SPATIAL AND TEMPORAL PATTERNS IN SHORT TERM EMPLOYMENT CHANGE WITHIN THE SOUTHERN ONTARIO URBAN SYSTEM

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ABSTRACT

"Regional growth theory requires the explicit introduction of two fundamental dimensions - time and space. The time dimension was successfully brought into economic theory with the release of Keynes' assumption of a constant production capacity. Model building in the field of growth theory of national economics continues to achieve high levels of theoretical sophistication, including the empirical application of rather abstract models. Independent of these striking developments in dynamic analysis was the introduction of the spatial dimension, mainly through the work of Walter Isard in the late 1950's. These two fundamental innovations, however, failed to be integrated. Growth theory formulated its models for a wonderland of no spatial dimension, and regional science did not bother to introduce the time dimension." (Siebert, 1969, pp. 5 - 6).

The importance of incorporating temporal dynamics into building urban and regional planning models is becoming increasingly recognized. Forrester's (1969) urban dynamics model, which gives a purely temporal, non-spatial simulation

model of the city is one example of this line of development. The Lowry (1964) model of urban land use has been given a number of temporal reinterpretations such as the Tomm and Empiric models (Lowry, 1967). A third approach is the work focussing on the spatial transmission and description of business cycle impulses in urban and regional economic systems. The present study falls in line with the last approach. It involves an empirical identification of the variations in the timing and intensity of employment fluctuations existing among cities in Southern Ontario.

Economic change or growth in one urban place is viewed as, at least, a partial function of changes taking place elsewhere in the urban system. The structure of urban interdependencies is conditioned by the frictions of distance, by the existence of urban size thresholds and hierarchies and by inter-market, industrial and financial linkages. These spatial relations are examined in reference to growth pole theory and to the literature on economic fluctuations in urban/regional systems. Some spatial considerations in growth pole theory are discussed first, followed by a review of a number of limitations and neglected issues found in the empirical research. Based on this theoretical and empirical review, the study attempts to show how an analysis of urban short run phenomena such as cyclical fluctuations is related to growth pole theoretical constructs and how it is useful in the empirical testing of growth pole processes and in planning applications.

A conceptual framework is then outlined, structuring the way economic impulses are generated through national, regional and local mechanisms and transmitted through the urban system and how the impacts of these impulses on urban centres vary in intensity and timing. From this conceptual framework, three analytical procedures for examining certain questions about change in an urban system and for investigating spatial interdependencies in urban short run economic behaviour, are outlined. First, factor analysis as a technique for studying spatial--temporal patterns in the intensity and timing of growth among cities is presented. Second, a model that deals with the decomposition of urban time series data into three components, a long term growth trend, a national cyclical component and a regional component, is presented. Third, a model for testing for spatial-temporal growth trends (polarization trends) at the regional level is developed. Time series data, consisting of monthly industrial composite employment indicies for a five year time period from January, 1968, to December, 1972, for 29 cities in Southern Ontario, are applied to the analytical methodologies. The monthly observations are seasonally adjusted, using dummy variables and least squares multiple regression. Some concluding statements are made in the final chapter.

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CHAPTER I

INTRODUCTION

The rapid urbanization in Canada, particularly during the post-war years, and the consequent problems of congestion, pollution, unstructured urban sprawl and the general depreciation of the "quality of life" at the metropolitan level and of spatial disparities in levels of economic development at the national level, will be matters of increasing urgency during the decades to come. As a result of this disorderly and unbalanced growth, there has been accelerated interest in systematic and continuous research on the Canadian urban system as well as in particular sub-national systems. It has been realized by both federal and provincial policy makers that "the only meaningful conceptualization of the urban problem is the one that sees it in terms of the urban system itself" (Lithwick, 1970, p. 45). In the Ontario context, the "Design for Development" which is structured around the key concept of a "Toronto Centred Region" is concerned with regulating and altering the directions of growth within the urban systems of Ontario.[1] Of

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1. See Design for Development: The Toronto Centred Region. Toronto: The Queens Printer and Publisher, 1970.

particular interest in this study is the importance given to the role of growth centres or "Centres of Opportunity" in the planning policies. Thoman expresses the general intent as follows:

> "The recognition of systems of urban centres functionally related to each other and of the key role of growth points, enables the provision of assistance to slow growth areas through tapping of the dynamic energy of the growth areas." (Thoman, 1969, p. 11).

It is evident from the above planning concepts that the efforts of geographers in the area of systematic research, particularly with respect to the investigation of spatial patterns of economic interaction, intercity relations and urban growth, will represent an important input into the planning process. A considerable amount of literature has accumulated, especially during the last decade, relating to spatial, structural and growth characteristics of the Ontario urban system. An excellent source of this ongoing research is found in a collection of papers completed in the Department of Geography, University of Toronto and edited by L.S. Bourne and R.D. MacKinnon (1972).

Unfortunately however, most of the geographic research have been exercises in comparative statics rather than dynamics. This emphasis on the static structure of urban systems may be attributed to two main factors: 1) the conceptual and theoretical formulations which have dominated urban geography research over the past decade or so and; 2) the lack of good time series data and mathematical and statistical techniques used to test the theory.

Considering first the theoretical limitations, central place theory has become a traditional framework by which geographers have examined regional systems of cities (Thoman and Yeates, 1966; Marshall, 1969). However, central place theory is essentially a static formulation lacking any truly dynamic dimension (King, 1971, p. 9). Further, central place analyses are also limited in scope because of their overwhelming emphasis on the tertiary sector of the economy, arguing that the size, function and spacing of urban centres are determined by the demands for tertiary services and goods in the city's hinterland. On the other hand, supply considerations of the market system are virtually ignored. It is only recently that central place theory has been able to provide constructs in the dynamic analysis of urban systems as found in the spatial diffusion studies by Berry (1972, 1973) Hudson (1972) and Pred (1971).

Similarly, export base theory which attempts to explain economic growth in terms of industry mix and multiplier effects lacks an adequate temporal dimension. Maxwell (1965), Hartwick and Crowley (1972) utilize export base concepts in their studies on Canadian urban systems. However, export base analysis, which begins with the very troublesome assumption that it is possible to divide firms into either basic or non-basic industries do not explain the kinds and quantities of commodities that a city or region will export over time. Furthermore, a fixed multiplier between exogenous changes in export demand and induced changes in local employment is often assumed.[2] It has been stated that export base theory is appropriate for analyzing long term economic growth but Massey (1973, p. 7) argued that "short term fluctuations and the constant state of disequilibrium may seriously distort the particular value of the basic service ratio at the base year."

The second major factor for the static framework in urban systems analysis referred to above is that of data availability and related statistical techniques. It is not surprising that most research in Canadian urban systems has been static and cross-sectional in nature given the low quality of urban economic data. The lack of spatially, temporally and sectorally disaggregated data has long hindered

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2. See, for example, Yeates and Lloyd (1969).

geographers' analyses of urban systems. As a result of this data insufficiency as well as the static theoretical formulations, most empirical tools such as shift/share analysis, factor analysis and regression analysis have also been limited to static applications, the underlying assumption being that a cross-sectional analysis is "logically viewed as the cumulative outcome of a series of development processes up to that point in time" (Bourne and MacKinnon, 1972, p. 51).

The outcome of the above limitations is that there exists numerous studies concentrating on the classification problem of identifying groups of cities with similar growth and structural characteristics, most often through factor and principal components analysis.[3] However, inferences on the nature of causal influences operating within the urban system can only be speculative since the time dimension is ignored. This problem is further accentuated in classification studies since the grouping of cities according to some index of similarity, such as factor loadings, need not be spatially continuous.

Some studies have attempted to relate the urban system to the growth processes in Ontario by incorporating a

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3. Studies concerned with the classification problem using factor analysis include Hodge (1966), King (1966, 1967), Britton (1972), Bunting (1972) and Barber and Britton (1971).

time dimension. In these studies, temporal change is taken into account only by including variables relating to levels or rates of change, as for example, percentage population growth (Golant, 1972; Barber and Britton, 1971), labour force growth (Crowley, 1971) or level of in-migration (Siegel and Woodyard, 1971). Another approach is to compare urban economic characteristics or groupings of cities between discrete points in time (Bunting, 1972; King, 1966, 1967). Hartwick and Crowley (1972) and Hodge (1972) utilized shift/share techniques to investigate components of urban growth but such an analysis "yields little insight into the detailed form of regional growth as it occurs over time and cannot provide any useful information on the variable responses of different cities and regions to economic fluctuations occurring over time" (King, Casetti, Jeffrey and Odland, 1972, p. 37).

The above studies have yielded little information about the functioning of the urban economic systems and to the understanding of intercity relations and interdependencies, not only in a spatial but also in a temporal framework. The use of "place particular" characteristics instead of flow or interaction data does not allow for any conclusions to be made on interurban interaction. It is worth noting that Lithwick (1970, p. 50) makes a similar point arguing that "an approach ... that fails to see the impact of city A on city B, and through it the feedback into the whole urbanization process -- ultimately will be unable to cope meaningfully with urban reality." Collins (1972, p. 20) also expressed the same argument stating that the "interplay of economic and social forces is too complex to be formulated within the simple cause and effect relationship of a deterministic framework; yet it is precisely this static framework that has been employed to model the economic landscape."

There are a few examples in the Canadian literature which have explicitly analyzed spatial interaction. Thoman and Yeates (1966), Carol (1969), Marshall (1969) and Ray (1968) investigated consumer shopping behavior to delimit functional regions, applying certain central place theoretical notions. Simmons (1972) also attempted to identify inter-city relations in terms of regional hierarchies by analyzing interaction data consisting of telephone messages, airline traffic and commodity flows. Flow data consisting of manufacturing plant movement has been utilized to investigate industrial migration patterns by Collins (1972), Kerr and Spelt (1960), Field and Kerr (1968) and Ray (1965). Apart from the latter four, these studies are also limited by their static framework as are the classification studies.

Whereas these studies have been useful, to some degree, in understanding of the direction and intensity of interaction, they offer little insight into the timing of interaction or into the economic linkages between cities. As a result, the delimited functional regions tend to be descriptive and are limited in the structuring of regional planning policies. On the other hand, the industrial migration studies do incorporate a temporal dimension in their analysis; however, the emphasis has been on structural change in the urban system, that is, on "permanent" changes, concentrating more on industrial locational factors rather than on spatial interaction or interdependencies.

In all these "interaction" studies little is known about the more intangible flows such as economic (forward and backward) linkages or changes in supply-demand functions not only over space but also over time, within the Ontario urban system. The purpose of this study is to study the spatial-temporal patterns of economic fluctuations in the Ontario urban system using growth centre theory as the conceptual framework. The problem is to study the role of the urban centre and the urban system in the generation, transmission and absorption of short run phenomena or economic impulses (that is, urban business cycles as manifested by local monthly employment levels). The underlying objective is to identify patterns of economic interaction in the defined urban system. As such, the present study falls within the ongoing research of investigating the economic characteristics of the Ontario urban system. However, it differs from most of the other empirical research, not only in the Canadian context but also in geography generally, in two significant ways. First, the time dimension is explicitly introduced by developing and testing models of intercity relations and interdependencies that deal not only with variations over space but also over time. Second, the study is concerned with 'intangible' industrial and financial linkages, a theme which has received considerable attention in growth pole theoretical discussions but which has received little attention in the empirical research literature. Regional business cycles is a well established research theme in the field of economics (for example, Vining, 1946, 1949; Borts 1960; and Brechling, 1967) but the study of urban business cycles or the "geography of business cycles" has only recently received awareness.[4] Nevertheless, the importance of urban business cycles in Canadian geographic literature has been hinted at by Barber

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4. The literature on urban business cycles is reviewed in the following chapters.

(1972, p. 160) who noted that growth in urban systems is a continuous process and that the analytical techniques used such as discriminant analysis, "cyclical or other temporal variations in both the growth process and the variables used to identify the causal factors are ignored."

The importance of business cycle impulses in the Ontario economy is more clearly evident in the following account on the General Motors strike during the latter months of 1970 as reported in the Ontario Manpower Review:[5]

> "The effects of the dispute have not been confined to General Motors, but have permeated most sectors of the economy. Some 4,000 companies in Canada supply General Motors with input ranging from semi-processed materials to auto parts and the stoppage has reduced daily shipments to General Motors by about $3.4 million. Layoffs have been extensive." (September-October, 1970, Vol. 3, No. 5, p. 12)

> "The automotive feeder industries have been severely affected by the decline in orders from automobile manufacturers. The industry is widely represented throughout Central Ontario, with production ranging over car radios, seat belts, bumpers, windshields, sealers, panels automotive trim and metal stampings, polyurethane foam and plastic products, hoses, foam rubber and automatic components, wiring harness, steering wheels,

5. Ontario Manpower Reviews are published bimonthly by the Manpower Information and Analysis Branch of the Ontario Region, Department of Manpower and Immigration, Toronto.

carburetors, head lights, wheel discs, mufflers and car upholstery. The employment outlook is poor for unskilled and semi-skilled workers in this industry as most firms have been compelled to lay off staff. The hardest hit firms were Dual Specialties Ltd., Collingwood, with over two hundred on lay-off; Davidson Rubber Company Ltd., of Port Hope, with 117 production workers laid off; Decor Metal products Ltd., Midland, 78 employees; Whitaker Cable Corporation Ltd., Owen Sound, 76 female workers; ... ."
(January-February 1970, Vol. 3, No. 1, p. 12)

The above account clearly indicates the impact which short-run phenomena may have on economic activity levels in an urban system and vividly portrays the economic linkages that tie together the interurban economic system. It provides an excellent example of what Haggett (1972, pp. 434 - 435) refers to as the multi-level, multi-national multi-sectoral diffusion of an economic shock. A total of 23,626 workers were directly involved by the General Motors strike [6] and if employment cutbacks in related or linked industries could be added, this figure would be much greater. Between the years 1968 and 1971, a total of 932 strikes and lockouts, of which 599 were in the manufacturing sector, occurred in Ontario, involving 428,191 workers (294,727 in manufacturing)

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6. Strikes and Lockouts in Canada, 1971, Labour Canada, 1973, p. 62.

and lasting altogether, 12,141,140 man-days (8,144,730 in manufacturing).[7]

The present study focusses on the simpler aspects of change in an univariate series (industrial composite employment indices) and concentrates on the identification of spatial interrelationships. The patterns of impulse transmission and interaction are not well known but are of considerable interest, both in theory and planning. This study uses growth pole theory as the conceptual and theoretical framework for the analysis. Growth pole theory is particularly appealing in this context, in comparison to other theories of regional/urban economic growth and spatial interaction, for several reasons. First, it draws together two branches of regional analysis which in the past have been pursued independently of each other: analysis of regional economic growth and analysis of the spatial structure of regional economic activity (Parr, 1973, p. 174). Growth pole theory includes not only a spatial but also a temporal dimension in its formulation. "The concept of growth poles considers the process of change and thus has obvious dynamic (or at least strong temporal) implications" (Parr, 1973, p. 192). This dynamic feature represents a valuable framework for

7. See Appendix A.

understanding the dynamics of the urban system.[8] Finally, the growth pole notion has received quasi-official sanction in the context of overall regional policies for Ontario. Therefore, an interpretation of the results presented later in this study is called for if any consideration is to be accorded the results in the context of these planning policies.

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8. The relationship between a study of short term phenomena (such as urban business cycles) and growth pole is discussed in Chapter III.

