the three industrial groups examined earlier in the dissertation. Table 19 shows the percentage change in total employment between 1951 and 1961 for the 46 cities in the sample. The cities have been arranged in descending order of rates of growth. Alongside each percentage change, the direction of change in the dependent variable for each industry group has been shown, indicating in effect whether a city's growth was above or below average in each of the three industry groups.

TABLE 19

PERCENTAGE CHANGE IN TOTAL EMPLOYMENT 1951-1961

AND DIRECTION OF CHANGE IN DEPENDENT VARIABLES IN

NATIONAL REGIONAL AND LOCAL INDUSTRIES

	Percentage Change	ΔE_N^*	ΔE_R^*	ΔE_L^*
1. Cornwall	103	+	+	+
2. St. Catharines	89	+	+	+
3. Welland	89	+	+	+
4. Calgary	79	+	+	+
5. Edmonton	77	+	+	+
6. Sudbury	70	+	+	+
7. Drummondville	63	+	+	+
8. Saskatoon	62	+	+	+
9. London	58	+	+	+
10. Toronto	48	+	+	+
11. Kitchener	45	−	+	+
12. Regina	44	+	−	+
13. Ottawa	42	−	+	+
14. Moncton	41	+	+	+
15. Lethbridge	41	+	+	−
16. Kingston	39	+	+	+
17. Belleville	36	+	+	−
18. Montreal	36	+	−	+
19. Halifax	33	+	+	−
20. Vancouver	35	+	−	+
21. Hamilton	32	−	−	+
22. Brantford	32	−	+	+
23. Guelph	31	+	−	+
24. Oshawa	31	+	−	+
25. Port Arthur	31	+	−	+
26. Brandon	29	−	−	−
27. Granby	27	+	+	−
28. Sarnia	26	−	−	+
29. Chatham	25	−	−	−
30. Quebec	25	−	−	−
31. Winnipeg	24	−	−	−
32. Chicoutimi	22	−	−	+
33. Moose Jaw	22	+	−	−
34. Saulte St. Marie	22	−	+	+
35. Sherbrooke	14	−	−	−

Continued...

Table 19 Continued...

36. St. Jean	12	+	−	+
37. St. Johns	12	−	−	−
38. Trois Rivieres	11	−	−	−
39. Shawinigan Falls	7	−	−	−
40. Peterborough	6	+	−	−
41. Timmins	4	−	+	−
42. Valleyfield	4	−	+	+
43. Victoria	4	−	−	−
44. St. John	3	+	−	−
45. Windsor	2	−	−	−
46. Sydney	−2	−	−	−

Several patterns emerge from the data. First, there is a group of fast growth cities, in particular the first 10 cities in the table, all of which have above average growth in all three industry groups. Included among these ten cities are metropolitan areas (Toronto, London, Saskatoon, Edmonton and Calgary) and highly specialised national industry cities (Cornwall, St. Catharines, Welland, Sudbury and Drummondville). For most of these cities, the period 1951-1961 saw the establishment of one or more new national industries, and large expansions in existing industries. Cornwall, for example, doubled its employment in pulp and paper manufacturing, thereby adding to a national industry sector that already included clothing and textiles. Edmonton and Calgary established petroleum-based industries in this period, and all other cities in this group added to both regional manufacturing and regional service industries.

A second group of cities had slower growth because either their national or their regional industries expanded at rates below the national average. National industry growth was below average in Kitchener, Ottawa, Saulte St. Marie and Brantford for example. Their existing national industries grew slowly and they were unable to attract large new industries in the manner of the cities in the first group. Regional industry growth was below average in Regina, Montreal and Vancouver in this period, once again reducing these cities' overall growth rates. The slow regional industry growth in Montreal and Vancouver probably was associated with the low employment in Provincial Administration in these cities. The majority of employees in this category were in Quebec and Victoria respectively.

Finally, there is a third group of cities all with relatively low growth rates and all with less than national average growth in two or three employment sectors. Prominent within this group are certain metropolitan areas (Quebec and Winnipeg) and small cities such as Shawinigan Falls, Trois Rivieres, Peterborough and St. John's. Quebec and Winnipeg were identified in the earlier analysis as slow growth metropolii; they both lack the large national industry manufacturing sector that is common to most of the metropolitan areas, and their regional manufacturing activity is not as well developed as in other cities of a comparable size. Consequently, they have been unable to generate growth in these sectors equivalent to the national average growth and hence, their overall employment growth has been slow. This is likely to continue unless national industries are attracted but Quebec has to compete with Montreal for new industries, while Winnipeg has to overcome problems of distance to major markets. In the long term, it is difficult to see these cities matching the rates of growth of centres such as Toronto, London, Edmonton and Calgary.

An explanation of slow growth in small cities generally revolves around the fortunes of particular industries. For example while the employment in pulp and paper manufacturing doubled in Cornwall between 1951 and 1961, it fell in both Shawinigan Falls and Trois Rivieres. For both of these cities, this involved serious declines in total national industry employment, and consequently slow growth. Sherbrooke, Valleyfield, Timmins and Saint John all had absolute decreases in national industry employment while Peterborough and St. Jean had decreases in regional industry employment in this period. Unless new national industries are established, or regional industries expanded, it is not likely these cities can have rapid growth. The growth of regional industries is often hindered by the absence of a large city nearby, or a small trade area population (both important in the slow growth in St. John's, Saint John and Sherbrooke). The experience of Drummondville, St. Catharines, and Welland contrasts with the slow growth of Timmins, Trois Rivieres and Shawinigan Falls, because the first three cities added employment to both national and regional industries between 1951 and 1961. As the potential for regional industries in the last three cities is poor, and they have had difficulty in expanding their national industries, it is likely that their slow urban growth will persist.

In summary, urban growth will be rapid only in cities with an industrial base comprising national and regional industries. The analysis has shown that growth in national manufacturing industries is related to the population size of a city, and as a rule large cities experience above average growth in these national industries. Regional industries were found to depend upon certain elements of regional spatial structure, such as trade area population and distance to larger cities. Cities with above average regional industry growth are most likely to be located in regions with high populations, near large cities. The combination of favourable circumstances for above average national and regional industry growth explains the concentration of rapid urban growth in the Quebec-Ontario urban system, particularly the Montreal-Windsor corridor. Here are found large cities, dense populations and a closely integrated urban system, factors which explain rapid national and regional industry growth in the region's cities. In addition, Ray (1968) has shown that U.S. subsidiaries that are established in Canada have a strong preference for locations in Southern Ontario between Toronto and Windsor, which helps explain the rapid growth of St. Catharines and Welland. The concentration of urban growth in this region is likely to continue so long as national and regional industries remain sensitive to the variables identified in this analysis.

2. AN EVALUATION OF THE MODELS OF EMPLOYMENT CHANGE

The models developed in the earlier chapters have predicted the direction of change in employment correctly in all three industry groups in the following cities:

Montreal	Moncton
Toronto	Guelph
Vancouver	Sydney
Edmonton	Quebec
Calgary	Hamilton
Saskatoon	Sarnia
Regina	

The predictions of the direction of change have been correct for two employment sectors (national and regional industries) for the following additional cities:

Moose Jaw	Chicoutimi
Lethbridge	Sherbrooke
Belleville	Winnipeg
St. Jean	Windsor
Peterborough	

Thus, for these cities the regression models have correctly captured the association of variables related to the direction of employment change. However, the models have a tendency to be inaccurate in predicting employment change in small cities which have large proportions of their work force in national industries. Examples of this tendency were Drummondville, Granby, Cornwall and Timmins. The models are unable to handle these cities accurately as they interpret their small regional employment and trade area populations as pertaining to slow growth in both national and regional industries. In fact, to accurately predict the growth of industry in these cities, one probably requires a detailed knowledge of first, their industrial activities and, second, the recent growth and present demand and supply conditions in the respective industries in each city.

This last point highlights a particular interpretation of the results presented here. The models provide statistical relationships between variables, for aggregates of industries. Results show, for example, that subgroups of industries cannot be relied upon to behave in the same manner as the aggregate. Subgroups of national, regional and local industries have their own unique characteristics that are masked by the statistically strong relationship found in the analysis of industry aggregates. Consequently, the general findings refer only to the three aggregates of industries used in this study.

It was proposed at the outset that industries in cities satisfy two sources of external demand - one from the nation and another from the region. It remains to be established that national and regional industries do in fact respond to different forces. The results presented so far have shown that the metropolitan influence of a city is important to employment change in each industry group and that national and local industries both respond to city size related variables (such as infrastructure and city income). However, regional industry employment changes depend upon elements in the regional spatial structure (such as trade area population and distance to closest larger city). The issue to resolve is whether regional industries are in fact sensitive to city size related variables and whether national and local industries in turn, are sensitive to variables that measure regional spatial structure.

This has been tackled in a direct way by applying the national industry model from Chapter 4 to regional industry employment change, and the regional industry model from Chapter 5 to employment change in both national and local industries. In the case of using the regional model to predict change in the national industries, the following estimates were obtained.

$$\Delta E_N^* = -764.83 + \underset{(1.17)}{.22}\,\text{DCL} + \underset{(4.78)}{13.85}\,\text{METRO} + \underset{(.004)}{.006}\,\text{TRADE AREA POP}$$

$$R^2 = .24$$

The results shown in Table 20 show that the level of explained variance in national industry employment change is much lower than when measures of city size (such as infrastructure) are used as predictors. Not only are the values obtained for the parameters on the variables DCL and TRADE AREA POP statistically insignificant, but also the contribution of these variables to the explained variance is much weaker than it is

TABLE 20

SUMMARY OF STEPWISE ROUTINE - NATIONAL INDUSTRIES

Step Number	Variable Entered	R^2	ΔR^2	F to Enter
1	METRO	.18	.18	9.85
2	TRADE AREA POP	.23	.05	3.14
3	DCL	.24	.01	.03

in the regional industry model.