CHAPTER II

GROWTH AND CHANGE IN URBAN SYSTEMS: A THEORETICAL AND EMPIRICAL REVIEW

Spatial Considerations in Growth Pole Theory and Planning Applications

The growth pole hypothesis was first outlined by Perroux (1955) in an attempt to understand the mechanisms whereby developmental impulses are transmitted across a whole economy. In his formulation, growth poles are economic sectors which exhibit early and robust growth and which exert a positive effect on the growth of linked sectors. It is through the writings of such scholars as Boudeville (1968), Friedmann (1969), Hansen (1968) and Lasuen (1969, 1973) that the spatial dimension has been introduced into the Perrouxian framework. Growth poles, or growth centres,[1] have become identified with urban places which experience growth earlier in time, than neighbouring centres or the surrounding hinterland and which exert a positive effect on the growth in linked or interdependent centres.

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1. The term growth centres has been commonly used in the literature with respect to "geographic space" and growth poles with respect to "economic space" (see Darwent, 1969). In this study both terms are used in the former context.

Growth pole strategies have been firmly espoused by planners in many countries and these efforts have been documented in several publications.[2] However, in many cases, growth pole strategies have failed to achieve their objectives. Hansen (1971, p. 193), for example, noted that "the designated (growth) centres have generally remained stagnant or else the growth which has been stimulated by public measures has not been transmitted to the surrounding hinterland." Lasuen (1973, p. 137) remarked that "when the concept is used in planning, the failures of the policies centred upon it are normally attributed to the ways and means by which it has been implemented, never to the inadequacy of the concept itself." It has been argued that these inadequacies in growth pole policy may be traced to the shift from economic to geographic space and the failure to maintain the dynamic aspects of the original theory (Lasuen, 1969; Hansen, 1971; Thomas, 1972).

King (1973) identified four elements which must be incorporated into a spatial growth pole theory. The four elements are briefly discussed below.

(i) "A spatial growth pole theory will begin with the specification of some form of a

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2. See; Hansen, 1971 and various mimeographed publications of UNRISD Programme IV - Regional Development.

> spatial system within which the different processes come into play." (King, 1973, p. 4).

According to King, two alternative assumptions may be considered. First, the formulation might begin with the assumption of a Von Thunen-type system in which there is one urban centre and the surrounding agricultural region. The second alternative may begin by assuming a set of cities which are interconnected and perhaps interdependent.[3] This set of cities may be further conceptualized in two alternative frameworks. First, a unipolar economic landscape may be assumed in which the growth rate and the spatial transmission of growth impulses (i.e., spread and backwash effects) at each centre within this landscape depends only upon distance from the given growth centre, thereby resulting in a concentric gradation of growth levels and in single-pole sub-regions. (Robinson and Salih, 1971; Casetti, King and Odland, 1970). Second, a system of multiple growth centres of varying size and importance may be assumed in which case at least some of the points in the region are affected by more than one pole. "A hierarchy characterized by different orders of poles, with fewer poles of higher order exercising a stronger influence

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3. King, Casetti and Jeffrey (1969) begin with this assumption.

further away, and with poles of higher order tending to be evenly spaced, would eventually tend to produce a 'landscape' of the type that is postulated by central place theories" (Casetti, King and Odland, 1971, p. 378).

It has been hypothesized in the literature that the transmission of economic impulses are far stronger between urban centres than between an urban centre and its hinterland (Nichols, 1969(b); Berry, 1969). Friedmann (1966) also recognized the importance of an urban system arguing that growth is transmitted through an "urban matrix" and that economic development is closely related to the emergence of a highly developed and interconnected functional hierarchy of cities. Nichols (1969b, p. 207) offers further support by stating that "it seems probable that the propulsive influence of a growth pole is felt first in other major towns in the region and in the rural area immediately surrounding the growth pole, and then eventually spreads from these urban centres to the other interstital areas."

(ii) "Given the assumed spatial setting which presumably is in some sort of initial equilibrium, then the growth pole theory will have to state how disequilibrium is induced. For this is certainly what the growth pole hypothesis is about, namely that some form of disequilibrium is introduced which generates flows or

> spread effects out from the growth pole
> and presumably continues until equilibrium
> is restored." (King, 1973, p. 5).

Spatial growth pole theory in its simplest form depicts the transmission of economic prosperity as the result of two opposing forces. On the one hand, "polarization" (Hirschmann, 1958), "backwash" (Myrdal, 1957) or "reinforcing" (Siebert, 1969) effects tend to accentuate spatial disparities in growth rates or levels of economic development since they relate to the tendency of growth factors (for example, skilled labour, capital) to be drawn from the "periphery" to the "core". On the other hand, "trickling down" (Hirschmann, 1958), "spread" (Myrdal, 1957) or "withdrawl" (Siebert, 1969) effects tend to bring about equalization of growth rates over space and time. This duality between centrifugal and centripetal growth processes is demonstrated in the "centre-periphery" or "cumulative-causation" models developed by Hirschmann (1958), Myrdal (1957) and Friedmann (1966, 1969).

Several channels of impact or spread and backwash mechanisms, through which equilibrium is achieved, have been discussed in the literature. The triggering mechanisms for the generation of spread and backwash effects may be i) economic such as expanding job markets, increased demand for agricultural products, manufactured goods, services and so on, differential wage rates, attractiveness of urban centres to entrepreneurs because of economies of scale, uncertainty or alternatively, the unattractiveness of urban centres because of congestion, land costs, pollution and so on; or, ii) social and political. (Nichols, 1969(b); Hermansen, 1972; Siebert, 1969; Thomas, 1972; Morrill, 1972; Friedmann, 1966, 1969, 1972; and Hirschmann, 1958). According to Siebert (1969), "one of the basic reasons for a growth pole to arise is the immobility of at least one growth determinant" (p. 191), and "only these mobilities can explain the location of the key industry and its development" (p. 192).

In summary, equilibrium and disequilibrium models of change depend on the existence of recognizable processes that either reduce or intensify spatial variations in change (timing and intensity). The equilibrium - disequilibrium nature of urban systems change is not a settled topic in geography and regional analysis. Nevertheless, it becomes necessary to study the interdependency patterns of urban centres in order to cast some insight into the spatial equilibrium nature of change.

(iii) "Once a spread effect is postulated then it is essential to allow for the dampening down of this process as it occurs over time and space. In other words, in what way is the effect at different points in the system especially as regards the intensity and the timing of its impact. (King, 1973, p. 7).

Whereas the second component was concerned with the generation and transmission of growth impulses, the third spatial element is related to the spatial/temporal incidence of growth impulses. In general, the interaction between spread and backwash effects will determine the level of development at any point in the spatial system. In turn, the spatial distribution of these levels will depict a 'development surface' or 'economic landscape'. The form of this surface will be dependent on the number and spatial distribution of growth centres, the strength of the influence that each of them exercises and the distance decay of such influences (Casetti, King and Odland, 1971, p. 378). Economic interdependence, hierarchical linkages and distance decay effects all determine the timing, direction and intensity of spatial interaction. Nichols (1969(b), p. 195) for example, noted that "the associations between one town and another will also vary according to the type of region." Therefore, if the economic base of an area is industrial, cities may have developed substantial functional and transportation linkages with other centres. However, if a city's economic base is dominated by industries dependent on 'extra-regional' demand (that is, national or international demand) as is the case for cities based on mineral exploitation, growth impulses are not transmitted to the surrounding region and the urban centre may become an enclave of economic growth, relatively autonomous of regional or growth pole processes (Stohr, 1972, p. 9; see also Berry, 1973, p. 7).

> (iv) "Finally, assuming that the spatial growth pole theory combines all of the above elements, then it should be possible to develop normative models to answer certain specific questions." (King, 1973, p. 7).

For example, growth pole theory in its present form, is unable to answer, with any degree of confidence, questions such as what is the necessary level of and phasing of investment required in a designated growth pole to raise income or employment levels in centres within the spatial system.[4]

Limitations and Neglected Issues in Growth Pole Research

The problem of testing, through quantification and mathematical operationalization, some of the spatial aspects

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4. For a more detailed discussion of the problems of growth pole theory in the formulation of planning strategies, see; Cameron (1970), Darwent (1969) and Nichols (1969(a).

of growth pole theory has been noted by several authors. Hoover (1969) for example, presented the following argument:

> "We do not yet know much in which favourable economic effect is propagated from an urban centre to the surrounding territory or the range and speed of the various impacts." (p. 352).

Similarly, Nichols (1969(b), p. 194) observed that "the question of whether or not growth will diffuse outward into the surrounding region, however, has hardly been touched to date." This lack of empirical observation may be attributed to two related problems: (1) the increasing generalization and elusiveness of growth pole concepts making practical application on a scientific basis difficult (Hermansen, 1972, p. 161) and; (2) the unsatisfactory available methods for determining whether spatially polarized growth did occur in a given context or for identifying growth centres (Casetti, King and Odland, 1971, p. 377).

Two distinct problems in growth pole research may be identified: (1) the identification of growth centres in geographic space and; (2) the testing of hypothesis that polarized growth did occur with respect to exogenously given poles (Casetti, King and Odland, 1970, p. 379). Each problem in turn, may be approached in one of two ways (Moseley, 1973(a);

1973(b)). First, the researcher may investigate the processes, spatial flows or channels of impact through which spread effects may operate. Alternatively, he may examine the spatial pattern or "shape" of the development surface in which the "height" of this surface at each observation (i.e., urban centre) is determined by its past growth performance measured by some surrogate index such as population change or by a multi-variate index. Berry's "gradients of urban influence" typify this approach (Berry, 1969, 1973).

In the "Design for Development" policies for Ontario, five major considerations were suggested for identifying potential "Centres of Opportunity":

> "The first involves the size of each centre and its associated urban area. A second is the past rate of growth, particularly of the centre but also of the adjacent areas. A third is the inter-industry mix within the center and the trends in this mix. The fourth is concerned with the infra-structure of this potential growth point ... The fifth involves transportation and communication linkages among growth points." (Thoman, 1969, pp. 17 - 18).

On the basis of these considerations, centres such as Barrie, Midland, Port Hope - Cobourg, Burlington, Hamilton, St. Catherines and Simcoe have been identified as centres having the greater potential for development.[5]

It is beyond the scope of this paper to review the empirical studies in the growth pole literature. The interest in this section will be focussed on some of the neglected issues and limitations in the research literature.

Most of the empirical literature have been cross-sectional and static in nature. Temporal change is taken into account only through the inclusion of variables relating to the levels or rates of change from one point in time to another. Berry (1973), for example, used per cent population change between 1960 and 1970, median income levels in 1960 and 1970 and immigration rates, 1960 and 1970 to analyze growth patterns in the United States.[6] However, little is known about the speed of transmission of economic change from the study. Lasuen (1973) suggested that, in order to achieve a spatial-temporal conceptualization, spatial economic analysis must be combined with temporal economic analysis.

Related to the above approach, several studies have been concerned with the problem of identifying growth centres.

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5. See; Design for Development: Niagara (South Ontario) Region. Toronto: Regional Development Branch, 1970, Chapter VII and, Design for Development: The Toronto Centred Region. Toronto, The Queens Printer and Publisher, 1970, p. 3.

6. See also, Moseley (1973(a)) and Semple, Gauthier and Youngmann (1972).

Trend surface analysis is a common statistical tool used to identify "peaks" (which may be interpreted as growth centres) in a spatial series concerned with growth phenomena (Casetti and Semple, 1968; Semple, Gauthier and Youngmann, 1972; Harvey and Greenberg, 1972; and Moseley, 1973(a)). Berry (1973) similarly identified growth centres by exploring the topography in the gradients of urban influence for "peaks" (p. 136). However, such analyses do not yield information about the existence of any spread mechanisms, "nor does it tell us anything about the character of the pole itself other than that it is a peak or a pit in regard to the values of this spatial series" (King, 1973, p. 10). Parr (1973) suggested that the overall effects of a groth pole on its hinterland region changes over time. A sequence of three phases was hypothesized: (1) an initial phase with positive overall effects (spread processes dominate over backwash processes); (2) an intermediate phase during which overall effects would be unfavourable (backwash effect greater than spread effects) and; (3) a final phase in which overall effects are favourable once again (p. 207).

The emphasis on a time dimension leads into another aspect of growth pole theory which has not been clearly defined in the literature: the distinction between growth and development. The terms growth poles (centres) and development poles have both been used in the literature but no distinction between the two have been made except in Lausen's (1973) recent article. This distinction is important in the framework of the present study. Lausen (1973) defined development economics as a long term analysis concerned with structural change and growth economics as a short term analysis focussing on the causes and characteristics of growth in economic/spatial systems, and not on structural change. Similarly, Friedmann (1972, p. 86) defined growth as "an expansion of the system without a change in its structure." He further argued that if growth is allowed to pass through a series of successive structural transformations of the system, development occurs. In the growth pole literature, interest has been on the development economics side. This is not surprising since growth pole theory is most often conceived as the basis for formulating planning strategies concerned with decreasing spatial disparities in levels of development and welfare, a long term perspective. The main point being made in this paragraph is that spread processes (mechanisms of generation, transmission and absorption of growth impulses) and the interpretation of empirical results depend on the type of data used, on the spatial scale (national, regional, urban-hinterland) and spatial system investigated and on the length of time analyzed. It would appear that the interpretation in any empirical study of different trigerring spread mechanisms and the spatial impact of spread processes depends on whether the researcher is concerned with long run development or short run growth. No distinction of this sort has been made in empirical studies. In the present study, the aim is to investigate the "growth economics" through an analysis of urban business cycles. The concern is to examine the spatial transmission of economic fluctuations, and variations in the timing and intensity of growth between cities in Southern Ontario resulting from short run growth forces.

Another limitation in the research literature is that the testing for spread effects has commonly been approached in a single pole spatial system (Nichols, 1969(b); Robinson and Salih, 1971; and Moseley 1973(a), 1973(b)). In such a system, it is assumed that growth at each point depends only upon distance from the nearest pole. However, a more realistic spatial setting would include a system of poles of varying size and importance in which more than one pole affects the growth of at least some of the points in the region resulting in simultaneous multiple polarization patterns (Casetti, King and Odland, 1971).

Studies investigating growth pole effects have also failed to differentiate between national and regional components of growth, as postulated by shift/share analysis. Spread and backwash effects are directly related to regional forces and, therefore, if interest is centred on the analysis of spatial spread processes, the national component of growth must be first removed from the spatial-temporal data series. This argument is referred to again in the following section and in the proceeding chapter.

Finally, empirical studies have concentrated on "permanent" changes in change such as innovation diffussion (Berry, 1972, 1973), population change and so on, and on "tangible" flows (spatial interaction) such as commuting patterns, purchases of industrial materials and shopping patterns (Moseley, 1973(b)). However, short run phenomena and spatial interaction via "intangible" linkages such as industrial (forward-backward) and financial linkages has not received any attention. This neglect is particularly surprising in view of the strong emphasis on notions of 1) forward and backward linkages in relation to the transmission of changes in demand which affect economies of scale and

2) induced growth.

Time Series Analysis of Change in Urban and Regional Systems

It is surprising, in view of the emphasis in the growth pole literature, on forward and backward linkages as related to "propulsive" or "key" industries and on innovation diffusion as proposed in the works by Lasuen (1969, 1971, 1973) and Friedmann (1966, 1969) in particular, and the empirical research emphasis on spatial interaction and diffusion (Berry, 1972, 1973) that the spatial patterns of cyclical interaction and transmission of business cycle impulses has received almost no attention. Nevertheless, there has been in recent years an increasing amount of research in the analysis of economic fluctuations as an approach to understanding spatial interdependencies.[7] The purpose of this section is, first to briefly review this work on urban business cycles and, second, to bring out some arguments which support the use of an urban business cycle approach within a growth centre framework, and to show how the analysis of urban fluctuations in urban systems is able to overcome some of the limitations,

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7. For a more detailed review see; Jeffrey (1970), Bannister (1974) and Sant (1973).

and incorporate neglected issues, discussed in the previous section.