When the national industry model was used to estimate employment change in regional industries, the results shown below were obtained (the summary of the stepwise routine is in Table 21).

$$\Delta E_R^* = -3082.74 - \underset{(.007)}{.009}\, E_{R+L} + \underset{(1290.96)}{897.09}\, \text{LOG } E_N + \underset{(7.14)}{40.89}\, \text{METRO}$$

$$R^2 = .44$$

Once again, the levels of explained variation are much lower than the 70% obtained when the regional spatial structure variables were used to estimate change in regional industries. The infrastructure and national industry employment variables have parameter values not significantly different from zero, and their joint contribution to explained variance once the variable METRO has been entered is only 2%.

Finally, the regional industry model was used to predict employment change in local industries and the following results were obtained.

$$\Delta E_L^* = -266.32 + \underset{(9.08)}{52.55}\, \text{METRO} + \underset{(.008)}{.016}\, \text{TRADE AREA POP}$$

$$R^2 = .49$$

The level of explained variance in local industry employment change associated with these elements of regional spatial structure is lower than that achieved when city income was used as a predictor. The variable

TABLE 21

SUMMARY OF STEPWISE ROUTINE - REGIONAL INDUSTRIES

Step Number	Variable Entered	R^2	ΔR^2	F to Enter
1	METRO	.42	.42	32.4
2	E_{R+L}	.43	.01	1.01
3	LOG E_N	.44	.01	.48

TABLE 22

SUMMARY OF STEPWISE ROUTINE - LOCAL INDUSTRIES

Step Number	Variable Entered	R^2	ΔR^2	F to Enter
1	METRO	.44	.44	34.82
2	TRADE AREA POP	.49	.05	4.09
3	DCL	.49	.00	.001

DCL has such a weak statistical association with the dependent variable that it does not enter the regression and the other variable, TRADE AREA POP, makes only a 5% contribution to explained variance.

These results confirm the conclusion that employment change in cities responds to two distinct forces - the first exerted by the nation on national industries, and the second by the region on regional industries.

3. CONCLUSIONS

This empirical analysis of Canadian urban growth had three general objectives. The first was to establish the distinction between national, regional and local industries in cities; the second was to isolate the forces that conditioned employment change in these groups and the third was to show that a predictive strategy was likely to be a useful one in modelling employment change in cities. These objectives are now reconsidered in the light of the preceding analysis.

The disaggregation of employment into national, regional and local industries is difficult to achieve using only data on labour force composition. There are certainly obvious examples of each category but the distinctions between a national and a regional industry, or between a regional and a local industry are not always clear. Data were presented to show the distinction between industries from two points of view. The first was the association between industrial employment and city population size and it was clear that national industries are not as closely related to city population size as are local industries. The second approach was based on the share of city employment that each industry commanded. Once again, national industries, with large shares in a few cities, differed clearly from the local industries. However, there was a problem in classifying some industries. Electrical appliance manufacturing, for example, had some characteristics both of a national industry and of a regional industry. In summary, the approach adopted here, which relied upon measures of city employment in industry groups, is not sufficiently powerful to achieve a clear discrimination between groups. It is likely that the only really satisfactory solution to this problem will depend upon detailed market data for a sample of firms in each industry.

The classification of employment into national, regional and local industries, albeit not a perfectly satisfactory one has focussed attention on some different issues in urban growth. The real contribution of this classification is in the emphasis it brought upon regional industries. As noted earlier, it was proposed that industries in cities satisfy two sources of external demand - one from the nation and another from the region. The results show that growth in national industries is closely tied to population and other city size related variables, while regional industries are sensitive to two different variables, distance to the closest larger city and trade area population.

The classification also has focussed attention upon employment change in local industries. High levels of explained variance in local industry employment growth, relative to a national average, are associated with the level of development in a city economy at the start of a time period. This confirms that the local industry sector does have some autonomy of its own and research that has treated it simply as an appendage to export industries has oversimplified its behaviour.

It has been shown that subgroups within each employment category do not necessarily behave in the same way as the aggregates to which they belong. The three groups - national, regional and local industries - are not entirely homogeneous in terms of how subgroups within them react to the independent variables used in the regression models. This raises the question of the interpretation that can be placed upon the results of the analysis of aggregate employment change. Perhaps the only valid interpretation is that industries in cities are influenced by national;regional and local economic forces some of which have been identified in this study. The aggregate results do not provide the basis for models that predict change in any one industry in all cities, or in a group of industries in one city. The models have been shown to be unreliable in both of these circumstances. Hence, the research establishes that cities are influenced by external forces operating at two scales, the nation and the region, and in addition, they have local economies in which growth is not solely dependent on concomitant changes in the other employment sectors.

This study also has provided a different interpretation of two factors that are often cited in studies of Canadian urban economic growth. These are the effects first, of metropolitan areas and, second, of regional differences within the country upon the growth of cities.

An index of metropolitan influence was incorporated into the analysis of change in industry groups and it had an important role in predicting employment changes in all three industry groups. It is clear that the growth of industrial employment in Canada occurs mainly in metropolitan areas, but this simple statement masks some of the intricacy of the situation. The influence of the metropolitan area is not purely one of size, but rather it is an expression of the availability of scale economies, of the complexity of metropolitan functions and of the influence that metropolitan areas have upon other cities within regional subsystems of cities. It is possible, for example, that metropolitan areas experience slow growth and in the 1951-1961 period, Windsor, Winnipeg and Quebec were all in this category. At the same time, Toronto, Edmonton, Calgary, Ottawa and London had growth greater than the national average in all three industrial categories. The changes in employment in these cities are associated with the development of their infrastructure, which in turn is associated with their influence within their own regional systems of cities. Toronto, for example, has had fast national industry growth because it has been able to assemble a large variety of service functions; these are related to its role as the major regional centre in Ontario, and this also explains Toronto's regional industry growth. In summary, metropolitan areas only have rapid growth when they have both national industry growth, due to their infrastructure, and regional industry growth, associated with their role in a regional system of cities.

The role played in urban growth by regional differences within Canada was analysed directly by focussing on the behaviour of regional industries. The prediction of employment change in regional industries relative to the national average change was based on measures of regional spatial structure such as distance to the closest larger city, trade area population and metropolitan influence in the system of cities. The possible significance of inter-regional variation in income was studied, but it did not add to the levels of explained variance in models of regional industry employment. The results established that the size and distribution of cities within a region is the critical element in that region's development. This is a modified interpretation of the influence of regional differences on urban growth; these have been previously discussed simply in terms of the income disparities between regions. Thus one finds for example, that in the Montreal-Windsor corridor, two-thirds of the cities have regional industry employment changes greater than the national average, whilst relatively isolated cities like Sydney, St. John's, Chicoutimi, Port Arthur and Sherbrooke have less than national average growth in both national and regional industries. Consequently, the regional dimension in Canadian urbanism is not related solely to the contrast between high and low incomes in different regions; the contrasts in connectivity and complexity in the regional urban systems are also important factors.

4. AREAS FOR FUTURE RESEARCH

There appear to be two directions in which future research into urban growth could move. The first would involve a continuation of research along the lines developed in this dissertation, whilst the alternative would be to reconsider attempts to handle the question of urban growth as a problem in spatial analysis.

The first approach would rely on the structure used in the present study, but would attempt to disaggregate industrial employment and to analyse the behaviour of each industry separately. Burrows, Metcalf and Kaler (1971) attempted to forecast employment by major industry groups for each county in the U.S. They used 22 separate industry groups and 39 estimating variables. Included among these variables were estimates of costs of production and measures of distance, together with a range of socio-economic and amenity variables. Levels of explained variation in the regression models for each industry group varied from 91% for a model of employment change in agriculture (the model had 19 predictor variables) to 7% for a 5 independent variable model of textile industry employment change. Their study tackled the problem of the behaviour of individual industries but the performance of the models was very uneven. It does, however, provide an example of a multi-industry multi-variable approach, though its use as a predictive tool is likely to be limited. The great variability between industry groups in terms of proportion of explained variance contributed by each model does suggest there is scope to improve the models, and this could be a path for future analysis.

An alternative strategy, using this same approach, would be to concentrate on the growth of individual cities and attempt to develop predictive models for employment change in each city. As pointed out earlier, this approach would require time series data for industry employment and until data of this type are available for consistent industry definitions and for sufficiently long periods of time the cross-sectional approach will have to be relied upon in urban industry growth analysis.

A second major avenue of future research would assume that the prediction of urban growth in a system of cities is explicitly a problem in spatial analysis and would search for the structure of spatial auto-correlation functions that are relevant to city growth. The models developed in this dissertation have only recognised the spatial influence on urban growth implicitly by incorporating measures of distance and trade area populations as predictor variables. However, the level of activity in each city is influenced by the corresponding levels of activity in other cities in the system. Models that capture this effect have been tested for a regional system of cities (King, Casetti and Jeffrey, 1969) and for a system of contiguous counties (Cliff and Ord 1971). It remains to establish the autocorrelation effects between urban growth rates in a national system of spatially dispersed cities.

In summary, future research will need to develop theoretical approaches to measuring spatial autocorrelations among cities, and simultaneously improve empirical understanding of the behaviour of individual industries in cities. However, both approaches will need to adequately handle the two major problems faced in this dissertation. The first is the difficulty in satisfactorily classifying employment into clearly separate groups and the second is the impact a few cities have upon the significance attached to general relationships found in the analysis. To re-iterate, the research persistently found employment change in cities such as Toronto, Montreal, Edmonton and Calgary was well in excess of the changes predicted by the model. It is likely that future analysis of this kind will meet such problems; an ability to articulate general findings on urban growth will always be limited by the disproportionate effect of a few cities on the behaviour of the urban system.