1) Empirical Studies

King, Casetti and Jeffrey (1969, 1971, 1972) have sought to identify variations existing among cities in the United States in the timing and intensity of economic fluctuations. In the original study (King, Casetti and Jeffrey, 1969) an attempt was made to model the transmission of economic impulses through the urban system. A model involving a system of difference equations was outlined and in that model the level of economic activity (unemployment) in a city at time, t, was expressed as a linear function of the corresponding levels for other cities in the system and of exogenous national factors. Some of the implications of the model were tested using lagged correlation analysis on the residuals obtained by regressing each city's economic time-series on the corresponding national series. The residual series were considered to correspond to the regional component of growth. In a later study (King, Casetti and Jeffrey, 1972) the model was extended by incorporating a structural component following Brechling's (1967) original formulation, and a weighted cyclical (national) component.[8] Jeffrey and Webb (1972) also applied the model to the Australian regional system.[9] In the two latter studies, interest was centred only on a discussion of the estimated parameters. Jeffrey (1974) extended the analysis by analyzing the residuals from the regression model using unemployment data for United States cities. Factor analysis was used to investigate the residual time series (that is, the regional economic impulses) and a grouping of cities were identified from the results. King, Casetti, Jeffrey and Odland (1972) also used factor analysis to study variations in the intensity and timing of employment growth among cities in the United States. The analytical procedures used in this study are discussed in the next chapter. Factor analysis was also used in another study by King and Jeffrey (1972). However, this study differed from the preceeding paper in that the analysis was performed on a time series data matrix in which the rows were the time periods and columns were the cities;[10] whereas in the other study

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8. The national time series was weighted by an industry mix factor which removes the possibility that a city's industries have different unemployment rates than the national rate.

9. National series in this study was not weighted.

10. This approach is more typical of other studies using factor analysis. A discussion of the difference between the two approaches is presented in the next chapter.

(King, Cassetti, Jeffrey and Odland, 1972) cities were the observations (rows) and the time intervals were the variables (columns). Factor analysis of the latter data series yielded a set of reference curves or functional relationships in which each regional cyclical component is expressed as a function of the time variable.

A similar line of research focussing on unemployment patterns in certain areas of England has been developed by Bassett and Haggett (1971) and Bassett and Tinline (1970). In these studies, spectral analysis was used to estimate the relevant parameters. Haggett (1971) applied lead-lag correlation and cross-spectral analysis of unemployment time series to investigate interregional connections.

2) Value of Urban Time Series Analysis in Growth Pole Research

The concept of growth poles considers the process of change and spatial disequilibrium and thus has obvious dynamic implications. This section attempts to show how a study of economic fluctuations in urban systems is useful in understanding spread processes, both in a theoretical and empirical context, and how such an analysis may offer valuable information in structuring growth pole strategies.

(i) Theoretical considerations

The first mention of short-run phenomena in a growth pole theoretical context is found in Perroux's classical paper (Perroux, 1955). In his original formulation, Perroux stated that changes in profits, and therefore levels of output, of individual firms are "induced" by the output and input of another firm. Furthermore, the author argues that one consequence for an understanding of growth resulting from this change is that "it shows how short-term expansion and long-term growth of large groups of firms can be brought about" (Perroux, 1955, p. 96).

Perroux's notion of "induced" change is clearly related to interindustry linkages and to unbalanced economic theory as postulated by Hirschmann (1958). Briefly, unbalanced growth theory attempts to explain how and why changes occur in industrial sectors, mainly manufacturing, and therefore, it is a theory of sectoral polarization of growth.

Considerable attention in this area of study is focussed on the key role of certain industrial sectors within the economic system. A study of these industries with respect to the services of input (backward linkages) and the destination of their outputs to other industries (forward linkages) and/or to final demand consumption, reveals the large importance of their high level of technical complementaries. These industries also tend to be large, fast growing and innovative and are called "propulsive industries" by Perroux (1955) and "master industries" by Hirschmann (1958). Such industries, because of their high direct and indirect linkages, would presumably induce the largest growth by increasing outputs and inputs to linked industries.

Given this hypothesis that structural change is based primarily on induced economic growth via technological linkages and the transmission of economies of scale, there is, therefore, utility to view such growth in a short run temporal framework as well as in the long run (Thomas, 1972, pp. 5 - 6). It is worth repeating at this point that growth pole theory and research has emphasized the latter perspective, that is, growth in the long run. Furthermore, empirical studies have only investigated "tangible" flows or linkages (for example, commodity flows) and on permanent changes (i.e., development) and neglected "intangible" flows of economies of scale and growth (i.e., short run change).

One of the most ambitious attempts to interrelate sectoral, spatial and temporal dimensions of growth pole theory is found in a recent publication by Lasuen (1973). The basic argument in Lasuen's discussion was that the analysis of interaction within a system of poles needs to provide three sets of hypothesis:

> "...those explaining the sectoral clusters; those indicating how geographical clusters occur; and those revealing how the interactions between sectoral and geographical clusters result in a system of growth poles." (p. 164).

In an attempt to relate sectoral growth pole theory to a system of growth centres, the author hypothesized the following:

> "(a) The growth pole is a regional (instead of national) sectoral cluster of establishments (instead of industries) linked to a regional export activity (instead of a leading industry) which is located in one or various of the geographical clusters of the region; (b) the system of growth poles, and any one of them, grows through the impulses generated by national demand, transmitted through the regional export activities and adjusted by inter-pole competition; (c) growth is transmitted to the sectoral peripheries of the pole through forward and backward market linkages (instead of input-output linkages) between the establishments, and to the geographical periphery through the effect of the same mechanism corrected by locational factors." (p. 164).

Lasuen further argued that in order to achieve such a conceptualization, two analytical frameworks must be related: 1) urbanization or spatial economic analysis which is concerned with the effect of space on economic relations and, 2) temporal economic analysis which focusses upon the effect of time on economic relations. The temporal framework was further subdivided into two components, development economics or long term analysis concerned with the problem of secular stagnation, and growth economics or short term analysis which originated in response to the need to control business cycles.

Lasuen's study represents one of the few attempts to relate spatial and temporal dimensions in growth pole theory. Unfortunately, the author's primary objective was to relate innovation diffusion processes to the above hypothesis and as a result emphasis was placed on "development economics" rather than "growth economics." Nevertheless, the conceptual framework outlined in this study is directly relevant to a study of urban business cycles. This will become more evident in the following chapter.

(ii) Empirical considerations

Despite the increasing number of studies testing growth pole concepts, Hoover's (1969, p.352) observation, quoted earlier, that "we do not yet know much in which favourable effect is propagated from an urban centre to the surrounding territory or the range and speed of the various impacts still stands. Through the analysis of urban business cycles it is possible to gain greater insight into the processes of regional change and development (Sant, 1973, p. 1). This statement may be supported on two arguments. First, empirical research up to date has generally been cross-sectional and static in nature as have been most studies in geography. There exists a need to reformulate research statements about variations in spatial structure and intercity relations to include not only the spatial dimension but also a temporal one (King, 1971, p. 13). An analysis of economic fluctuations in urban systems is able to incorporate both prerequisites.

Second, an analysis of the spatial transmission of economic fluctuations falls in line with the well established theme in urban geography and growth pole research of investigating the economic characteristics, and spatial interaction within, regional systems of cities. The spatial transmission of cyclical impulses through a system of cities can be identified with the second component of spatial growth pole theory discussed in the second chapter. Suppose that some disequilibrium is introduced into a system of cities which generates flows or spread effects from a growth pole and which presumably continues until equilibrium is restored, then, by investigating the susceptibility of urban centres to economic impulses (i.e., their ability to absorb economic impulses) and their ability to transmit these impulses to other centres in the system, one is able to examine how this input of "energy", such as a change in demand, is distributed throughout the urban system until equilibrium is restored. Harvey (1970) neatly summarizes the argument made here:

> "...it is therefore misleading to think of adjustment in the urban system as a homogeneous process proceeding at a unified rate. Their varying speed of adjustment means that there are substantial differentials in the disequilibrium in the system at any one point in time." (p. 271).

The susceptibility of an urban centre to economic impulses will be determined by its ability to respond to change which in turn will determine the speed and intensity of spread effects between the growth centre and the linked city. These two variables, timing and intensity are explicitly considered within an urban business cycle analytical approach.

Finally, an argument was made earlier that growth pole research requires that a distinction be made between national and regional factors of growth. In other words, if spread effects and polarized growth are to be investigaged, than a quantitative separation of national and regional components of growth is required. Only by this way can "true" spread effects be analyzed. Studies on urban business cycles have shown how national and regional factors may be removed from urban time series data.

(iii) Planning considerations

With respect to growth centre planning, an understanding of the cyclical behaviour of urban centres would provide valuable information for structuring such policies.

To the extent that the business cycle differs between cities, corrective action must be differentiated accordingly. If the local cycle is primarily a national phenomena (that is, national forces strongly influence local cyclical behaviour) then, if a policy which invests resources into a regional growth centre with the objective of raising income or employment levels, for example, in the surrounding centres, is adopted, the transmission of these impulses to these centres may not occur. But if the local cycle is strongly influenced by changes in economic activity levels in other centres (i.e., it is susceptible to regional forces), then a growth pole policy may achieve its planning objectives. Therefore, the extent to which an urban economy is affected by national and regional forces is an important consideration not only in investigating spread effects as argued earlier, but also in policy making. Lithwick (1970) makes a similar point:

> "...the major determinant of the city's development will continue to be the national economy. This gives to the urban system a crucial national dimension that is usually lost sight of particularly in policy analysis and development."

An analysis of how responsive centres have been, and might be in the future, also has important implications in the problem of identifying potential growth centres. King, Casetti, Jeffrey and Odland (1972, p. 37) suggest that:

> "The identification of certain leading sectors or regions as propagators and transmitters of economic fluctuations throughout the national urban system could provide valuable information for structuring regional planning policies in much the same fashion as the identification of leading industrial sectors has facilitated economic planning."

In other words, some centres may respond very quickly to growth stimuli and the spread effects may be triggered off comparatively early in the process whereas other centres may be more resistant and the transmission of the growth impulse into the surrounding region may be delayed as a consequence (King, 1973, p. 1).

The aims of the remainder of the study are: 1) to investigate spatial-temporal patterns of employment growth in the Southern Ontario urban system and; 2) to obtain some insight into how cyclical impulses are transmitted through the urban system.

It is hypothesized that cyclical impulses originate within certain cities, either as a derived response to national business conditions or from purely local phenomena and are transmitted through the urban system via a series of import-export ties (production linkages and/or hierarchical linkages) (Jeffrey, 1970). In other words, it is postulated that urban economic time series are composed of a national business cycle and a regional or spatial factors that affect particular segments of the urban system. In the process of transmission the local impact of regional impulses will be dampened by the friction of distance and over time. The fundamental premise is that cities displaying similar short run cyclical fluctuations in their economies are characterized by a high degree of economic interaction.

CHAPTER III

ECONOMIC FLUCTUATIONS IN REGIONAL URBAN SYSTEMS

In this chapter, a conceptual framework is first outlined structuring the way economic impulses are generated and transmitted through a system of urban economies and how the impacts of these impulses on urban centres vary in intensity and timing. Next, a statistical framework is presented which is divided into three parts. First, the use of factor analysis as a technique for studying spatial-temporal patterns of economic growth is outlined. The proposed analysis is based on a study by King, Casetti, Jeffrey and Odland (1972) who applied factor analysis to study patterns in urban employment growth in the United States. Second, a model is developed for the quantitative separation of the local impact of national and regional economic impulses. King, Casetti and Jeffrey (1972) and Jeffrey and Webb (1972) provide the basic references for this section. Finally, a model developed by Odland, Casetti and King (1973) for testing for spatial-temporal growth trends at the regional level is formulated.

Conceptual Framework

Assume that there exists a strongly developed regional system of cities in which there are hierarchical patterns of economic interaction and interdependence. Among the cities there is a variation in industry mix and export base characteristics. "The structural linkage between economic activities result also in strong spatial linkages between cities specializing in particular complementary activities" (King, Casetti and Jeffrey, 1969, p. 213). Also assume that within this regional urban system, there exists a "sub-system" of growth poles and that the spread effects originating from these centres is dampened over time and space, the degree of which depends on the position of each growth centre in the hierarchy of growth centres and the strength of inter-urban linkages.

It is worth noting here that Lithwick (1970) also makes a similar argument with respect to the Canadian urban system:

> "In a mature economic system, because of extremely high levels of industrial specialization, supply linkages are very complex. As a result, most intermediate inputs into the smallest central place have their origin in other parts

> of the national and even international economy, in some other urban system. ... It is these flows which tie each unit to others in extremely complex ways, constituting the national urban network." (pp. 49 - 50).

Next assume that short term economic impulses are introduced into the urban system. Over time, these cyclical impulses will produce local economic fluctuations in employment, unemployment and wage levels, for example. The literature on regional (Isard, 1960) and urban (Thompson, 1965) business cycles suggest that these impulses will be of two types. First, there are national impulses resulting from the impact of exogenous national cyclical forces on local levels of economic activity. The impact of national cyclical impulses will be experienced in an approximately uniform manner over different centres although not over all sectors of the economy. The second type of impulse results from purely regional forces and, as argued elsewhere in this paper, it is these regional forces which are identified with spread effects.

Considering first national economic impulses, several causes may be given: changes in monetary and fiscal policy, anti-inflationary measures, trends in consumer saving as opposed to spending, changed business psychology with respect to investment, international trade relations and technological change. An excellent example of national forces impinging on local economies is found in the May-June, 1969 Ontario Manpower Review:

> "The federal budget introduced by Finance Minister Edgar Benson in June (1969), was in fact, primarily directed at curbing inflationary pressured in Toronto and other Ontario cities. The two measures which are intended to achieve this are a reduction in tariffs on manufactured products and the deferral, for a two-year period, of depreciation allowances on commercial construction." (p. 15).

The relative importance of national as opposed to regional cyclical fluctuations in determining the local levels of economic activity does not remain constant through time. King, Casetti and Jeffrey (1969) stated that:

> "The influence of the national factors can be expected to change through time and to constitute the dominant element whenever the economy is affected strongly by major policy decisions and national or international events. Instead, regionally generated economic impulses probably have greater relevance under normal economic conditions." (p. 214).

Short-run change may also result from several types of impulses operating at the same time. During the 1970 recessionary period, for example, the automobile industry experienced a very significant decline in employment. During January and February approximately 5,000 workers at car assembly and parts plants in Windsor alone were affected by lay-offs, short work weeks and production slowdowns. The following shows clearly how several "national" forces affected the industry during this period.

> "The depressed market conditions for the domestically produced products are attributable in part to consumer credit restraints stemming from government anti-inflationary policies, but are also the result of competitive foreign car imports and a changing preference on the part of consumers in favour of sub-impact and mini models." (Manpower Review, Ontario Region, January-February, 1970, Vol. 3, No. 1, p. 21).

The influence of industrial mix and export base characteristics on the susceptibility of urban economies to national cyclical fluctuations has been discussed extensively elsewhere in the literature (Borts, 1960; Isard, 1960; Thompson, 1965) and the arguments have been neatly summarized by King, Casetti and Jeffrey (1972, p. 346) and Jeffrey and Webb (1972, p. 144). The demand elasticity of a city's export industries, population size, industry mix, the progressiveness of firms in the city, the financial structures of these firms, and the nature of the market structures may all influence in one way or another the susceptibility of a city's economy to national economic fluctuations. It is reasonable to expect that these factors will also affect a city's reaction to regional cyclical impulses. Since the present study is centred on these regional impulses and spatial interaction (i.e., spread effects) at the sub-national level, the reader is referred to the literature quoted above for a more detailed discussion on the variations of cyclical instability to national fluctuations between urban places. Nevertheless, these considerations are important in growth pole studies since one requirement for a city to function as a growth centre is that it must have a national propulsive innovative industry which has strong linkages with regional/local industries such that national growth impulses are diffused through the economic-urban system (Lasuen, 1973).