APPENDICES

APPENDIX 1

THE SAMPLE OF CITIES USED IN THE ANALYSIS WITH SPECIFICATION OF SPATIAL UNITS USED FOR DATA COLLECTION

	City	Spatial Unit
1.	Belleville	City Proper
2.	Brandon	City Proper
3.	Brantford	City Proper
4.	Calgary	Metropolitan Area 1951
5.	Chatham	City Proper
6.	Chicoutimi	City Proper
7.	Cornwall	City Proper
8.	Drummondville	City Proper
9.	Edmonton	Metropolitan Area 1951
10.	Granby	City Proper
11.	Guelph	City Proper
12.	Halifax	City Proper
13.	Hamilton	Metropolitan Area 1951
14.	Kingston	City Proper
15.	Kitchener	Kitchener, Waterloo, Galt
16.	Lethbridge	City Proper
17.	London	City Proper
18.	Moncton	City Proper
19.	Montreal	Metropolitan Area 1951
20.	Moose Jaw	City Proper
21.	Oshawa	City Proper
22.	Ottawa	Metropolitan Area 1951
23.	Peterborough	City Proper
24.	Port Arthur	Port Arthur, Fort William
25.	Quebec	Metropolitan Area 1951
26.	Regina	City Proper
27.	St. Jean	City Proper
28.	Saint John	City Proper
29.	St. John's	City Proper
30.	St. Catherines	City Proper
31.	Sarnia	City Proper
32.	Saskatoon	City Proper
33.	Saulte Ste. Marie	City Proper
34.	Shawinigan Falls	Shawinigan Falls, Grand Mère
35.	Sherbrooke	City Proper
36.	Sudbury	City Proper

...Cont'd

APPENDIX 1 Continued...

37.	Sydney	Sydney, Glace Bay, New Waterford
38.	Timmins	City Proper
39.	Toronto	Metropolitan Area 1951
40.	Trois Rivieres	Trois Rivieres, Cap de la Madelaine
41.	Valleyfield	City Proper
42.	Vancouver	Metropolitan Area 1951
43.	Victoria	City Proper
44.	Welland	City Proper
45.	Windsor	Metropolitan Area 1951
46.	Winnipeg	Metropolitan Area 1951

APPENDIX 2

POPULATION OF CITIES IN SAMPLE 1951

	City	Population
1.	Belleville	19519
2.	Brandon	20598
3.	Brantford	36727
4.	Calgary	142315
5.	Chatham	21218
6.	Chicoutimi	55912
7.	Cornwall	16899
8.	Drummondville	14341
9.	Edmonton	176782
10.	Granby	21989
11.	Guelph	27386
12.	Halifax	100626
13.	Hamilton	280293
14.	Kingston	33459
15.	Kitchener	76605
16.	Lethbridge	22947
17.	London	95343
18.	Moncton	27334
19.	Montreal	1471851
20.	Moose Jaw	24355
21.	Oshawa	41545
22.	Ottawa	292476
23.	Peterborough	38272
24.	Port Arthur	66108
25.	Quebec	276242
26.	Regina	71319
27.	St. Jean	19305
28.	Saint John	50179
29.	St. John's	52873
30.	St. Catharines	37984
31.	Sarnia	34697
32.	Saskatoon	53268
33.	Saulte Ste. Marie	32452
34.	Shawinigan Falls	37992
35.	Sherbrooke	50543
36.	Sudbury	42410
37.	Sydney	67326
38.	Timmins	27743

...Cont'd

APPENDIX 2 Continued...

39.	Toronto	1210353
40.	Trois Rivieres	64741
41.	Valleyfield	22414
42.	Vancouver	561960
43.	Victoria	51331
44.	Welland	15382
45.	Windsor	163618
46.	Winnipeg	356813

Source: Census of Canada, 1951, Volume 1, Table 3 and Table 12.

APPENDIX 3

PREVIOUS CLASSIFICATIONS OF INDUSTRIES

A. Vining (1946)

Vining developed an array of industries ranging from national industries at the top to local industries at the bottom. He did not require exact specification of a regional industry group.

The array he produced was tabulated below:

1. Autos and Auto Equipment
2. Coal Mining
3. Crude Oil and Natural Gas Products
4. Leather and Leather Products
5. Transportation Equipment
6. Non Ferrous Metals and Products
7. Iron and Steel and Their Products
8. Machinery Manufacturing
9. Textile Products and Apparel Manufacturing
10. Paper and Allied Products
11. Chemicals and Allied Products
12. Petroleum and Coal Products
13. Logging, Sawmills and Planing Mills
14. Stone, Clay and Glass Products
15. Other Mines and Quarries
16. Furniture and Miscellaneous Wooden Goods
17. Agriculture
18. Printing and Publishing and Allied Manufacturing
19. Finance, Insurance and Real Estate
20. Domestic Personal Service
21. Amusement, Recreation etc.
22. Food and Kindred Products Manufacturing
23. Communications
24. Government
25. Wholesale Trade
26. Utilities
27. Construction
28. Transportation
29. Other Personal Services

...Cont'd

APPENDIX 3 Continued...

30. Business Services and Repair Services
31. Professional and Related Services
32. Retail Trade

B. Isard (1953)

National Industries:-

1. Agricultural Machinery
2. Motor Vehicles
3. Aircraft
4. Machine Tools
5. Petroleum
6. Engines and Turbines
7. Coal and Coke
8. Ferrous Metals
9. Shipbuilding
10. Textile Mill Products
11. Lumber and Timber Products
12. Merchandise and Service Machine
~~13. Rubber~~
14. Transportation Equipment ~~not classified elsewhere~~
15. Electric Machinery not classified elsewhere
16. Non Ferrous Metals
17. Leather and Leather Goods
18. Apparel

Regional Industries:-

1. Industrial and Heating Equipment not classified elsewhere
2. Iron and Steel Foundry Products
3. All Other Manufactures
4. Agriculture and Fishing
5. Iron and Steel not classified elsewhere
6. Wood Pulp and Paper
7. Chemicals
8. Food Processing
9. Non Metallic Minerals
10. Furniture
11. Printing and Publishing
12. Miscellaneous Transportation
13. Steam Railroad Transportation
14. Eating and Drinking Places

...Cont'd

APPENDIX 3 Continued...

Local Industries:-

1. Business and Personal Services
2. Communications
3. Manufactured Gas and Electrical Power
4. Unallocated
5. Trade
6. Households
7. Construction

C. Mennes, Tinbergen and Waardenburg (1969)

International Industries:-

1. Agriculture and Livestock Production
2. Forestry
3. Logging
4. Hunting, Trapping and Game Propagation
5. Ocean and Coastal Water Fishing excluding Factory-Vessel Fishing
6. Factory-Vessel Fishing
7. Inland Water Fishing
8. Coal Mining
9. Iron Ore Mining
10. Metal Mining except Iron Ore Mining
11. Crude Petroleum and Natural Gas
12. Chemical and Fertilizer Mineral Mining
13. Non-Metallic Mining and Quarrying not classified elsewhere
14. Slaughtering, Preparation and Preserving of Meat
15. Manufacturing of Dairy Products
16. Canning and Preserving of Fruits and Vegetables
17. Canning and Preserving of Fish and Other Sea Foods
18. Manufacture of Grain Mill Products
19. Sugar Factories and Refineries
20. Manufacture of Cocoa, Chocolate and Sugar Confectionery
21. Manufacture of Miscellaneous Food Preparation (excluding perishable products)
22. Distilling, Rectifying and Blending of Spirits
23. Wine Industries
24. Breweries and Manufacturing of Malt
25. Soft Drinks and Carbonated Water Industries
26. Tobacco Manufactures
27. Spinning, Weaving and Finishing Textiles
28. Knitting Mills
29. Cordage, Rope and Twine Industries

...Cont'd

APPENDIX 3 Continued...

30. Manufacture of Textiles not classified elsewhere
31. Manufacture of Footwear
32. Manufacture of Wearing Apparel, except footnwear
33. Manufacture of Made-up Textile Goods, except wearing apparel
34. Sawmills, Planing and Other Wood Mills
35. Wooden and Cane Containers, and Cane Small Ware
36. Manufacture of Cork and Wood Products not classified elsewhere
37. Manufacture of Furnitures and Fixtures
38. Manufacture of Pulp, Paper and Paperboard
39. Manufacture of Articles of Pulp, Paper and Paperboard
40. Printing, Publishing and Allied Industries
41. Tanneries and Leather Finishing Plants
42. Manufacture of Fur Products, except wearing apparel
43. Manufacture of Leather Products, except footwear and other wearing apparel
44. Manufacture of Rubber Products
45. Basic Industrial Chemicals Including Fertilizers
46. Vegetable and Animal Oils and Fats
47. Manufacture of Paints, Varnishes and Lacquers
48. Manufacture of Miscellaneous Chemical Products
49. Petroleum Refineries
50. Manufacture of Glass and Glass Products
51. Manufacture of Pottery, China and Earthenware
52. Manufacture of Cement
53. Iron and Steel Basic Industries
54. Non Ferrous Metal Basic Industries
55. Manufacture of Metal Products except machinery and transport equipment
56. Manufacture of Machinery except electrical machinery
57. Manufacture of Electrical Machinery, Apparatus, Appliances and Supplies
58. Ship Building and Repairing
59. Manufacture of Railroad Equipment
60. Manufacture of Motor Vehicles
61. Manufacture of Motorcycles and Bicycles
62. Manufacture of Aircraft
63. Manufacture of Transport Equipment not classified elsewhere
64. Manufacture of Professional, Scientific, Measuring and Controlling Instruments
65. Manufacture of Photographic and Optical Goods
66. Manufacture of Watches and Clocks
67. Manufacture of Jewellery and Related Articles
68. Manufacture of Musical Instruments
69. Manufacturing of Industries not classified elsewhere
70. Ocean Transport
71. Air Transport
72. Transport not classifed elsewhere
73. Motion Picture Production and Distribution (cf. regional sectors)

...Cont'd

APPENDIX 3 Continued...

National Industries:-

1. Agricultural Services
2. Stone Quarrying, Clay and Sand Pits
3. Salt Mining and Quarrying
4. Manufacture of Miscellaneous Products of Petroleum and Coal
5. Manufacture of Structural Clay Products
6. Manufacture of Non-Metallic Mineral Products not classified elsewhere
7. Electric Light and Power
8. Gas Manufacture and Distribution
9. Steam, Heat and Power
10. Wholesale Trade
11. Banks and Other Financial Institutions
12. Insurance
13. Real Estate
14. Railway Transport
15. Road Passenger Transport, except omnibus operators
16. Water Transport except ocean transport
17. Government Services
18. Research and Scientific Institutions
19. Trade Associations and Professional and Labour Organizations
20. Libraries, Museums and Botanical and Zoological Gardens
21. Community Services not classifed elsewhere
22. Portrait and Commercial Photographic Studios

Regional Industries:-

1. Manufacture of Bakery Products
2. Manufacture of Miscellaneous Food Preparations (only perishable products)
3. Repair of Footwear
4. Repair of Motor Vehicles
5. Construction
6. Water S[illegible]ply
7. Sanita[illegible] Services
8. Retail [illegible]de
9. Tramwa[illegible] Omnibus Operators
10. Road T[illegible]port not classified elsewhere
11. Service[illegible] Incidential to Transport
12. Storage and Warehousing
13. Communication
14. Education Services
15. Medical and Other Health Services
16. Religious Organizations
17. Welfare Institutions
18. Legal Services
19. Accounting, Auditing and Bookkeeping Services

APPENDIX 3 Continued...

20. Engineering and Technical Services
21. Business Services not classified elsewhere
22. Motion Picture Projection (cf. international sectors)
23. Recreation Services except theatres and motion pictures
24. Domestic Service
25. Restaurants, Cafes, Taverns, and Other Drinking and Eating Places
26. Hotels, Rooming Houses, Camps, and Other Lodging Places
27. Laundries and Laundry Services: Cleaning and Dyeing
28. Barber and Beauty Shops
29. Personal Services not classifed elsewhere

APPENDIX 4

EMPLOYMENT IN NATIONAL, REGIONAL AND LOCAL INDUSTRIES IN THE SAMPLE OF CITIES, 1951 AND 1961

Data on employment in industry categories in Canadian cities was obtained from Appendix E Hartwick and Crowley (1973). This data was also tabulated as an Appendix to Grossner (1970).

This information was then processed for analysis in this dissertation. The first step was to allocate each industry category to one of national, regional or local industry groups and then the total employment in each category for the sample of cities and for each city was obtained.

This data was tabulated in two sections:-

(1) Aggregate Data for the sample of cities;

(2) Employment in each of the three industry groups in each city.

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1. AGGREGATE DATA

	1951	1961	Change 1951-1961	Change %
National Industries	444,000	472,722	28,722	6.46
Regional Industries	1,150,085	1,621,350	471,265	40.97
Local Industries	993,704	1,469,763	476,059	47.90

2. INDIVIDUAL CITY DATA [1]

1951

	City	National Industries	Regional Industries	Local Industries	Total Employment
1.	Belleville	525	4549	3269	8348
2.	Brandon	312	4232	3172	7716
3.	Brantford	5669	5537	4806	16012
4.	Calgary	5636	28030	25840	59506
5.	Chatham	1567	3792	3433	8792
6.	Chicoutimi	6553	4275	6105	16933
7.	Cornwall	2808	1546	2373	6727
8.	Drummondville	2778	1119	1734	5631
9.	Edmonton	5168	33817	32648	71633
10.	Granby	3661	2252	2728	8641
11.	Guelph	1770	6792	3423	11985
12.	Halifax	1978	24521	16226	42725
13.	Hamilton	31564	46809	34715	113088
14.	Kingston	1604	7122	5809	14535
15.	Kitchener	10315	14004	11149	35468
16.	Lethbridge	476	4158	4704	9338
17.	London	4478	21313	17102	42913
18.	Moncton	874	5556	4825	11255
19.	Montreal	119234	245226	214499	578959
20.	Moose Jaw	504	5273	3863	9640
21.	Oshawa	7944	5687	4585	18216
22.	Ottawa	6995	65385	42810	115190
23.	Peterborough	1626	9368	4904	15798
24.	Port Arthur	5063	11059	9075	25197
25.	Quebec	15281	43549	39580	98410
26.	Regina	1378	16495	13709	31582
27.	St. Jean	1396	5162	2214	8772
28.	Saint John	1270	10593	7498	19280
29.	St. John's	1121	9772	8149	19042
30.	St. Catharines	4908	5577	5651	16136
31.	Sarnia	4980	4538	4801	14319
32.	Saskatoon	466	11335	9561	11859
33.	Saulte Ste Marie	6097	3009	4098	13204
34.	Shawinigan Falls	5339	2982	4596	12917
35.	Sherbrooke	5186	7089	7286	19561
36.	Sudbury	7741	3566	5729	17036
37.	Sydney	10158	4969	6072	21209
38.	Timmins	4689	1860	3187	9736
39.	Toronto	70141	236201	215241	521583
40.	Trois Rivieres	7730	6850	8707	23287
41.	Valleyfield	4141	1946	2272	8359
42.	Vancouver	16357	109224	85931	211512
43.	Victoria	1258	10090	9564	20912

...Cont'd

44.	Welland	2703	1910	1895	6508
45.	Windsor	24111	20702	20305	65118
46.	Winnipeg	18877	71345	63512	153734

1961

	City	National Industries	Regional Industries	Local Industries	Total Employment
1.	Belleville	447	6540	4442	11429
2.	Brandon	301	5336	4348	9985
3.	Brantford	5280	8646	7292	21218
4.	Calgary	10479	47531	48549	106559
5.	Chatham	1380	4829	4832	11041
6.	Chicoutimi	6326	5766	8713	20805
7.	Cornwall	4175	4038	5453	13666
8.	Drummondville	3536	2231	3427	9194
9.	Edmonton	8503	60300	58604	127407
10.	Granby	3287	3839	3844	10970
11.	Guelph	1936	7920	5959	15815
12.	Halifax	2428	34846	19667	56941
13.	Hamilton	32023	61979	54813	148815
14.	Kingston	1856	10120	8248	20224
15.	Kitchener	9641	22421	19563	51625
16.	Lethbridge	223	6584	6351	13158
17.	London	5226	34153	28629	68018
18.	Moncton	799	8117	6902	15818
19.	Montreal	133411	337251	314350	785012
20.	Moose Jaw	564	6187	4976	11727
21.	Oshawa	9142	6964	7717	23823
22.	Ottawa	6548	94994	61834	163376
23.	Peterborough	1892	8492	6487	16871
24.	Port Arthur	5405	13977	13514	32896
25.	Quebec	14522	57003	51582	123107
26.	Regina	2186	22857	20494	45537
27.	St. Jean	1609	4940	3302	9851
28.	Saint John	1492	10215	8174	19881
29.	St. John's	522	11897	9001	21420
30.	St. Catharines	7904	11353	11307	30564
31.	Sarnia	5298	5312	7518	18128
32.	Saskatoon	539	17867	15725	34531
33.	Saulte Ste Marie	5550	4421	6174	16145
34.	Shawinigan Falls	5368	3208	5279	13855
35.	Sherbrooke	3971	8825	9699	22495
36.	Sudbury	10875	8139	9964	28978
37.	Sydney	7282	6510	6901	20693
38.	Timmins	3975	2157	3650	9782
39.	Toronto	83194	348688	340519	772401

...Cont'd

40.	Trois Rivieres	6407	9238.	10153	25798
41.	Valleyfield	2545	2851	3374	8770
42.	Vancouver	19306	142504	124447	286257
43.	Victoria	963	10280	8635	19878
44.	Welland	3898.	4200	4264	12362
45.	Windsor	14678	25571	26820	67069
46.	Winnipeg	16336	93086	80518	189940

APPENDIX 5

CALCULATION OF DEPENDENT VARIABLE

A. NATIONAL INDUSTRIES MODEL

	City	E_{N1951}	Expected Change in Employment	Actual Change in Employment	ΔE^{*}_{N}
		(1)	(2)	(3)	(3)-(2)
1.	Belleville	525	34	78	44
2.	Brandon	312	20	-11	-31
3.	Brantford	5669	366	-389	-755
4.	Calgary	5636	365	14843	4478
5.	Chatham	1567	101	-187	-288
6.	Chicoutimi	6553	424	-227	-651
7.	Cornwall	2808	182	1367	1185
8.	Drummondville	2778	180	758	578
9.	Edmonton	5168	334	3335	3001
10.	Granby	3661	237	374	137
11.	Guelph	1770	114	166	52
12.	Halifax	1978	128	450	322
13.	Hamilton	31564	2042	459	-1583
14.	Kingston	1604	104	252	148
15.	Kitchener	10315	667	-674	-1341
16.	Lethbridge	476	31	253	222
17.	London	4478	290	748	458
18.	Moncton	874	57	75	18
19.	Montreal	119234	7712	14177	6465
20.	Moose Jaw	504	33	60	27
21.	Oshawa	7944	514	1198	684
22.	Ottawa	6995	452	-447	-899
23.	Peterborough	1626	105	266	161
24.	Port Arthur	5063	327	342	15
25.	Quebec	15281	988	-759	-1747
26.	Regina	1378	89	808	719
27.	St. Jean	1396	90	213	123
28.	Saint John	1270	82	222	140
29.	St. John's	1121	73	-599	-672
30.	St. Catharines	4908	319	2996	2677