On the other hand, regional impulses originate within certain cities and are transmitted through the urban system via interindustry, financial and hierarchical linkages. Regional impulses may originate from a particular regional response to national cyclical forces. For example, a city which, because of its particular industrial mix, displays a distinctive national cyclical behaviour, may transmit similar fluctuations to other cities with which it is closely linked.

(Jeffrey and Webb, 1972). Purely local factors such as plant closures, local strikes, and shifts in local investment and consumption functions may trigger regional cyclical impulses.

Initially economic change will impinge most heavily upon certain industries located in certain cities and these changes in turn are transmitted to other industries within the city itself and to other cities where there is some degree of linkage. This transmission will be both direct and indirect. Directly the effect will be felt through changes in expenditure on the exports of other centres. Indirectly the effect will be seen in changes in expenditures on residentiary industries, first in the centres themselves, then in all other centres in the system,(King, Casetti and Jeffrey, 1972, p. 346; Jeffrey and Webb, 1972, pp. 144 - 145). The speed or timing of the reaction of a city to changes in the system as a whole and the size or intensity of the reaction will depend on the connectivity between the city and the urban system. The connectivity of the urban centre may be measured in terms of city size, position in the urban hierarchy, accessibility (distance) or industry mix (production linkages).

1) Economic Linkages and the Spatial Transmission of Economic Impulses

One mechanism through which regional impulses may be transmitted through the urban system is production linkages. In Perroux's original conceptualization of the growth pole, the author emphasized that a motor industry "induces the phenomena of growth" on affected industries primarily through interindustry linkages (Perroux, 1955, pp. 99 - 103). Since then many discussions of growth pole theory centred on those linkages as a prime element of the theory and this has continued to be a strong theme (Beyers, 1973, 1974; Moore, 1972; Hermansen, 1972; Campbell, 1974). "In particular, cost reductions due to productivity gains, innovation, and scale economies are viewed as providing the opportunity for propulsive industries to initiate growth, and to pass growth impulses through the linkage chains" (Campbell, 1974, p. 43). Structural linkages between economic activities also result in strong spatial linkages between cities specializing in particular complementary activities (King, Casetti and Jeffrey, 1969, p. 213).

Suppose a firm experiences an increase (or decrease) in demand for its products. The growth pole literature suggests that if the output of an industry in a particular sector increases, then its forward and backward linked sector either in the city itself or other centres, may experience growth resulting from external economies (pecuniary). An expansion in a given industry, A, located in city, i, may raise output demand or reduce production costs in a linked industry, B, located in city i or city j, which in turn may increase the profitability of investment on the part of entrepreneurs in B. If it does, it can be said that the expansion in industry A has generated external economies which are appropriated by industry B. If such economies are sufficiently large to stimulate investment in B, that is, to increase production by expanding infrastructural facilities and hiring additional workers, then external economies generated by expansion in A have "induced" investment in B. With associated price elasticities, price reductions could lead further to demand stimuli.

Besides induced growth via direct forward and backward linkages, increased output may also be transmitted indirectly via residentiary linkages. Increasing the output in industry A may cause the income of its employees to rise, leading to an increased demand for consumer goods and services and perhaps to an increase in local taxes. Local taxes, wage and salary payments find their way back into the local economy as local personal and government expenditures which in turn induce further output, income and employment (i.e., multiplier effect).

In summary, the timing and intensity variations in cyclical changes between urban centres will depend on the "mobility" of pecuniary external economies. Mobility here is defined, not in terms of actual movement (e.g., labour flows), but in terms of the spatial extent of interdependencies between activities (Siebert, 1969).

2) Hierarchical Linkages, Distance and the Spatial Transmission of Regional Cyclical Impulses

The second hypothesized type of interaction is through hierarchical linkages.

> "If the lead of Vining (1956) is followed and central place notions are allied with the export base logic then it be hypothesized that there exists regional (urban) sub-systems characterized by distinct cyclical patterns as a response to regional fluctuations transmitted through the sub-system via hierarchical linkages." (Jeffrey and Webb, 1972, p. 145).

The argument here, stated in simple terms, is that the susceptibility of an urban centre to regional fluctuations is a function of that centre's position in an urban network measured, for example, by city size, accessibility or position in the urban hierarchy. It is worth noting in this context, that Siegel and Woodyard (1971) have shown, using cross-sectional data, that the position in the urban hierarchy is a factor in the shaping of urban growth in Ontario; and from the innovation diffusion literature, Berry (1972, p. 114) hypothesized that "the innovation potential of a centre is a product of its position in the urban hierarchy."

The number and type of regional and national market orientated industries in an urban area is closely related to that city's position in an urban hierarchy (Isard, 1960, p. 345). The higher up the hierarchy the larger the market area that will be served and the larger the city size the greater the industrial diversification of the city (Thompson, 1965, p. 181). Thompson (1965, p. 46) also noted that with increasing city size, the importance of shifts in local investment and local-consumption-of-local-production functions comes to rival that of export multipliers in generating local fluctuations. The implication is that the largely self-sufficient local economies of metropolitan areas are more likely sources of independent cyclical shocks than the more open economies of smaller urban areas. Jeffrey (1974) extends this argument stating that:

> "Major metropolitan areas with their intricate industrial, financial and commercial structures and large local economies, might be expected to play a leading role in generating such regional impulses." (p. 114).

However, while metropolitan areas may generate regional impulses, these impulses may have little influence on economic activity levels in the city itself. As Thompson (1965) postulated, increased city size is associated with greater industrial diversification which in turn prompts a local cyclical response more closely approximating that of the nation.

Distance from the source of regional impulses may also affect a city's reaction to such impulse. The effect of distance will depend on whether the impulses are negative (e.g. decrease in consumer demand) or positive (increase in demand). Thompson's concept of marginality is applicable here (Thompson, 1973). According to his argument, if a firm is a marginal supplier in an industry, a cutback in final sales will be passed on to small sellers of marginal supply while captive sources of supply will be maintained. On the other hand, if an increase in sales is experienced, marginal firms will be the last to feel the change. Using a spatial analogy, a locality may possess the marginal high-cost facilities because of its out-of-the-way location. Remoteness from the market, resulting in higher transportation costs and a lower inter-urban competitive position, raises marginal costs and amplifies output variations in response to demand and supply fluctuations.

Framework of the Statistical Analysis

The following statistical framework is subdivided into three parts: 1) Analysis I which involves the use of factor analysis in studying spatial-temporal patterns of growth; 2) Analysis II which develops on a time series decomposition model and; 3) Analysis III which is concerned with the testing for polarized growth in a central place system.

1) Analysis I: A Factor Analytic Model of Spatial-Temporal Patterns in Urban Employment Growth

Factor analysis has traditionally been used in the analysis of associative interrelationships among a set of variables and such applications have sought to explain the total covariance of the set of variables in terms of a smaller number of underlying factors.[1] In these studies, however, the time dimension has largely been ignored, or it is taken into account only through the inclusion of variables relating to the levels or rates of change from one point in time to another, or by comparing factors between different points

1. See discussion in Chapter I, Introduction.

in time. There is little that can be inferred from such studies as to the nature of causal influences operating within the urban system.

The interest in this particular analysis is to investigate the variable responses of different cities in Southern Ontario to economic fluctuations occurring over time on the basis of the detailed forms of their growth paths. In a recent study, King, Casetti, Jeffrey and Odland (1972) used factor analysis to study variations in the intensity and timing of economic growth among cities in the U.S. urban system. The authors attempted to classify cities by the nature of their employment growth over the January 1957-December 1969 period. The particular form of factor analysis employed followed along the lines suggested by Sheth (1969) whereby the technique transforms a set of functional relationships (in a regional analysis framework, between some index of urban economic growth and time) into a series of linear components called "reference curves" representing major dimensions of economic growth over time. Each city has a set of coefficients relating individual city growth patterns to each reference curve.

Two features distinguish this use of factor analysis from its more familiar use in the analysis of associative relationships. First, the variables are not the cities but the discrete time intervals at which measures of economic growth for a city are recorded. Second, the analysis is performed on a covariance matrix rather than a correlation matrix. This is done to preserve important differences in the variances of the indices of economic growth between each time interval. If a principal axis factor analysis is performed, then a least squares solution is obtained in the sense that each successive reference curve maximizes the sum of squares in the residual matrix. When a covariance matrix is used, then all reference curves are correction terms summarizing regional deviations from a zero mean.[2]

In the empirical application of this technique, an attempt is made to relate the result to growth centre concepts. Ideally, the analysis should be performed on local growth curves from which industry mix, national, cyclical, and seasonal effects were removed. As King, Casetti, Jeffrey and Odland (1972, p. 42) suggested, from these competitive or regional share growth curves, dimensions of growth could be determined. Jeffrey (1974) applied this approach for the U.S. urban economic system. If the particular parameter

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2. These points have been discussed by King, Casetti, Jeffrey and Odland (1972, p. 38) and by Jeffrey (1974, p. 116).

values for each city on the reference curves are seen as the regional cyclical component of a time series then the individual parameters trace the interaction of an urban economy with the regional cyclical forces, that is, spread and backwash effects, affecting the system over time. However, due to time and data constraints, such an extension is not attempted in the present analysis. The objective of Analysis I instead is to simply differentiate cities in Southern Ontario by the nature of their employment growth over a five year period using seasonally adjusted data, standardized in the same manner as in the King, Casetti, Jeffrey and Odland (1972) study. The variable responses of different cities to economic fluctuations are investigated on the basis of the detailed forms of their growth paths. However, since each reference curve summarizes regional deviations from a zero mean, then each curve may be representative of major dimensions of sub-national (regional) dimensions of economic growth. Thus, the results of the analysis may be related to spread effects (i.e., spatial transmission of short term growth impulses).

The fundamental premise to be tested through factor analysis is that cities displaying similar short term cyclical fluctuations in their economies are characterized by a high degree of interaction. If distinct groups of cities can be identified with different regional factors, the implication is that their regional cycles are the product of distinct sub-national forces. If similar cities display a marked tendency to be contiguous in space, points to the importance of space in conditioning and setting restraints on the transmission of these regional cyclical forces through an urban system (King and Jeffrey, 1972, p. 224).

2) Analysis II: A Quantitative Separation of Spatial Economic Series

The problem of interest in this stage of analysis is to determine how national economic fluctuations are transmitted through a set of urban economies and how the impacts on the cities vary in intensity. In other words, this section is concerned with the relative cyclical stability of different city economies to national effects. However, since this study focusses on growth centre processes corresponding to the regional cyclical component in a city's time series data rather than the national cyclical component, the discussion of the results obtained in this phase of the analysis will be brief. The main purpose of Analysis II is to achieve a quantitative separation of urban economic fluctuations which are attributable to national and regional factors. The regional component of a city's growth path is then used as an input into Analysis III which explicitly tests for the existence of regional growth centres.

In a study by King, Casetti and Jeffrey (1969), the influence of exogenous national factors was removed from local time series by regressing each city's time series on the corresponding national time series. A lagged correlation analysis on the residuals was then performed in order to identify regional groupings of cities having similar responses in regard to the nature and timing of their regional cyclical component. This analysis was modified in a later study (King, Casetti and Jeffrey, 1972) to include not only a national but also a structural component. The model employed in this study was based on a technique presented by Brechling (1967) and it is this model which is used in the present analysis.

The model structures the employment rate, E_{jt}, in city j at time t as the sum of two additive components, a national cyclical component, N_{jt}, and a structural component, S_{jt}. The equation takes the following form:

$$E_{jt} = S_{jt} + N_{jt} \qquad (1)$$

N_{jt} identifies that part of urban employment attributable to national levels as follows and is defined as follows:

$$N_{jt} = a_j W_{jt} \qquad (2)$$

where W_{jt} is the national employment rate (or any other economic indicator) and a_j is a measure of the sensitivity of N_j to W. If $a_j = 1$ the city's cyclical fluctuations are as equally severe as the nation as a whole. If $a_j > 1$ its cycles are more severe, or if $a_j < 1$ less severe, than those of the nation. In the actual formulation of the model as presented in King, Casetti and Jeffrey's study (1972), a more precise separation of the national cyclical effect was obtained by using a weighted national series which took into account the industrial mix of cities. Their model also allowed for the possibility that the impact of the national factors on the city in question may only be felt after a certain time lag. However, due to data and time restrictions such an extension is not made in the present. Instead, it is assumed that a city's industries has the same employment rate as its national counterpart and that national forces impinge on all urban places simultaneously.

Before the national cyclical component was estimated in the King, Casetti and Jeffrey (1972) model, a structural component of local unemployment was taken into account. Following Brechling (1967), the structural component was assumed to conform to a quadratic time trend allowing it to change smoothly over time at a decreasing or increasing rate. Thus:

$$S_{jt} = c_j + b_j t + d_j t^2 \qquad (3)$$

where: S_{jt} = structural component of local unemployment in city j at time t.

$c_j = S_j$ = structural component at time zero.

b_j, d_j = coefficients of the quadratic time trend.

The structural component is analagous to the secular trend source of change in economic time series decomposition analysis which represents long term growth or decline occurring within the series. In the original formulation by Brechling, the structural component was related to structural unemployment, defined by King, Casetti and Jeffrey (1972) as unemployment caused by long term dislocations in labour market functioning which are brought about by structural shifts (such as changes in technology and final demand or changing locational patterns of industry and population) within the regional economic system. Viewed in this way, this structural component is similar to the development or long term trend discussed earlier.

(as opposed to the short term or 'growth' trend).

A similar line of reasoning may be applied to employment time series. Kosters and Welch (1970), for example, noted that:

> "at any point in time, there exists a level of employment with the economy's long term equilibrium path; call it normal employment. To the extent that realized employment differs from its long term equilibrium, we can presume that the deviation, which we call transitional employment, reflects a short term adjustment to unforeseen contingencies." (p. 3)

An example from their study may clarify the above definitions. Suppose a firm experiences an increase in demand. Before the firm is convinced that the increase will be maintained, output expands because the firm purchases inputs whose costs can be quickly recouped. For example, the firm might defer purchasing new capital goods with long recoupment periods and hire labourers that are good substitutes for capital. As it becomes convinced that increased demand will be maintained, its input composition is adjusted to reflect more 'normal' or longer term patterns of input requirements. During this readjustment 'transitional' employees may be replaced by capital and other workers. An analogous process will occur with contraction in demand. In short, as the level of economic activity fluctuates, some classes of workers will share more than proportionally in the transitions between peaks and troughs in aggregate demand. Fluctuations in employment of these 'marginal' workers will be exaggerated relative to total employment.

The model to be estimated then, expresses city employment E_{jt}, as a linear function of the normal component and the national series.

$$E_{jt} = c_j + b_j t + d_j t^2 + a_j W_{jt} \qquad (4)$$

The residuals of (4) can be identified as the regional cyclical component, R_{jt}, attributable to regional cyclical impulses. If the residuals are positive the implication is that regional forces are operating to produce a higher rate of local employment than the level of economic activity in the nation would suggest. If the residuals are negative the reverse is the case.

Each city's regional cyclical component will be comprised of a number of basic regional cyclical patterns, each reflecting the impact of a distinct set of regional forces on the urban economic system. That is,

$$R_{jt} = \sum_{k=1}^{m} b_{jk} r_{kt} \qquad (5)$$

where: R_{jt} = regional cyclical component of employment in with j at time t.

r_{kt} = the k^{th} regional cyclical pattern at time t.

b_{jk} = parameter indicating the extent to which r_{kt} comprises R_j. (Jeffrey, 1974)

Using local and national employment indices over time the parameters of equation (4) can be estimated by multiple regression techniques and R_{jt} is derived as a residual. However, according to Jeffrey (1974, p. 115) in estimating the parameters of equation (5), there exists a problem in that "the m 'independent' variables are unknown and must be derived as an output of the analysis." Therefore, regression analysis is inappropriate whereas time series factor analysis, such as the one used in Analysis I, may be used since it permits the simultaneous estimation of the regional cyclical components.