...Cont'd

31.	Sarnia	4980	322	318	-4
32.	Saskatoon.	466	30	73	43
33.	Saulte Ste Marie	6097	394	-547	-941
34.	Shawinigan Falls	5339	345	29	-316
35.	Sherbrooke	5186	335	-1215	-1550
36.	Sudbury	7741	501	3134	2633
37.	Sydney	10158	657	-2876	-3533
38.	Timmins	4689	303	-714	-1017
39.	Toronto	70141	4537	13053	8616
40.	Trois Rivieres	7730	500	-1323	-1823
41.	Valleyfield	4141	268	-1596	-1864
42.	Vancouver	16357	1058	2949	1891
43.	Victoria	1258	83	-295	-378
44.	Welland	2703	175	1195	1020
45.	Windsor	24111	1559	-9433	-10992
46.	Winnipeg	18877	1221	-2541	-3762

B. REGIONAL INDUSTRIES MODEL

	City	E_{R1951}	Expected Change in Employment	Actual Change in Employment	ΔE_R^*
		(1)	(2)	(3)	(3)-(2)
1.	Belleville	4549	1863	1991	127
2.	Brandon	4232	1734	1104	-629
3.	Brantford	5537	2269	3109	840
4.	Calgary	28030	11483	19501	5017
5.	Chatham	3792	1553	1037	[illegible]
6.	Chicoutimi	4275	1751	1491	-260
7.	Cornwall	1546	633	2492	1858
8.	Drummondville	1119	458	1112	654
9.	Edmonton	33817	13854	26483	12628
10.	Granby	2252	922	1587	664
11.	Guelph	6792	2783	1128	-1654
12.	Halifax	24521	10046	10325	279
13.	Hamilton	46809	19177	15170	-4007
14.	Kingston	7122	2918	2998	80
15.	Kitchener	14004	5737	8417	2679
16.	Lethbridge	4158	1704	2426	722
17.	London	21313	8739	12840	4101
18.	Moncton	5556	2276	2561	235
19.	Montreal	245226	100469	92025	-8444
20.	Moose Jaw	5273	2160	914	-1246
21.	Oshawa	5687	2330	1277	-1053

22.	Ottawa	65385	26788	29609	2821
23.	Peterborough	9368	3838	-876	-4714
24.	Port Arthur	11059	4531	2918	-1612
25.	Quebec	43540	17838	13463	-4375
26.	Regina	16495	6758	6362	-396
27.	St. Jean	5162	2114	-222	-2336
28.	Saint John	10593	4339	-378	-4717
29.	St. John's	9772	4003	2125	-1878
30.	St. Catharines	5577	2284	5776	3491
31.	Sarnia	4338	1859	774	-1085
32.	Saskatoon	11335	4652	6532	1880
33.	Saulte Ste Marie	3009	1233	1412	179
34.	Shawinigan Falls	2982	1222	226	-995
35.	Sherbrooke	7089	2904	1736	-1168
36.	Sudbury	3566	1461	4573	3112
37.	Sydney	4969	2036	1541	-495
38.	Timmins	1860	762	297	465
39.	Toronto	236201	96776	112487	15711
40.	Trois Rivieres	6850	2806	2388	-418
41.	Valleyfield	1946	797	905	107
42.	Vancouver	109224	44749	33280	-11469
43.	Victoria	10090	4134	190	-3944
44.	Welland	1910	783	2290	1507
45.	Windsor	20702	8482	4869	-3612
46.	Winnipeg	71345	29230	21741	-7489

C. LOCAL INDUSTRIES MODEL

	City	E_{L1951}	Expected Change in Employment	Actual Change in Employment	ΔE^*_R
		(1)	(2)	(3)	(3)-(2)
1.	Belleville	3269	1348	1173	-175
2.	Brandon	3172	1308	1176	-132
3.	Brantford	4806	1981	2486	504
4.	Calgary	25840	10656	22709	12025
5.	Chatham	3433	1416	1399	-17
6.	Chicoutimi	6105	2518	2608	90
7.	Cornwall	2372	979	3080	2101
8.	Drummondville	1734	715	1693	978
9.	Edmonton	32648	13464	25956	12491
10.	Granby	2728	1125	1116	-9
11.	Guelph	3423	1411	2536	1124
12.	Halifax	16226	6692	3441	-3251
13.	Hamilton	34715	14316	20098	5781

...Cont'd

14.	Kingston	5809	2396	2439	44
15.	Kitchener	11149	4598	8414	3816
16.	Lethbridge	4704	1940	1647	-293
17.	London	17102	7053	11527	4474
18.	Moncton	4825	1989	2077	87
19.	Montreal	214499	88459	99851	11391
20.	Moose Jaw	3863	1593	1113	-480
21.	Oshawa	4585	1890	3132	1241
22.	Ottawa	42810	17654	19024	1369
23.	Peterborough	4804	1981	1683	-298
24.	Port Arthur	9075	3743	4439	696
25.	Quebec	39580	16323	12002	-4321
26.	Regina	13709	5653	6785	1131
27.	St. Jean	2214	913	1088	175
28.	Saint John	7498	3092	676	-2416
29.	St. John's	8149	3361	852	-2509
30.	St. Catharines	5651	2330	5656	3325
31.	Sarnia	4801	1980	2717	737
32.	Saskatoon	9561	3943	6164	2221
33.	Saulte Ste Marie	4098	1690	2076	385
34.	Shawinigan Falls	4596	1895	683	-1212
35.	Sherbrooke	7286	3004	2413	-592
36.	Sudbury	5729	2363	4235	1872
37.	Sydney	6072	2504	829	-1675
38.	Timmins	3187	1314	463	-851
39.	Toronto	215241	88765	125278	36513
40.	Trois Rívieres	8707	3591	1446	-2144
41.	Valleyfield	2272	937	1102	165
42.	Vancouver	85931	35437	38516	3078
43.	Victoria	9564	3944	-929	-4873
44.	Welland	1895	781	2369	1587
45.	Windsor	20305	8374	6515	-1859
46.	Winnipeg	63512	26192	17006	-9186

APPENDIX 6

CALCULATION OF INDEX OF METROPOLITAN INFLUENCE

This index was calculated by regressing employment in a typically metropolitan function in each city against city population to remove the local city population effect on employment in that function. This strategy provided a residual value (one that represented the difference between the actual employment and that related directly with the city population). This residual was interpreted as metropolitan activity employment not due to city size and as such was an index of the city's metropolitan influence in an urban system.

This residual value was recorded for each city and entered each model of employment change as the variable METROPOLITAN.

The particular metropolitan activity used to calculate the index was employment in the occupational category "Stock and Bond Brokers" in 1951.

Employment in this category entered the regression reported below as the variable Y. The regression produced the following results:-

$$Y = -27.406 + \underset{(.00005)}{.0006} \text{ CITY POPULATION}_{1951} + \varepsilon$$

$$R^2 = .81$$

The Employment in each city, the Estimated Employment given this model, and the Residual value were tabulated below.

	City	Actual Employment in Stock & Bond Broker Category	Expected Employment in Stock & Bond Broker Category	Residual:- METRO.
1.	Belleville	2	-14	16
2.	Brandon	4	-13	17
3.	Brantford	5	-3	8
4.	Calgary	105	64	41
5.	Chatham	1	-13	14
6.	Chicoutimi	1	9	-8
7.	Cornwall	3	-16	19
8.	Drummondville	1	-17	18
9.	Edmonton	90	86	3
10.	Granby	1	-12	13
11.	Guelph	5	-9	14
12.	Halifax	1	39	-38
13.	Hamilton	67	144	-77
14.	Kingston	9	-5	14
15.	Kitchener	13	88	-75
16.	Lethbridge	15	-12	27
17.	London	37	35	2
18.	Moncton	4	-9	13
19.	Montreal	628	894	-266
20.	Moose Jaw	7	-11	18
21.	Oshawa	3	0	3
22.	Ottawa	44	145	-101
23.	Peterborough	7	-2	9
24.	Port Arthur	7	-2	9
25.	Quebec	76	154	-78
26.	Regina	23	19	4
27.	St. Jean	3	-14	17
28.	Saint John	16	6	10
29.	St. John's	6	7	-1
30.	St. Catharines	7	-2	9
31.	Sarnia	8	-4	12
32.	Saskatoon	23	7	16
33.	Saulte Ste Marie	6	-5	11
34.	Shawinigan Falls	0	-2	2
35.	Sherbrooke	9	6	3
36.	Sudbury	6	1	5
37.	Sydney	6	17	-11
38.	Timmins	2	-9	11
39.	Toronto	1165	710	454
40.	Trois Rivieres	5	15	-10
41.	Valleyfield	1	-12	13
42.	Vancouver	268	323	-55

...Cont'd

43. Victoria	12	6	6
44. Welland	2	-17	19
45. Windsor	38	76	-38
46. Winnipeg	125	206	-81

Sources: For Number of Stock and Bond Brokers: Census of Canada, 1951, Volume IV, Tables 6 and 14.

For Population - see Appendix 2.