Equation (4) is estimated in the following section of this study but the intention here is mainly to decompose local time series into its components in order to analyze spread effects (Analysis III). In other words, by removing the national component from the time series, it is possible to analyze "true" spread processes or 'regional' patterns of growth. Discussion of the parameters derived in the actual empirical fitting of the model is therefore only done at a general level. Returning to equation (5), no attempt is made to identify the various independent variables. Some understanding of regional cyclical forces, however, is made in Analysis I. As it will be noted later, the mean curve, from which the reference curves are derived, in this analysis closely approximates the national trend. If it is assumed that this is the case, and since all reference curves describe deviations from the mean curve, then each reference curve may be indicative of sub-national cyclical forces (that is, regional deviations from the zero mean).

3) Analysis III: Spatial-Temporal Regional Growth Trends

The purpose of this phase of the analysis is to test the hypothesis that spatial-temporal polarized growth did occur with respect to given growth centres in Southern Ontario. A method for testing this hypothesis recently proposed by Odland, Casetti and King (1973) is employed. The methodology is based on two other similar models developed by the same authors. Each of the three models correspond to a particular type of spatial system. The first proposed model

(Casetti, King and Odland, 1970) was developed to test the hypothesis that polarized did occur in a unipolar spatial system in which growth at each point in a defined region is solely a function of distance to one exogenously defined growth centre within the region. The method was elaborated in a later paper (Casetti, King and Odland, 1971) to incorporate a multiplicity of poles of different orders in which growth at any point in the region is a function of distance from all the poles in the region. Finally, the method was extended to allow for the testing of hierarchical polarized growth (Odland, Casetti and King, 1973). "The latter is here defined as the dynamic pattern in a central place setting wherein the level of growth at any point in the region is a function of distances from the nearest centres of each order in the hierarchy" (Odland, Casetti and King, 1973, p. 74). A common conceptualization in all three methods is that there exists "Z surface", Z being some function of the spatial co-ordinates of each point and time, the elevation of which "identifies the spatial distribution of the intensity of the phenomenon," such as employment levels. Spatial-temporal processes such as polarized growth may be investigated and measured by examining the temporal behaviour, that is, the "stretching and warping" of the Z surfaces that they generate.

The method employed here tests the hypothesis that polarized growth did occur within a central place hierarchy. This model involves the formulation that some measure of the intensity of a phenomenon at a point with co-ordinates x and y in a continuous region, S, within a time span, T, is a function of distances to the nearest exogenously given growth centre in each order of the hierarchy. Then each centre is associated with a set of distances, $(S_1, S_2, \ldots S_k)$ to the k order centres, each of which is the nearest centre of its particular order. Distance is defined in Euclidean geometric terms. That is,

$$S = \left[(x - x')^2 + (y - y')^2\right]^{\frac{1}{2}} \qquad (6)$$

where: S = distance between any point in the region to the k^{th} order growth centre.

x,y = spatial co-ordinates of any point.

x',y' = spatial co-ordinates of the given growth centre.

If employment levels, E, is used to measure the "intensity of the phenomenon," the model asserts that

$$E = E(t) \qquad (7)$$

where E is employment and t is time.

Assuming that there is a linear relationship between employment growth of a centre and time, the following is obtained:

$$E\ (t) = a + bt \qquad (8)$$

From (8) a spatial-temporal function, E (s, t) is generated such that it allows for changes in employment levels of an urban place at distances, S_1, S_2, ... S_k, from each given growth centre. Through the expansion method, the parameter of (8) are redifined as linear functions of S. Using a simple 2-order growth centre setting where there exists one first order and three second order growth centres, the following functions are defined:

$$a = a_o + a_1 S_1 + a_2 S_2 \qquad (9)$$

$$b = b_o + b_1 S_1 + b_2 S_2 \qquad (10)$$

where: S_1 = distance to the first order growth centre.

S_2 = distance to nearest second order growth centre.

By substituting (9) and (10) into (8), the following spatial-temporal trend equation is derived:

$$E\ (S_1, S_2, t) = a_o + a_1 S_1 + a_2 S_2 + b_o t + b_1 s_1 t + b_2 s_2 t \qquad (11,i)$$

In general terms (11,i) may be rewritten as :

$$E\ (S_1, S_2, \ldots S_i, t) = a_o + \sum a_i S_i + b_o t + t \sum b_i s_i \qquad (11,ii)$$

where: i = 1, 2, ... n = number of orders in the hierarchy of growth centres.

The parameters of equation (11, i, ii) are used to test for polarized growth with respect to (1) the first order or regional growth centre and (2) each succeeding order or sub-regional (secondary) growth centre.

Growth takes place in the region over the defined time period if the first derivative of (11,i) with respect to t is greater than zero. That is, using the simple two order hierarchy example,

$$\frac{\delta E \quad (S_1, S_2, t)}{\delta t} = b_o + b_1 S_1 + b_2 S_2 \quad > 0 \qquad (12)$$

for plausible values of S_1 and S_2.

Positive polarization with respect to the regional growth centres is confirmed if:

$$\frac{\delta^2 E \ (S_1, S_2, t)}{\delta t \ \delta \ S_1} = b_1 < 0; \qquad (13)$$

and with respect to secondary growth centre if,

$$\frac{\delta^2 E \ (S_1, S_2, t)}{\delta t \ \delta S_2} = b_2 < 0 \qquad (14)$$

Alternatively, negative polarization (that is, growth increases with increasing distance from the growth centre) if the partial derivatives, (13) and (14) are greater than zero.

Since the model tests for regional growth processes, then the "intensity of phenomena" should have the national effect removed. In the actual empirical application of the model, each urban time series data used in the parameter estimation procedure has the national component removed. This was achieved in Analysis II. The spatial-temporal trend, therefore, is generated from "true" regional spatial-temporal processes or spread and backwash effects.

CHAPTER IV

EMPIRICAL ANALYSIS: ECONOMIC FLUCTUATIONS IN THE SOUTHERN ONTARIO URBAN SYSTEM

Data Collection and Parameter Estimation

An empirical investigation of variations in urban economic time series requires data that are disaggregated by time and space. However, such an analysis is limited by the difficulty of obtaining ideal data; nor is there any real consensus of opinion as to what constitutes ideal data for such studies.[1] The problem is somewhat alleviated by the fact that the purpose in most of this study is to investigate the relative reaction of urban economies to short term economic impulses rather than the absolute levels of economic activity over time.[2]

Temporally disaggregated employment data are available, from monthly reports published by Statistics Canada, Labour Division entitled, "Employment, Earnings and Hours," in two forms: non-standardized industrial composite

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1. See Haggett (1971, p. 71) for a discussion on this problem.

2. This argument is made by King, Casetti and Jeffrey (1969, p. 215; 1972, p. 348).

employment and industrial composite employment index which is calculated by dividing each month's employment by the monthly average of the total base year, 1960, employment. The industrial composite includes all industries except for the following: 1) agriculture, fishing and trapping, education and related services, health and welfare services, religious organizations, private households and public administration and defence and; 2) companies with less than 20 employees in every month of a year. Because of the limitations of the survey to larger firms, there is somewhat uneven coverage of total employment by industry (especially in the service, wholesale and retail trade and construction sectors [3] and by cities. In this study, the employment index was used mainly because it was more readily available and because it showed larger variations between months.[4]

Industrial composite employment indices are available for 29 cities in Southern Ontario. These cities are shown in Figure 1. The Census of Population's "Metropolitan Area" definitions are used where applicable.[5] The definitions

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3. Appendix D shows the percentage of total estimated employment covered by the larger firm survey by industry division for Ontario.

4. Nonstandardized industrial composite employment data are rounded off to the nearest 100th. As a result, several continuous months may show no change at all.

5. In the 29 cities, 6 CMA's are included: Toronto, (continued)

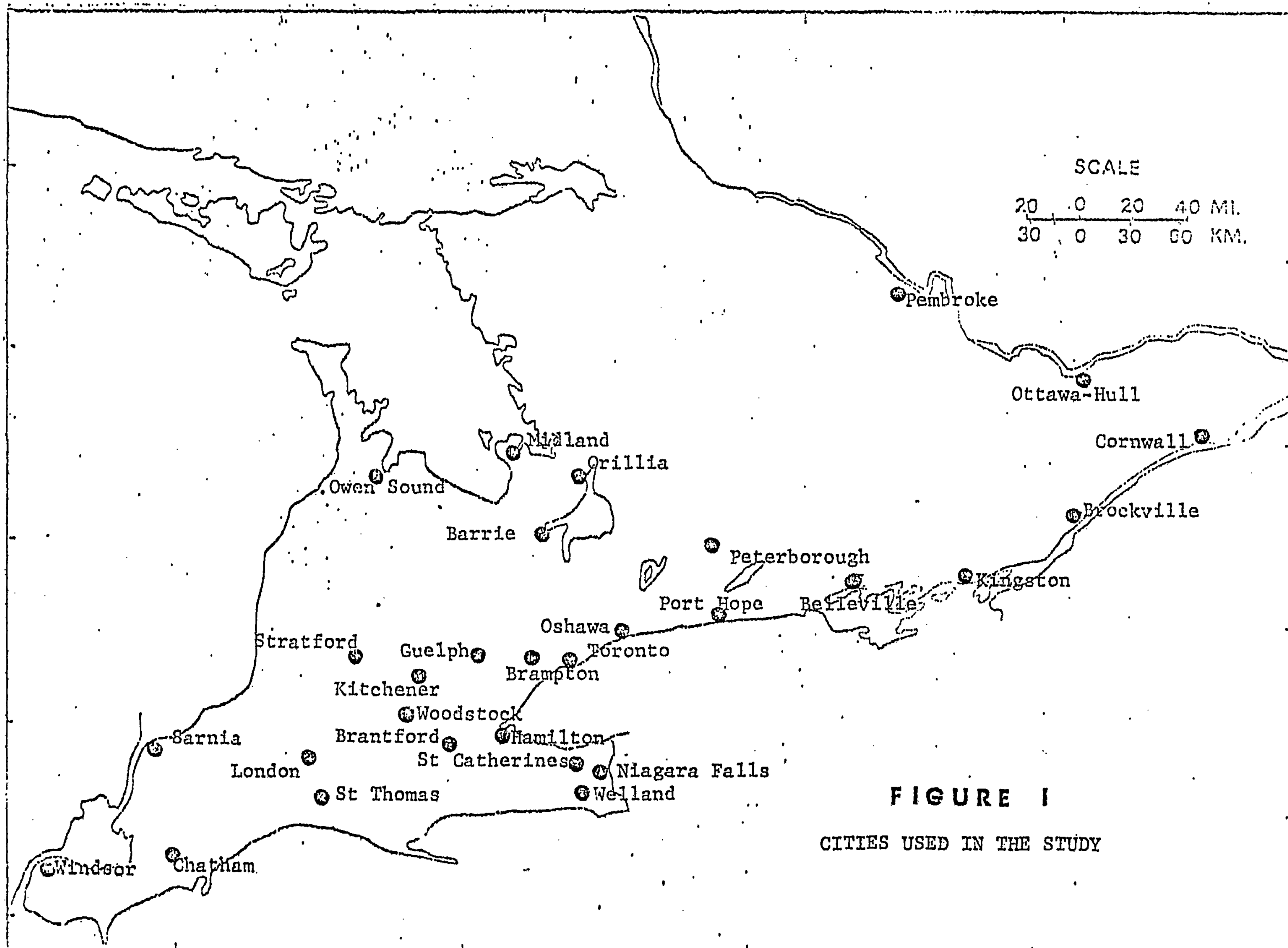

FIGURE I

CITIES USED IN THE STUDY

used for other cities are based on a labour market concept (that is, the surrounding territory as well as the urban area, are included in the city definition).

Finally, the time span in the study covers the period from January, 1968 to December, 1972. As the urban employment are not seasonally adjusted, the first step in the analysis was to remove the seasonal fluctuations. Dummy variables and simple least squares regression were used to obtain the seasonally adjusted data. A more detailed discussion of this seasonal adjustment procedure is presented in Appendix B. The national series was subjected to the same seasonal adjustment procedure.

In estimating the parameters in Analysis I, the factor analysis computer package, BMD X72 was used (see Dixon, 1969). A principal axis factor analysis, with no rotation, was performed on two covariance matrices.[6] Two data standardization procedures were applied to the seasonally adjusted data, which in turn were used as the inputs into the factor analysis. These procedures are described in the following section.

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5. (cont'd) Ottawa-Hull, Hamilton, London, Kitchener-Waterloo-Cambridge and Windsor.

6. No discussion is made here in reference to the different possible rotations. See Jeffrey (1974, p. 116) for a short discussion on this point.

In Analysis II, the parameters of the decomposition model were estimated using multiple regression techniques. The least squares regression programme, BMD 03R (see Dixon, 1968) was utilized. The stepwise multiple regression programme, BMD 02R (see Dixon, 1968) was used to estimate the parameters in the testing for polarized growth (Analysis III).

Empirical Results and Discussion

1) Analysis I: A Factor Analytic Model

The following analysis follows closely to the methodology used in the study by King, Casetti, Jeffrey and Odland (1972). In the latter study, the authors attempted to differentiate cities in the United States on the basis of the detailed forms of the cities' growth paths over time. Two standardization procedures were performed on the total non-agricultural employment series. The first procedure removed the effect of city size by dividing each monthly observation by the employment level in the first month, but retained the differences in the rates of growth. In the present study, published employment indices already have the city size effect removed since they represent ratios of each monthly employment to the base year. However, in order to focus attention on rates of growth during the five year period, it was necessary to "update" the indices. This was done by dividing each city's seasonally adjusted monthly index by the January, 1968 employment index and multiplying by 100.0.

The second standardized data set used in the above referenced study had both the effects of city size and growth rates removed by taking differences in employment levels between the first and each subsequent month and dividing it by the overall change in employment for each city over the entire reference period, and thereby, allowing the analysis to focus on the timing of growth. In the present study, the growth rate effect was removed from each city time series by subtracting the quadratic time function (growth trend), $a_1 t + a_2 t^2$ from the regression equation in the seasonal adjustment programme.[7] In order to focus on the timing of growth within the study period, each urban seasonally adjusted and detrended time series was divided by the January, 1968 industrial composite employment index and multiplied by 100.

The two resulting standardized data matrices each have 29 rows and 60 columns. The rows are the observations, the 29 cities, and the columns are the variables, the 60

7. The a_1 and a_2 coefficients are defined in Appendix B.

monthly intervals. The cell entries in each matrix, which was used as the input to the factor analysis, are the standardized employment indices. The results of the two factor analyses are given separately.

i) Rates of Urban Employment Growth: City Size Effect Removed.

The mean standardized curve for all 29 cities in Southern Ontario is shown in Figure 2 along with three selected urban time series which are representative of the deviate time series with respect to the mean curve. From a value of 100.0 in January 1968, the mean curve rises to a value of 108.0 in December 1972. In other words, over the 60 month time interval, the mean growth rate for all 29 cities was 8.0%.[8] The downswings during the first part of 1968 and during 1970 and the corresponding recovery periods are clearly apparent in Figure 2.

Factor analysis of the covariance matrix, derived from the original data matrix, yielded three reference curves (or, using more traditional terminology, three components) accounting for 87.8% of the total variance around the mean

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8. In comparison, the national series had a growth rate of 7.0% during the same period.