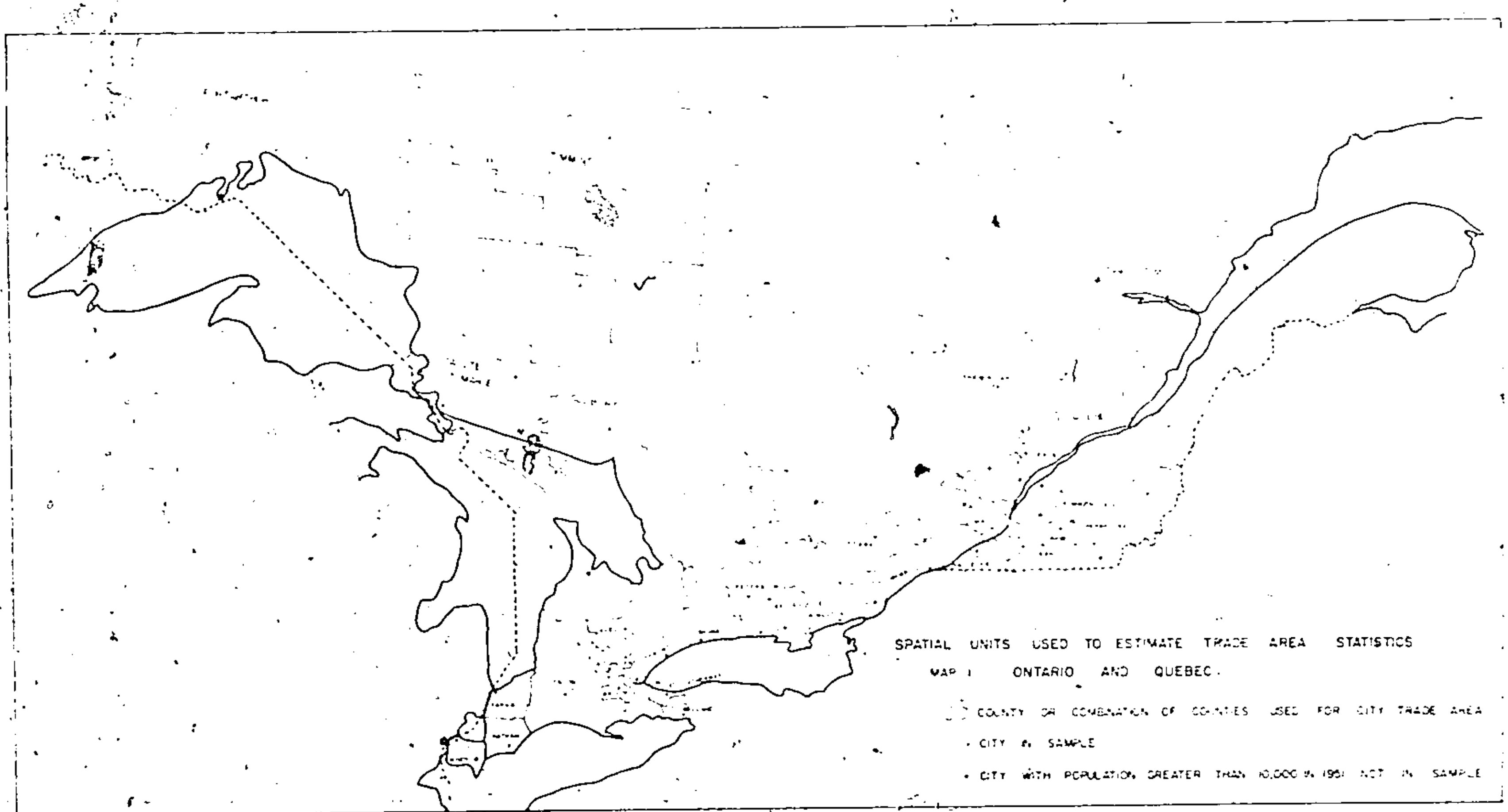
APPENDIX 7

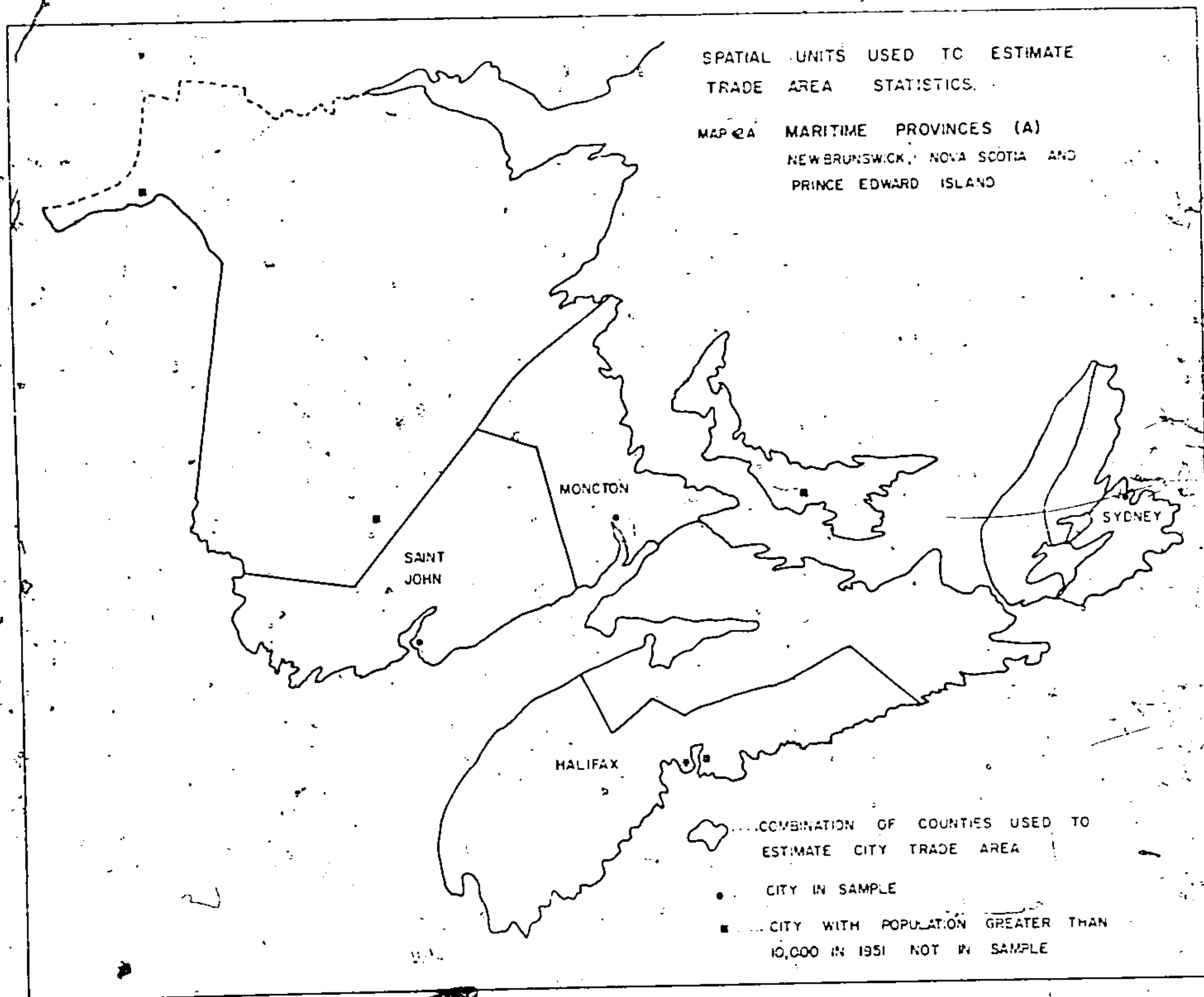
SPATIAL UNITS USED TO ESTIMATE TRADE AREA POPULATIONS IN REGIONAL INDUSTRY MODEL

City	Spatial Units Counties or Census Divisions
1. Belleville	Hastings, Prince Edward
2. Brandon	Manitoba Divisions 3, 4, 7, 8
3. Brantford	Brant
4. Calgary	Alberta Divisions 4, 5, 6 and half 7, 8, 9 British Columbia Divisions 1, 2
5. Chatham	Kent
6. Chicoutimi	Chicoutimi
7. Cornwall	Leeds, Stormont, Dundas
8. Drummondville	Drummond
9. Edmonton	Alberta Divisions, 10, 11, 12, 13, 14, 15, 16 and half 7, 8, 9 British Columbia Divisions 8, 10
10. Granby	Shefford
11. Guelph	Wellington
12. Halifax	Halifax, Digby, Lunenberg, Queens, Yarmouth, Shelburne
13. Hamilton	Wentworth, Haldimand
14. Kingston	Frontenac, Lennox and Addington
15. Kitchener	Waterloo
16. Lethbridge	Alberta Divisions 1, 2, 3
17. London	Middlesex, Oxford, Elgin, Norfolk, Huron, Perth
18. Moncton	Westmoreland, Albert, Kent
19. Montreal	Montreal Island, Chambly; Dexx Montagues, Terreboune, L'Assumption, La Prairie
20. Moose Jaw	Saskatchewan Divisions 7, 8
21. Oshawa	Ontario
22. Ottawa	Carleton, Lanark, Renfrew, Russell, Hull
23. Peterborough	Peterborough
24. Port Arthur	Thunder Bay
25. Quebec	Quebec, Levis, Bellechasse, Portneuf, Dorchester
26. Regina	Saskatchewan Divisions 1, 2, 3, 5, 6
27. St. Jean	Napierville, Iberville, St. Jean
28. Saint John	Saint John, Kings, Queens, Charlotte

...Cont'd

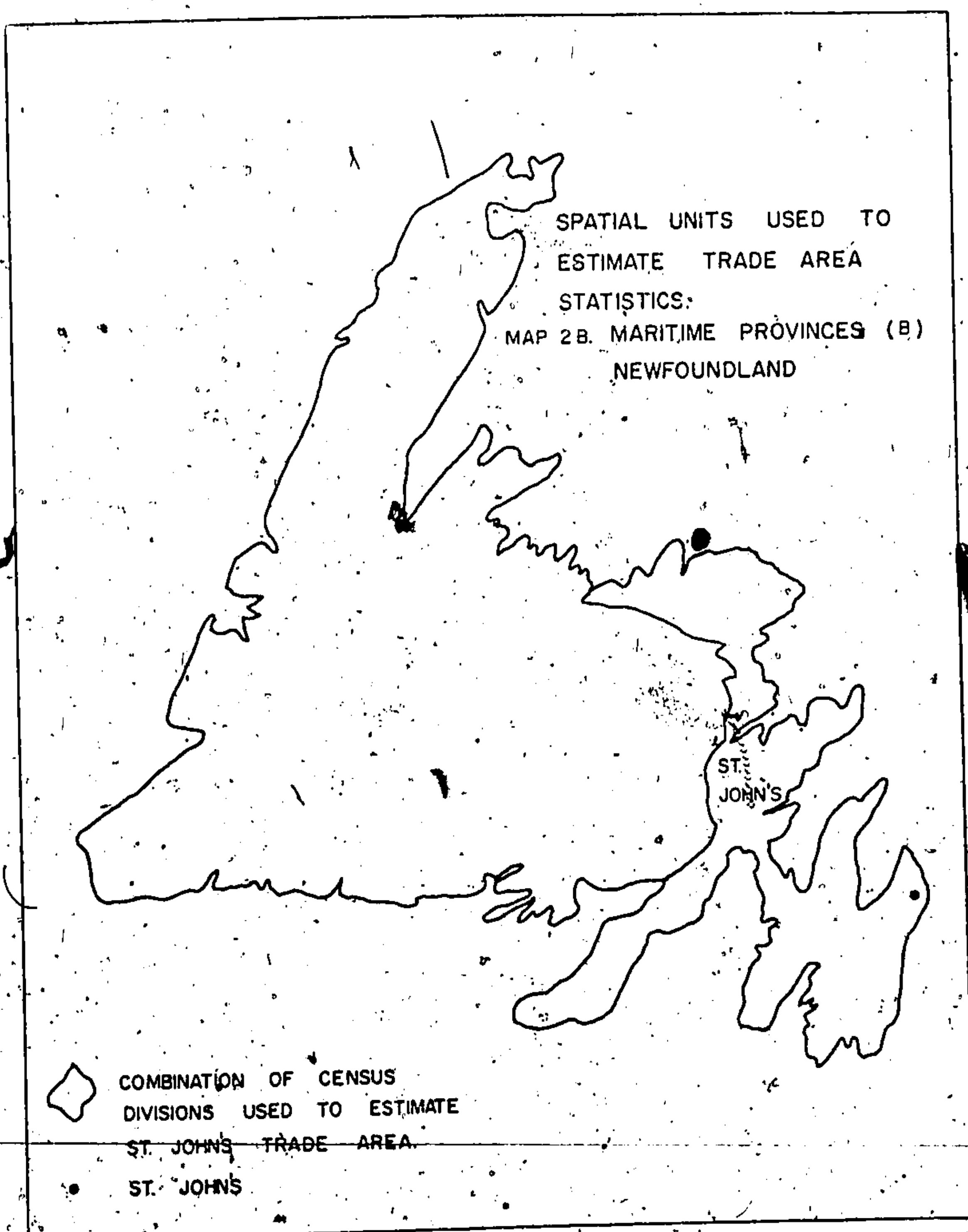
29.	St. John's	Newfoundland Divisions 1, 2, 7
30.	St. Catharines	Lincoln, half of Haldimand
31.	Sarnia	Lambton
32.	Saskatoon	Saskatchewan Divisions 9, 10, 11, 12, 13, 15, 16, 17
33.	Saulte Ste Marie	Algoma
34.	Shawinigan Falls	half of St. Maurice
35.	Sherbrooke	Arthabaska, Wolfe, Richmond, Sherbrooke, Stanstead
36.	Sudbury	Sudbury
37.	Sydney	Cape Breton, Victoria
38.	Timmins	Cochrane
39.	Toronto	York, Peel, Halton, Simcoe, Dufferin
40.	Trois Rivieres	Champlain, Maskinonge, half of St. Maurice
41.	Valleyfield	Beauharnois
42.	Vancouver	British Columbia Divisions 3, 4, 6, 7
43.	Victoria	British Columbia Division 5
44.	Welland	Welland
45.	Windsor	Essex
46.	Winnipeg	Manitoba Divisions 1, 2, 5, 6, 9, 10, 11, 12, 14.


SPATIAL UNITS USED TO ESTIMATE TRADE AREA STATISTICS
MAP I ONTARIO AND QUEBEC.
COUNTY OR COMBINATION OF COUNTIES USED FOR CITY TRADE AREA
CITY IN SAMPLE
CITY WITH POPULATION GREATER THAN 10,000 IN 1951 NOT IN SAMPLE



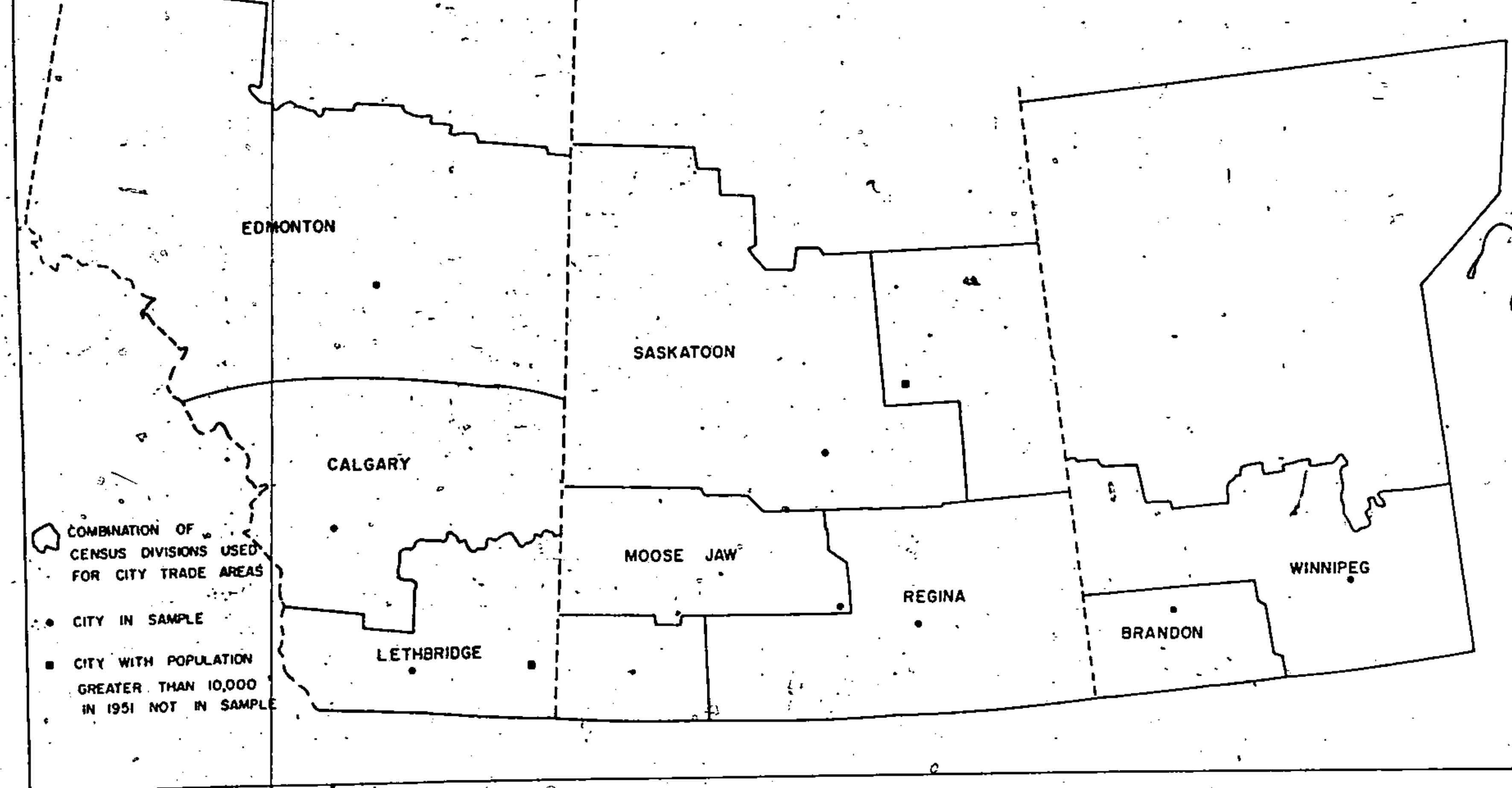
SPATIAL UNITS USED TO ESTIMATE TRADE AREA STATISTICS.