FIGURE 2

Mean Standardized Curve and Selected City Employment Series: Growth Rates ('68-'72)

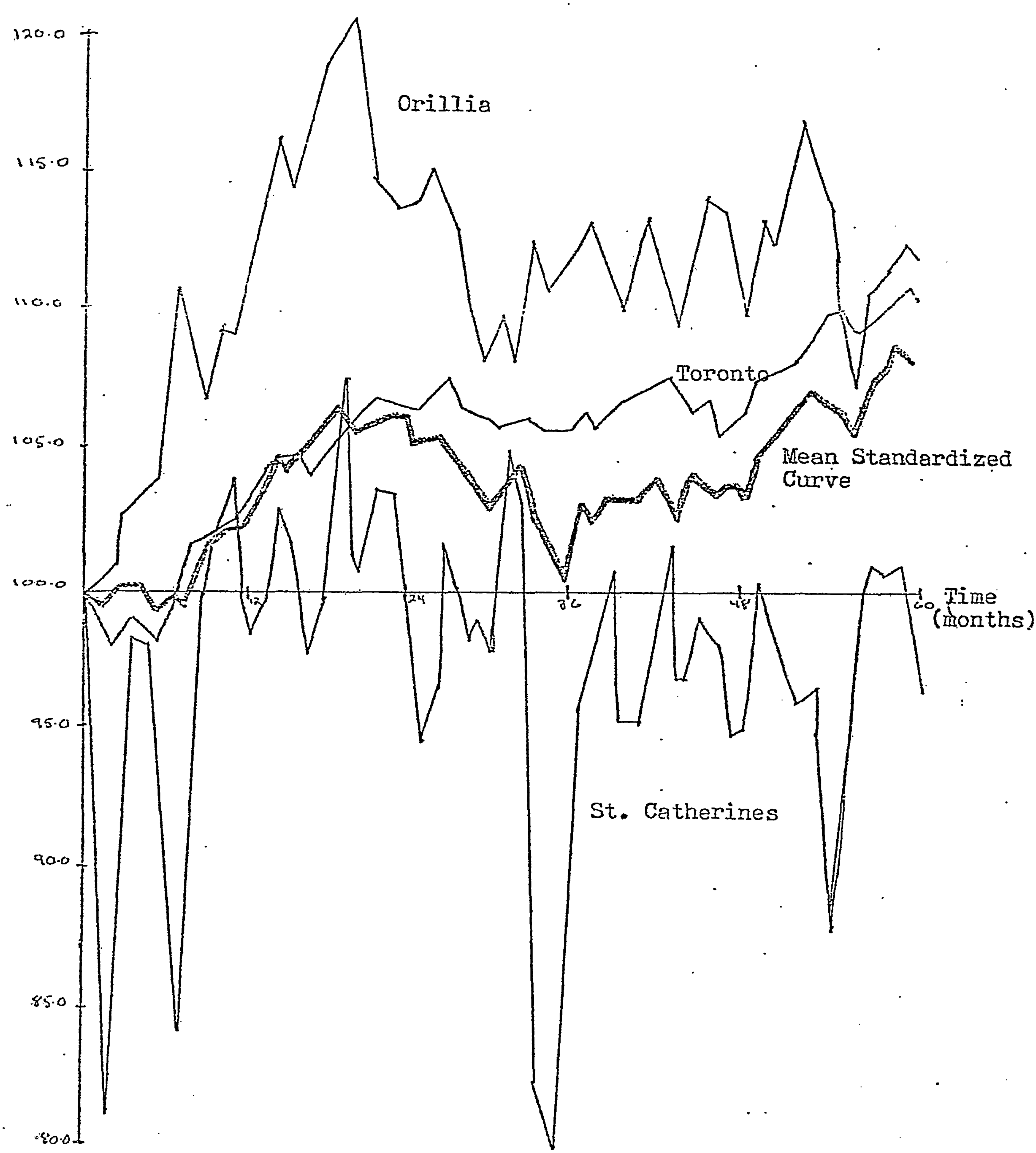

Table 1

Individual Parameter Coefficients
On The Three Reference Curves

	Coefficients		
	RC - 1	RC - 2	RC - 3
Barrie	.75335	.05517	-.07869
Belleville	.88322	.39472	.14641
Brampton	.83903	.03206	.70783
Brantford	-.81913	.26112	-.57222
Brockville	-1.47209	.29296	1.51082
Chatham	.12497	-1.28877	1.28841
Cornwall	-.75442	.30171	-.81642
Guelph	-.74807	.79115	-.14259
Hamilton	-.14235	.49131	.83342
Kingston	-.40875	.52911	-.22530
Kitchener	.65627	-.09464	.07325
London	-.30017	-.11785	.49453
Midland	2.92871	-1.51835	1.14532
Niagara Falls	-.24099	.65083	1.34132
Orillia	1.05679	1.20329	-1.61171
Oshawa	-1.04605	-3.24415	-2.19479
Ottawa	1.07222	.36127	.35602
Owen Sound	.01172	.99604	-1.71305
Pembroke	-1.35236	-.63041	.84834
Peterborough	-.13791	1.10194	-.45110
Port Hope	-.83818	.49913	-.60980
Sarnia	-.37105	.32099	-.70114
Stratford	.52393	-1.54213	.93318
St. Catherines	-1.07266	-1.57348	-.54149
St. Thomas	2.00594	.19478	-1.64678
Toronto	.33167	.26276	.30309
Welland	-.53002	1.35706	1.09309
Windsor	-.85030	-.33517	.80180
Woodstock	-.10331	.24755	-.57570

standardized curve.[9] The three reference curves are shown in Figure 3. The extent to which each city's growth curve comprises each reference curve is measured by its set of individual parameter estimates, given in Table 1, on each reference curve. Cities whose standardized growth curves are closely approximated by the mean standardized curve, such as Toronto (see Figure 2), will have individual parameter values close to zero. It may be further argued that cities which have coefficients close to zero on any reference curve tend to self-sufficient local economics in the sense that their activity levels are not susceptible to regional shocks or forces.

Reference curve 1, RC - 1, accounted for 72.7% of the total variation. The RC - 1 coefficients are mapped in Figure 4. In general, RC - 1 displays a long term - five year growth trend which approximates a monotonic function of time, with a low value of 0.28 in April 1968 to a high of 10.80 in July 1972 (see Figure 3). Cities which grew faster than the average, with growth curves consistently above the mean, have positive individual parameter values, the larger

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9. Additional reference curves were obtained but only those which had more than 5% explanation of total variance are examined here.

FIGURE 3

Reference Curves: Rates of Growth

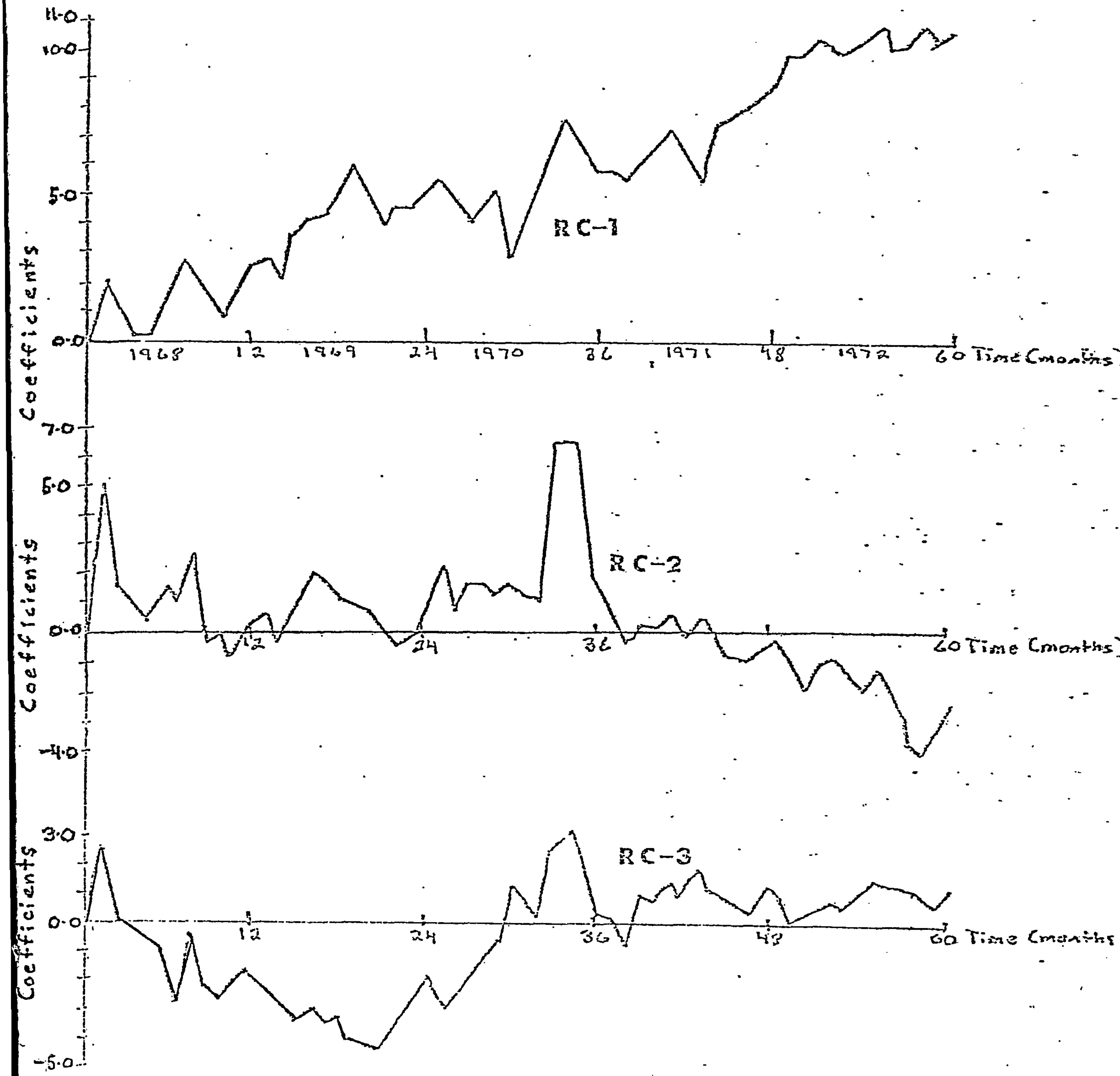
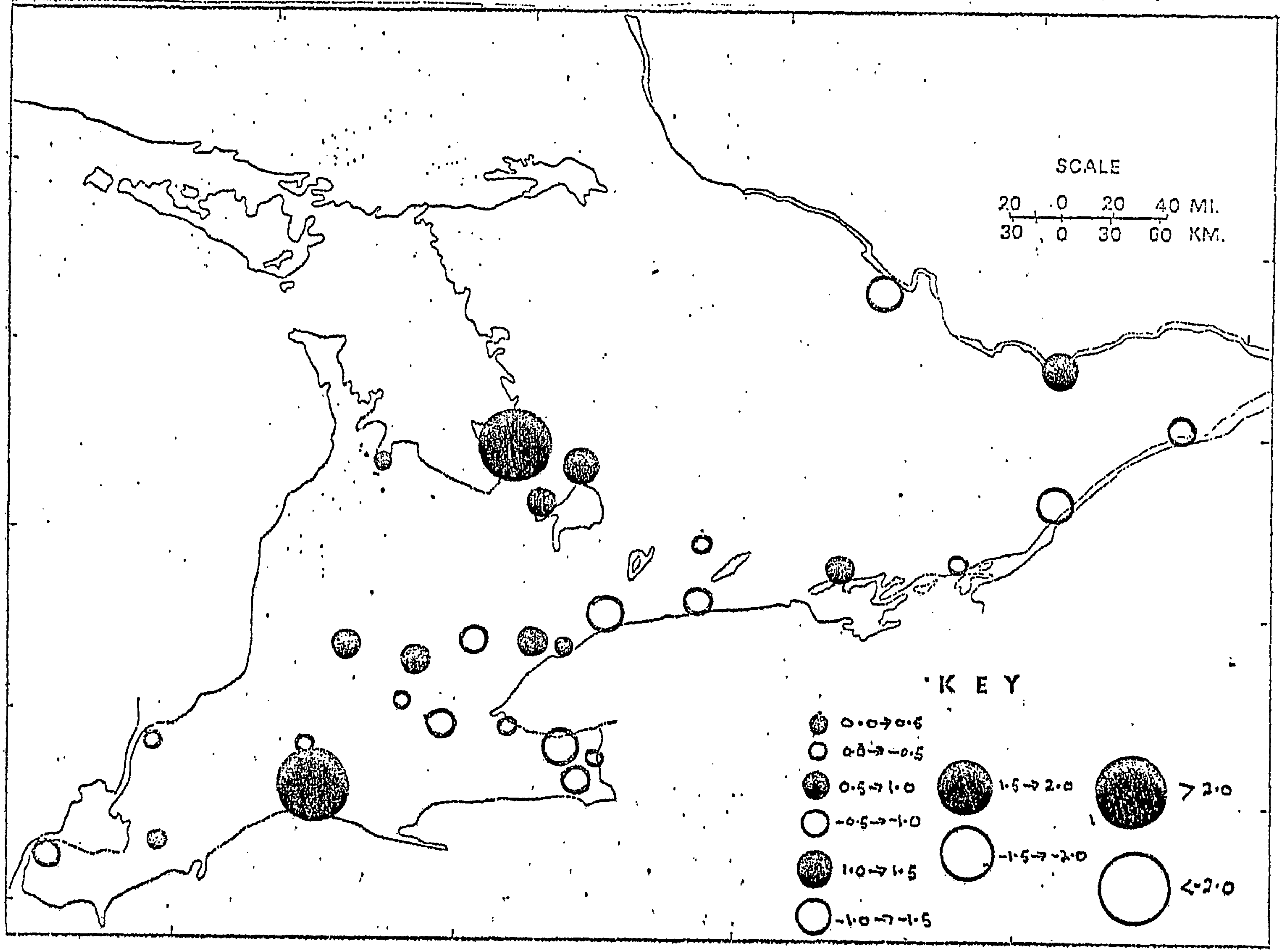


FIGURE 4. INDIVIDUAL CITY COEFFICIENTS ON REFERENCE CURVE ONE (RC-1)



the coefficient, the faster the rate of growth. Conversely, cities that grew slower than average, with standardized growth curves consistently below the mean, have negative coefficients.

Some spatial patterns emerge in Figure 4. For example, large positive values (fast growth rates) are predominant in the Georgian Bay-Lake Simcoe area (Midland and Orillia displaying large positive $> +1.00$, coefficients). On the other hand, slow rates of growth are characteristic of the Niagara region with St. Catherines exhibiting a large negative (< -1.00) coefficient. Except for Ottawa and Belleville, slower than average rates of growth are found in all cities east of Toronto. On the other hand, cities located in the Toronto-Windsor corridor have growth rates closely resembling the mean curve, that is, their coefficients are close to zero. St. Thomas (a fast growth rate) and Guelph (a slow growth rate) are exceptions.

The recent local buildup of industries in Midland, Brampton, Barrie, Belleville and Ottawa contributed to the fast rates of growth exhibited by these cities during the reference period. Midland as well as Owen Sound were designated as Canada Manpower Centres (CMC) in 1965 which allowed the two centres to take advantage of industrial incentives under the Area Development Agency (ADA) for the purpose of attracting new firms to the area and of expanding and modernizing existing firms.[10] Yeates and Lloyd (1969) have recently analyzed the impact of the industrial incentives in the Southern Georgian Bay Region based on 1964 - 1967 employment data. Their investigation found that the spatial impact of the ADA program on various aspects of employment growth was fairly evenly distributed. Job opportunities had greatly increased and "growth industries" were beginning to displace the traditional primary based industries in all CMC's.[11] Midland and Owen Sound had approximately equal shares (30.8% and 29.1%, respectively) in the total "direct' induced employment" for the entire designated area. However, based on the RC - 1 coefficients, the results in the present analysis indicate that Midland has experienced a considerably faster rate of employment growth between 1968 and 1972 than Owen Sound (whose growth path closely approximated the mean curve), suggesting that Yeates and Lloyd's conclusions may be

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10. Collingwood was also designated as a CMC by ADA in 1965.

11. Yeates and Lloyd (1969, p. 51).

somewhat premature.[12]

Ottawa's fast growth rate reflects the increasing employment in the metal fabricating and sophisticated electronic equipment industries which have located in the city because of the available skilled and professional labour supply and because of its location between the large Montreal and Toronto markets.[13]

Cities which have experienced considerably slower than average rates of growth tend to have large firms (in terms of number of employees) in the transportation equipment manufacturing sector, particularly in motor vehicle manufacturing and motor vehicle parts and accessories manufacturing industries.[14] Oshawa and St. Catherines, and to a lesser degree, Windsor, are examples of automobile specialized cities experiencing slow rates of growth. Several factors have contributed to their slow growth rates: consumer constraints stemming from government anti-inflationary policies, competitive foreign car imports and a changing preference on the part of

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12. Their study period only covered a two year interval following the introduction of the ADA program.

13. Ontario Manpower Review, May-June, 1969, p. 11, July-August, 1969, p. 11.

14. Appendix C lists the major employees by industry group (3-digit) and by city. A discussion of the data gathering used is found in Appendix C.

consumers in favour of sub-compact and mini models. These factors contributing to the depressed market conditions facing the automobile industry have been reviewed in several reports of the Ontario Manpower Review. St. Thomas and Brampton also have a significant large employment in the automobile industry but, in contrast to the other cities, they have experienced fast rates of growth. This implies that relative location rather than industry mix may be a more important variable in influencing the growth rate of Brampton and St. Thomas.

Industry mix and the presence of slow growing industries have also affected the growth rates in other cities. For example, cities specializing in steel and related industries such as Hamilton and Welland or in textile and chemical industries such as Cornwall, Sarnia, Niagara Falls and Kingston have experienced slow rates of growth.[15] Brantford which specializes in the manufacturing of agricultural implements also experienced a slow growth rate because of weakening demand resulting from the overstocking of equipment in the United States, lagging sales of Canadian wheat particularly curing 1968 and 1969 and local strikes.

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15. See Appendix C.

The individual coefficients for the second reference curve (RC - 2), which accounted for 8.10% of the variance around the mean curve, are listed in Table 1 and mapped in Figure 5. Cities with large positive and negative parameters on RC - 2 experienced considerable oscillations in their employment growth rates whereas cities with parameter values closer to zero exhibited more stable growth trends. Therefore, RC - 2 coefficients may be interpreted as indices of instability in growth rates. In this context, Thompson's discussion on instability in urban growth trends is relevant.[16] No clear spatial pattern is evident in Figure 5 except that cities in the Georgian Bay and Niagara regions displayed the greatest growth trend instability. However, the mixture of

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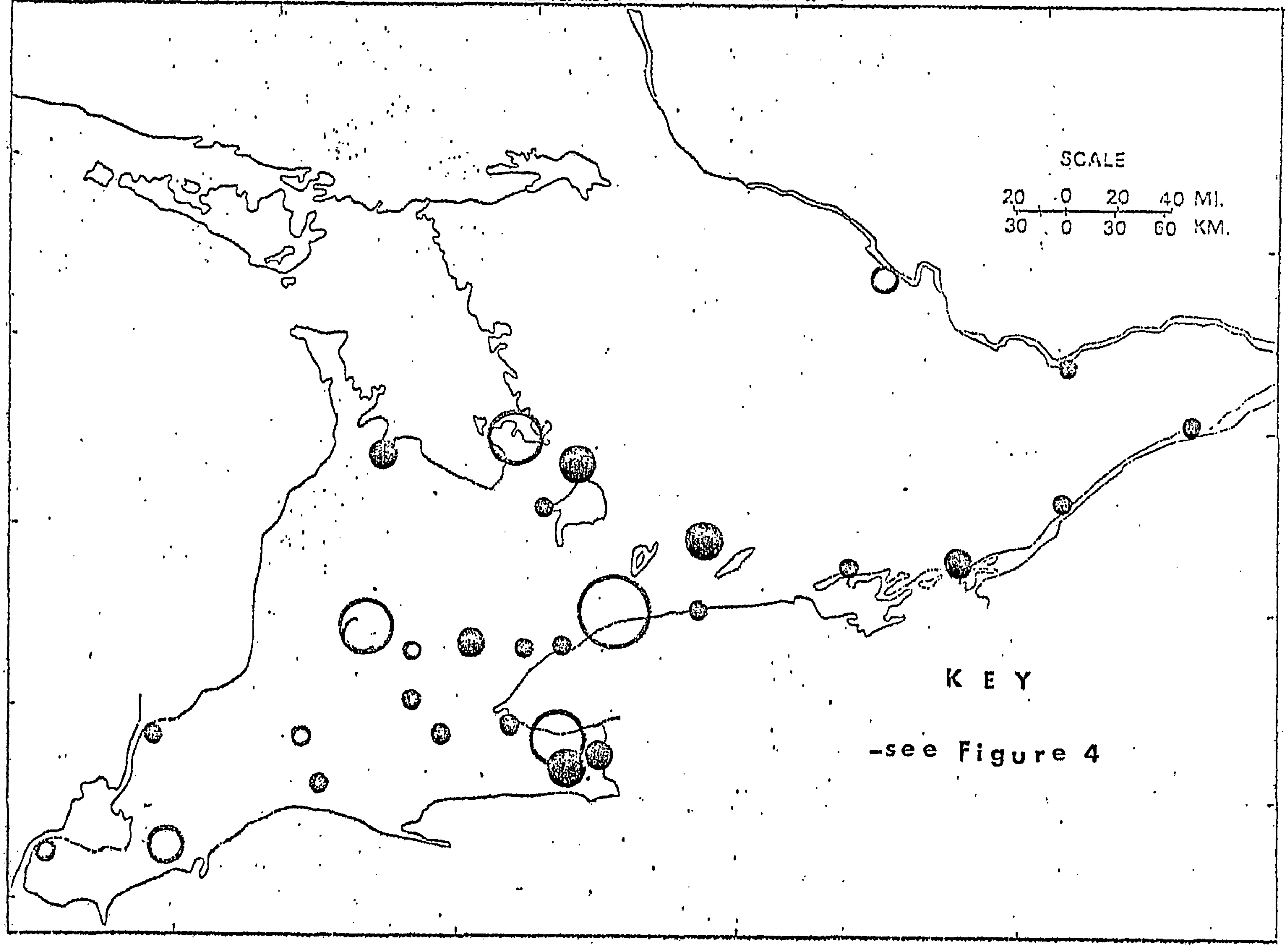
16. See: Thompson, 1965, pp. 160 - 162. Thompson identifies three kinds of economic stability: seasonal, cyclical and growth. Seasonal stability is not examined in this paper but some observations may be made in relation to their behaviour on the basis of the parameters obtained in the seasonal adjustment procedure found in Appendix B. Cyclical stability is concerned with the sensitivity of local economies to the national peaks and troughs in a time series. This dimension is examined in Analysis II. Growth instability (shifts in growth trends) is relevant in the present context.

FIGURE 5. INDIVIDUAL CITY COËFFICIENTS ON REFERENCE CURVE TWO (RC-2)



positive and negative coefficients in both regions suggests that industry mix may be an important variable. Cities with large positive coefficients (Welland, Orillia, Peterborough and Owen Sound) exhibited a slower rate of growth than predicted during the last quarter of 1969, perhaps resulting from the steel strike (August 1 to October 20, 1969) when the mean curve was at a peak and faster rates of growth during August, September and October, 1970 while the overall economy was experiencing a downswing. Cities with large negative parameters (Oshawa, St. Catherines, Stratford, Midland and Chatham) were strongly influenced by the 1970 General Motors strike but the impact of the steel strike was small.

Reference Curve 3 (RC - 3), accounting for 7.06% of total variance, is associated with slow growth during the first two years, a faster growth rate during 1970 and a levelling off during the last two years. No regional pattern is clearly apparent in Figure 6 except that large coefficients are found once again in the Niagara and Georgian Bay regions.

ii) Timing of Urban Employment Growth:
City Size and Growth Rate Effects Removed

The mean standardized curve for the second factor analysis is shown in Figure 7, along with the employment series

FIGURE 6. INDIVIDUAL CITY COEFFICIENTS ON REFERENCE CURVE THREE (RC-3)

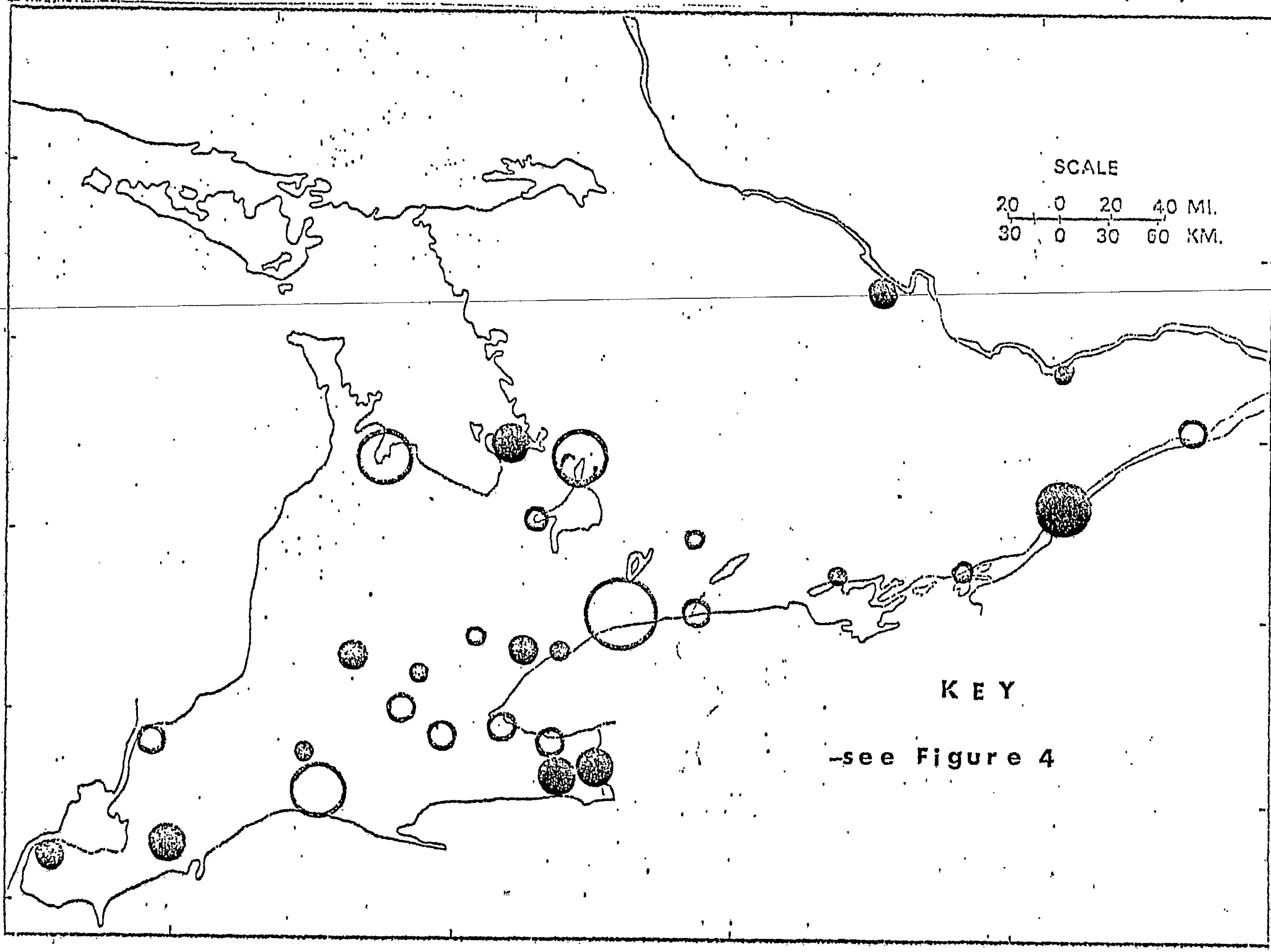
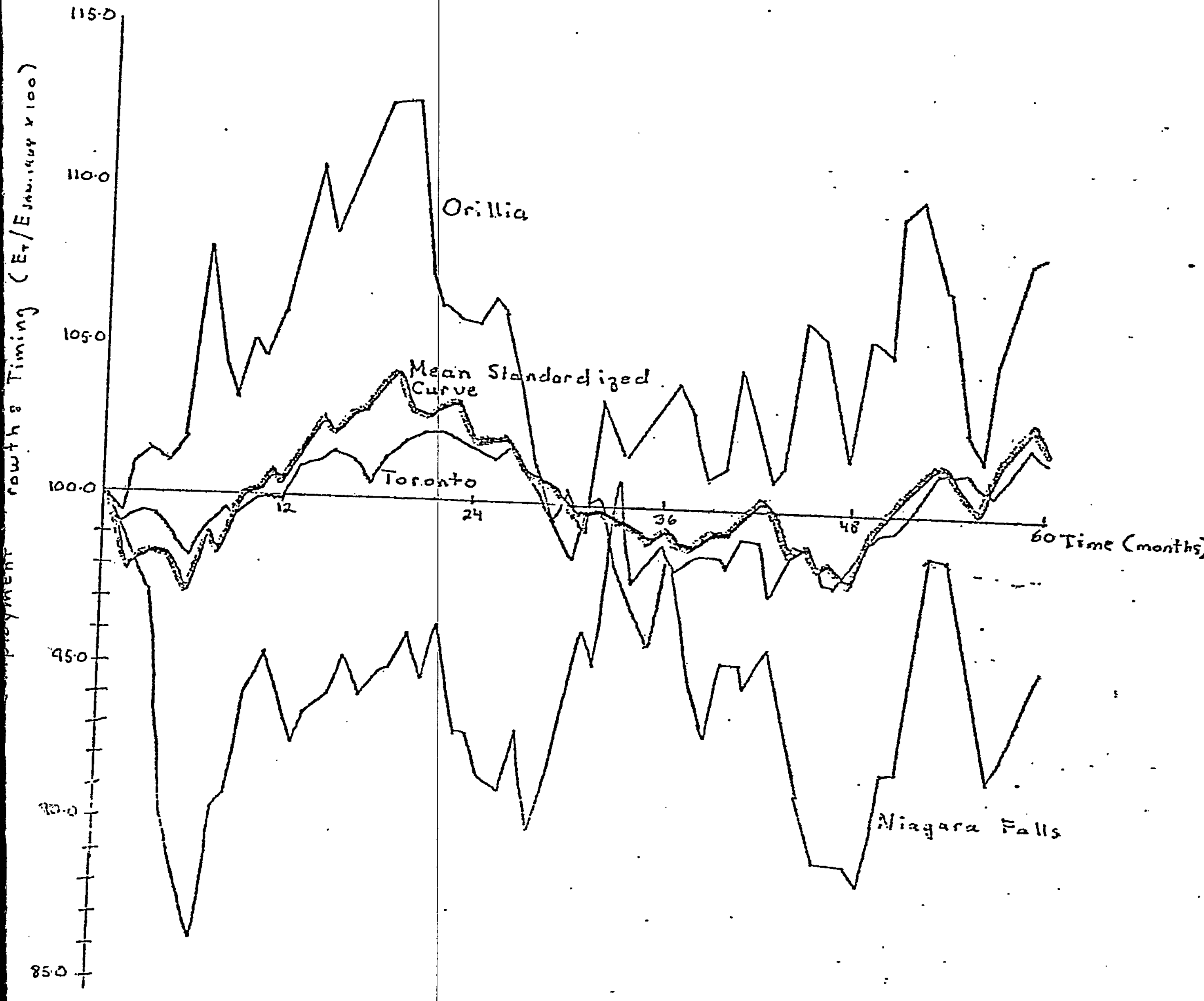


FIGURE 7

Mean Standardized Curve and Selected City Employment Series: Timing of Growth



for Toronto, Orillia and Niagara Falls. The factor analysis on the covariance matrix of the second standardized data matrix yielded three reference curves (RC - 1', RC - 2', and RC - 3') which accounted for 81.9% of the total variance around the mean curve. All the remaining reference curves individually accounted for less than 5% of total variance and were excluded from further analysis. The three reference curves are plotted in Figure 8 and the individual city coefficients are listed in Table 2.