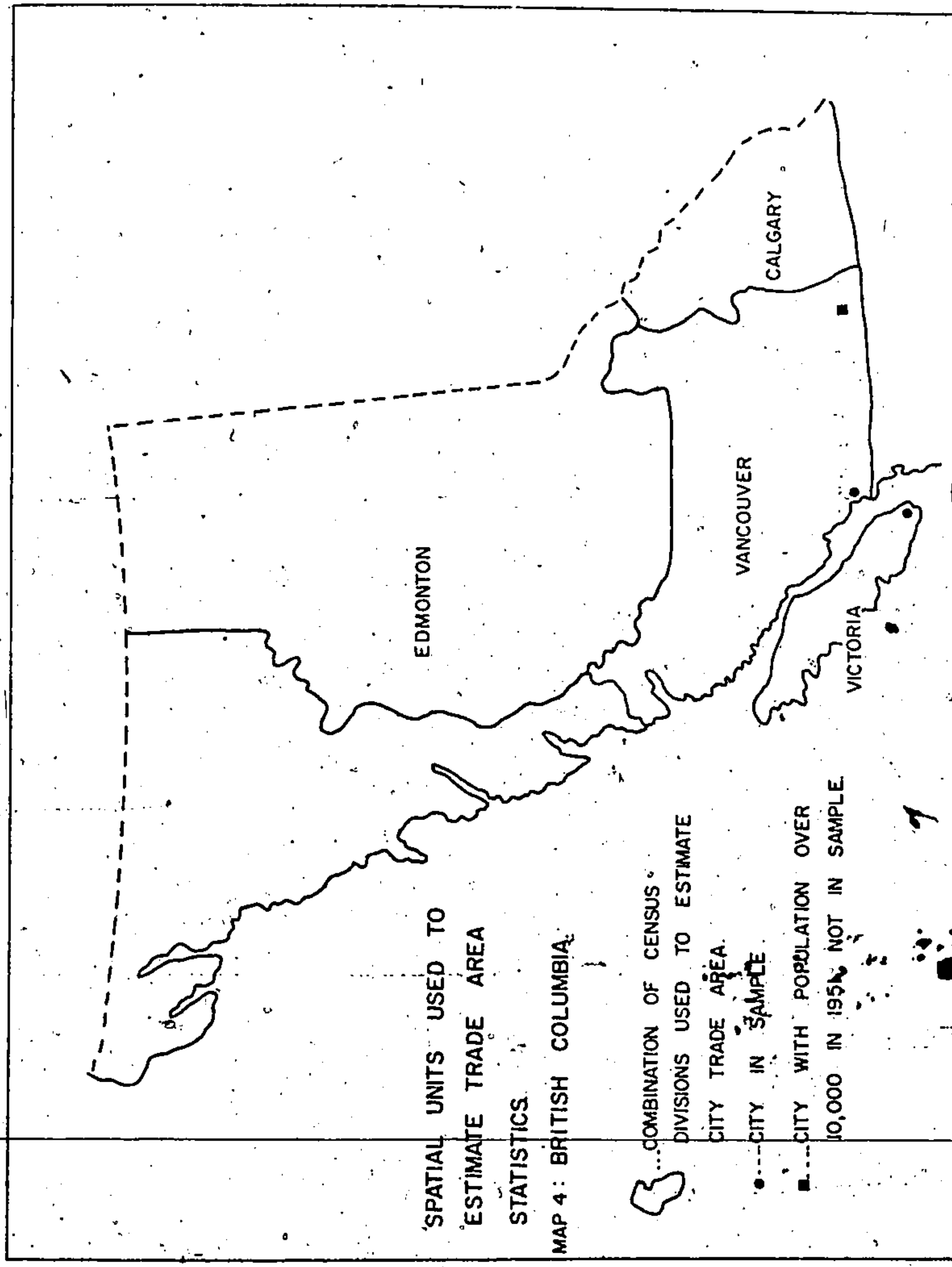
MAP 2A MARITIME PROVINCES (A)
NEW BRUNSWICK, NOVA SCOTIA AND PRINCE EDWARD ISLAND


SPATIAL UNITS USED TO ESTIMATE TRADE AREA STATISTICS:
MAP 2B. MARITIME PROVINCES (B) NEWFOUNDLAND
ST. JOHN'S
COMBINATION OF CENSUS DIVISIONS USED TO ESTIMATE ST. JOHNS TRADE AREA.
ST. JOHNS

SPATIAL UNITS USED TO ESTIMATE TRADE AREA STATISTICS

MAP 3: PRAIRIE PROVINCES.





SPATIAL UNITS USED TO ESTIMATE TRADE AREA STATISTICS

MAP 4: BRITISH COLUMBIA

APPENDIX 8

POPULATION OF TRADE AREAS

	City	1951 Population of Trade Area
1.	Belleville	54779
2.	Brandon	122076
3.	Brantford	36130
4.	Calgary	183257
5.	Chatham	57910
6.	Chicoutimi	60072
7.	Cornwall	47377
8.	Drummondville	43879
9.	Edmonton	395765
10.	Granby	21733
11.	Guelph	39544
12.	Halifax	164566
13.	Hamilton	9928
14.	Kingston	52184
15.	Kitchener	2642
16.	Lethbridge	109608
17.	London	325704
18.	Moncton	89355
19.	Montreal	94494
20.	Moose Jaw	55543
21.	Oshawa	45543
22.	Ottawa	210795
23.	Peterborough	22517
24.	Port Arthur	39259
25.	Quebec	89058
26.	Regina	241265
27.	St. Jean	32107
28.	Saint John	84527
29.	St. John's	154330
30.	St. Catharines	186679
31.	Sarnia	40263
32.	Saskatoon	282826
33.	Saulte Ste Marie	32044
34.	Shawinigan Falls	55863
35.	Sherbrooke	159333

...Cont'd

36.	Sudbury	67180
37.	Sydney	61197
38.	Timmins	56107
39.	Toronto	230537
40.	Trois Rivieres	134337
41.	Valleyfield	16334
42.	Vancouver	225214
43.	Victoria	163672
44.	Welland	107851
45.	Windsor	53532
46.	Winnipeg	229116

Note: Trade Area Population data was calculated by summing Population of Counties or Census Divisions that comprised the Trade Area (Appendix 7) and subtracting Population of the city itself (Appendix 2).

Source: Comparative County Market Data Business Year Book 1952. McLean Hunter, Toronto.

APPENDIX 9

DISTANCE TO CLOSEST LARGER CITY 1951

	City	Closest Larger City	Distance in Miles
1.	Belleville	Peterborough	45
2.	Brandon	Winnipeg	125
3.	Brantford	Kitchener	20
4.	Calgary	Edmonton	180
5.	Chatham	London	50
6.	Chicoutimi	Trois Rivieres	180
7.	Cornwall	Montreal	70
8.	Drummondville	Trois Rivieres	30
9.	Edmonton	Calgary	180
10.	Granby	Montreal	60
11.	Guelph	Kitchener	20
12.	Halifax	Quebec	410
13.	Hamilton	Toronto	40
14.	Kingston	Oshawa	125
15.	Kitchener	Hamilton	35
16.	Lethbridge	Calgary	125
17.	London	Hamilton	90
18.	Moncton	Saint John	70
19.	Montreal	Toronto	300
20.	Moose Jaw	Regina	70
21.	Oshawa	Toronto	50
22.	Ottawa	Montreal	100
23.	Peterborough	Oshawa	45
24.	Port Arthur	Winnipeg	430
25.	Quebec	Montreal	175
26.	Regina	Winnipeg	830
27.	St. Jean	Montreal	25
28.	Saint John	Halifax	125
29.	St. John's	Sydney	350
30.	St. Catharines	Hamilton	40
31.	Sarnia	Windsor	60
32.	Saskatoon	Regina	170
33.	Saulte Ste Marie	Sudbury	160
34.	Shawinigan Falls	Trois Rivieres	30
35.	Sherbrooke	Trois Rivieres	30
36.	Sudbury	Toronto	220

...Cont'd

37.	Sydney	Halifax	200
38.	Timmins	Sudbury	140
39.	Toronto	Montreal	300
40.	Trois Rivieres	Quebec	70
41.	Valleyfield	Montreal	40
42.	Vancouver	Toronto	2100
43.	Victoria	Vancouver	50
44.	Welland	St. Catharines	60
45.	Windsor	Toronto	210
46.	Winnipeg	Toronto	1000

Distances were measured as straight line distance between the two cities.

APPENDIX 10

CALCULATION OF ESIMATED CITY INCOME 1951

An estimate of City Income 1951 was made by calculating Income per Head in the county, or counties, surrounding each city; and multiplying this amount by the Population of the City (Appendix 2).

The data on County Incomes and County Population were tabulated below.

	City	County Income $000	County Population	Estimated City Income $000
1.	Belleville	32912	74298	22410
2.	Brandon	17355	40791	8779
3.	Brantford	44456	72857	22410
4.	Calgary	140900	195352	102646
5.	Chatham	32783	79128	8790
6.	Chicoutimi	19813	115904	9557
7.	Cornwall	19690	48456	6866
8.	Drummondville	10083	53426	2706
9.	Edmonton	128494	226199	100422
10.	Granby	11087	43722	5573
11.	Guelph	29092	66930	11903
12.	Halifax	75062	162217	46562
13.	Hamilton	231105	266083	243447
14.	Kingston	33172	66099	16791
15.	Kitchener	87547	126123	53174
16.	Lethbridge	40907	35879	26162
17.	London	100670	162139	59197
18.	Moncton	29983	80012	10242
19.	Montreal	921380	1503443	998570
20.	Moose Jaw	19808	50421	9568
21.	Oshawa	45682	87099	21792

...Cont'd

22.	Ottawa	174281	334829	152235
23.	Peterborough	34965	60789	22013
24.	Port Arthur	68277	105367	42837
25.	Quebec	81885	252890	89446
26.	Regina	68944	113614	43278
27.	St. Jean	10452	28702	7030
28.	Saint John	35148	74497	23674
29.	St. John's	21330	149543	7541
30.	St. Catharines	54421	89366	23131
31.	Sarnia	35278	74960	16329
32.	Saskatoon	41817	84365	26403
33.	Saulte Ste Marie	39017	64496	19631
34.	Shawinigan Falls	36053	93855	14594
35.	Sherbrooke	22925	62166	18638
36.	Sudbury	66832	17036	25863
37.	Sydney	45328	120306	25366
38.	Timmins	41028	83850	13574
39.	Toronto	1102286	1282295	1133885
40.	Trois Rivieres	36053	93855	24869
41.	Valleyfield	13174	38748	7620
42.	Vancouver	437681	649238	378842
43.	Victoria	129206	215003	30847
44.	Welland	84170	123233	10506
45.	Windsor	154174	217150	116166
46.	Winnipeg	257994	382583	278846

Source: For County Income and County Population: Comparative County Market Data 1951. Business Yearbook MacLean-Hunter, Toronto, 1952.

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