Cities with positive individual coefficients on RC - 1', accounting for 51.20% of the total variance, have timing scores consistently above the mean while cities with negative parameters have their timing curves consistently below the mean. The individual parameters on RC - 1' can therefore be interpreted as indices of the timing of growth ranging from early (large positive values) to late (large negative values) growth. (See Figure 9)

Late growth is characteristic of cities which have a large proportion of total employment in steel or automobile and related industries. Early growth is found in cities located in the Georgian Bay region and in cities specializing in chemical and related industries (Sarnia and Cornwall).

FIGURE 8

Reference Curves: Timing of Growth

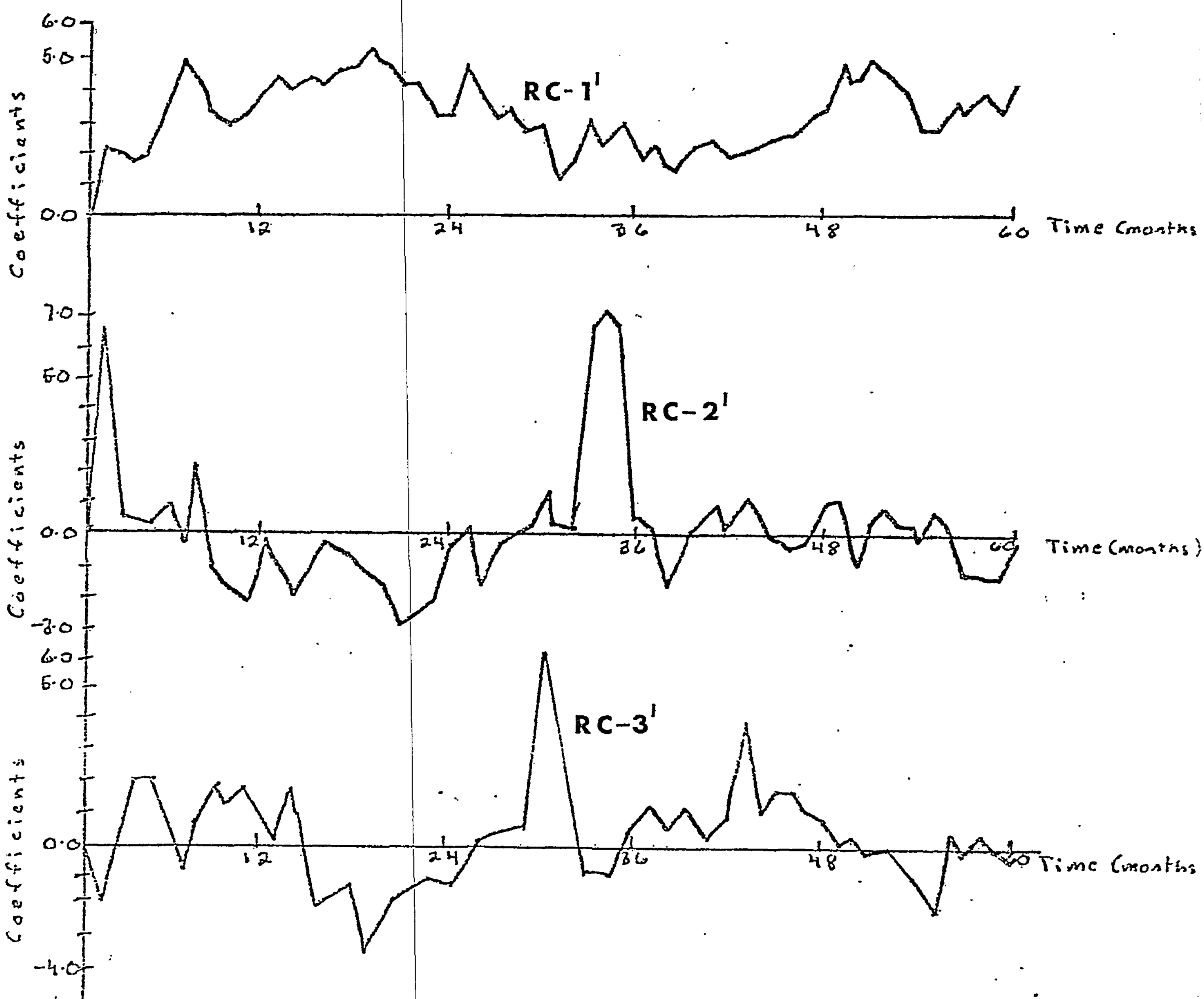


FIGURE 9. INDIVIDUAL CITY COEFFICIENTS ON REFERENCE CURVE ONE' (RC-1')

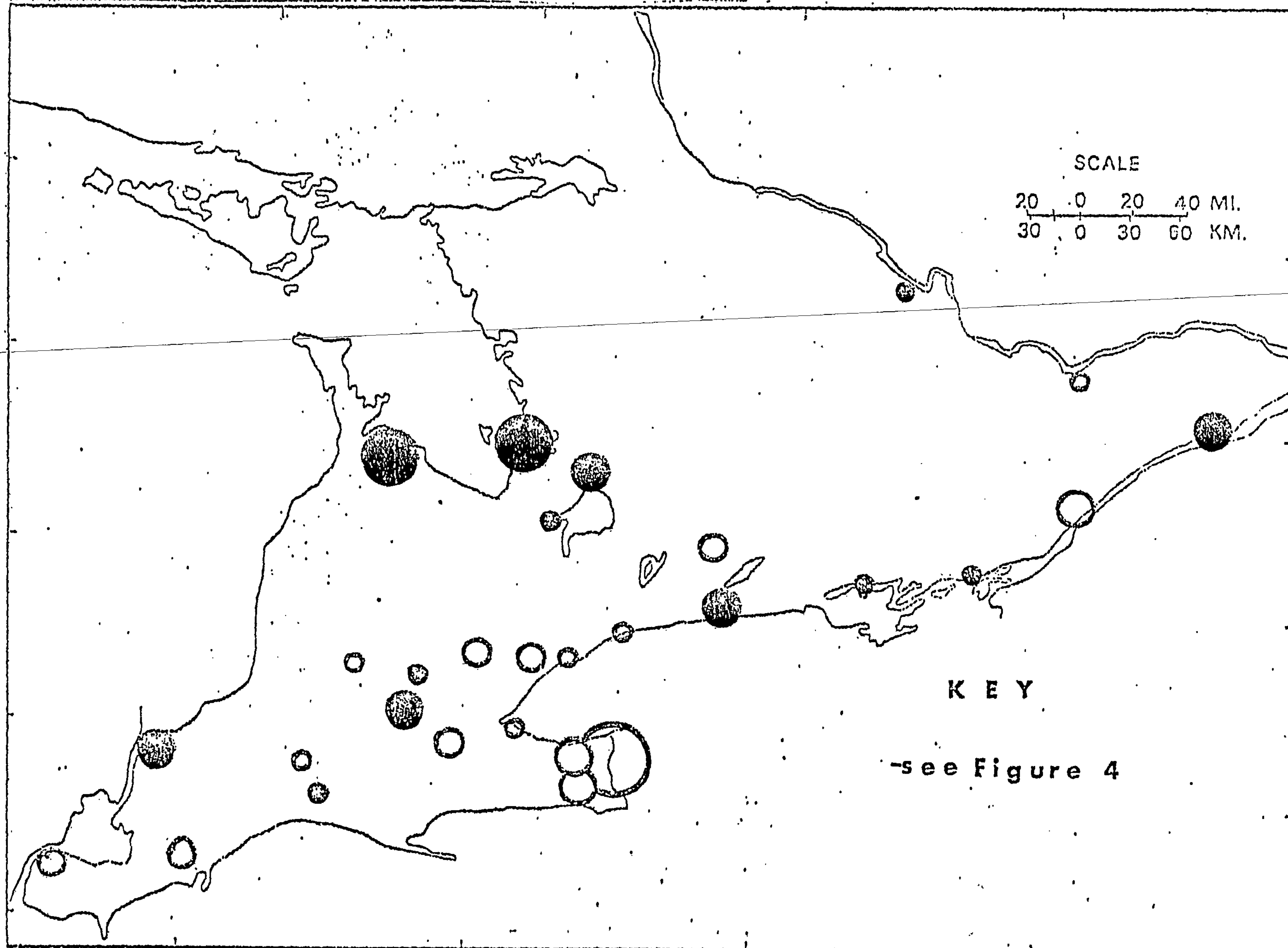


Table 2

Individual Parameter Coefficients
On The Three Reference Curves

City	Coefficients RC - 1	RC - 2	RC - 3
Barrie	.45261	.23375	-.79032
Belleville	.14561	.38657	.27780
Brampton	-.91870	.19929	.14922
Brantford	-.64949	-.25843	-1.22998
Brockville	-1.40445	.89837	.08628
Chatham	-.75646	-.16404	-.38170
Cornwall	1.37171	.07561	.07826
Guelph	-.55031	.25747	.23289
Hamilton	-.12725	.84303	.73640
Kingston	.26557	.30651	.05508
Kitchener	.28593	.07507	-.04037
London	-.28404	.21614	.26787
Midland	1.66325	.25699	.47023
Niagara Falls	-2.00837	.87685	-.41901
Orillia	1.44612	.09817	-.10768
Oshawa	-.13314	-4.24347	1.01427
Ottawa	-.29442	.38626	.16207
Owen Sound	1.52135	.00253	-.27600
Pembroke	.40518	.35008	.40030
Peterborough	-.54245	.30390	-.22964
Port Hope	1.28686	.23464	1.03391
Sarnia	1.48604	.16800	.26361
Stratford	.00484	-.40050	-.06233
St. Catherines	-1.44642	-2.11856	.75999
St. Thomas	.03465	-.66217	-4.43279
Toronto	-.04943	.35738	.21174
Welland	-1.45871	1.18461	1.27742
Windsor	-.77888	.07268	.32038
Woodstock	1.03279	.06352	.17210

The two remaining reference curves exhibit considerable fluctuations in the timing of growth. RC - 2' and RC - 3' accounted for 19.13 and 11.56% respectively, of total variance around the mean standardized curve. (See Figures 10 and 11) Only three cities, Oshawa (-4.24), St. Catherines (-2.12) and Welland (1.18) have individual parameters greater than ± 1.00 on RC - 2' (see Figure 10). Negative values are associated with cities which have a large part of their employment in the automobile industry. However, only six cities out of twenty-nine had coefficients greater than 0. This implies that the considerable fluctuations experienced by the automobile industry during the five year study period had relatively small spatial impact.[17]

With respect to RC - 3', only St. Thomas (-4.43), Brantford (-1.23), Welland (1.28) and Port Hope (1.03) had coefficients greater than ± 1.00. The effect of the Stelco strike (August 1 to October 20, 1969) is shown on RC - 3'. In comparison to RC - 2', the third reference curve exhibits a peak in July 1970, which leads the RC - 2' peak. This indicates that cities with positive coefficients experienced

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17. Total employment in the transportation equipment industry (S.I.C. #323) fluctuated considerably between 1968 and 1971: 1968 - 96,146, 1969 - 100,032, 1970 - 92,339 and 1971 - 99,011. (Census of Manufacturing, Statistics Canada.)

FIGURE 10. INDIVIDUAL CITY COEFFICIENTS ON REFERENCE CURVE TWO' (RC-2')

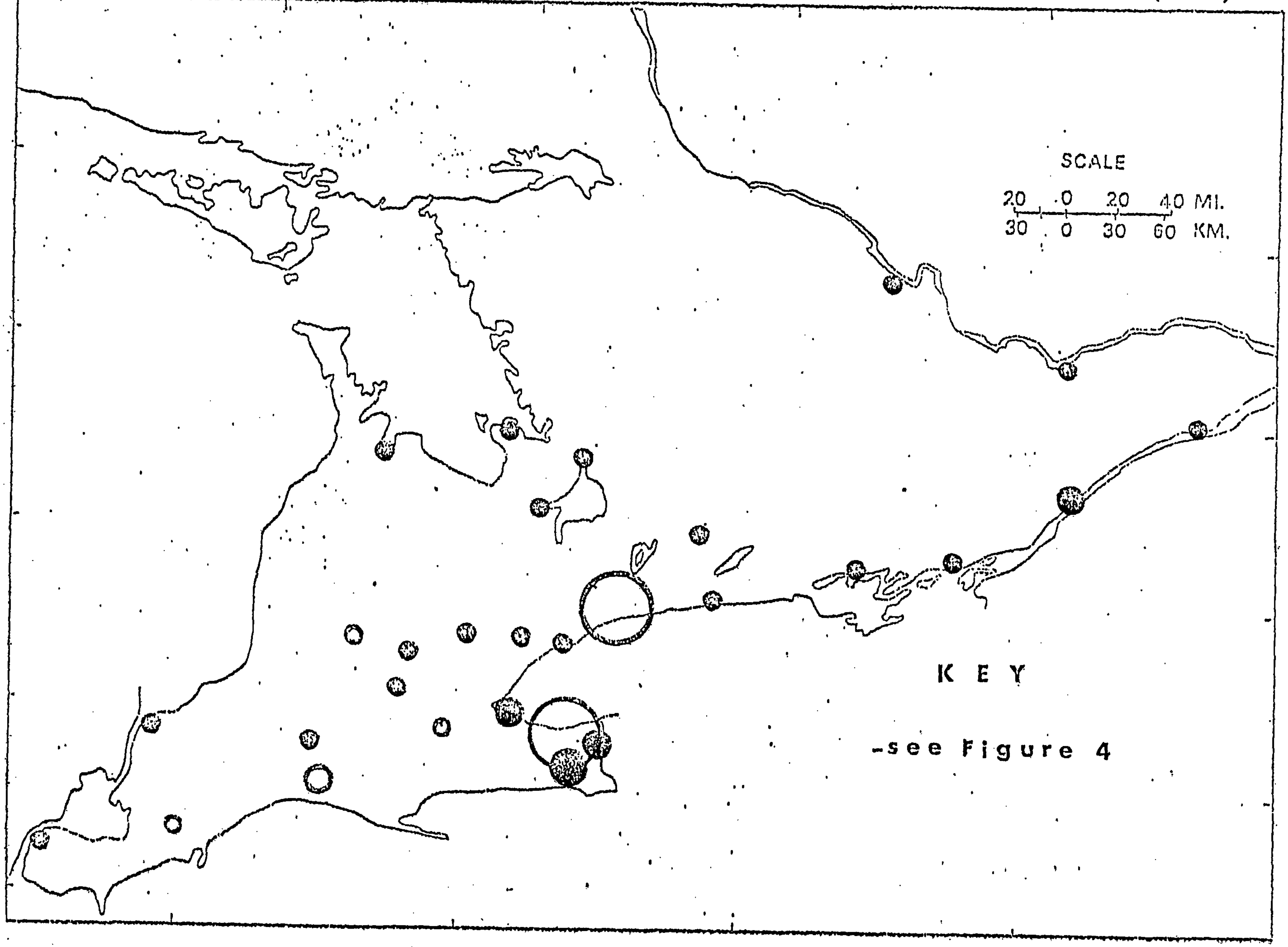
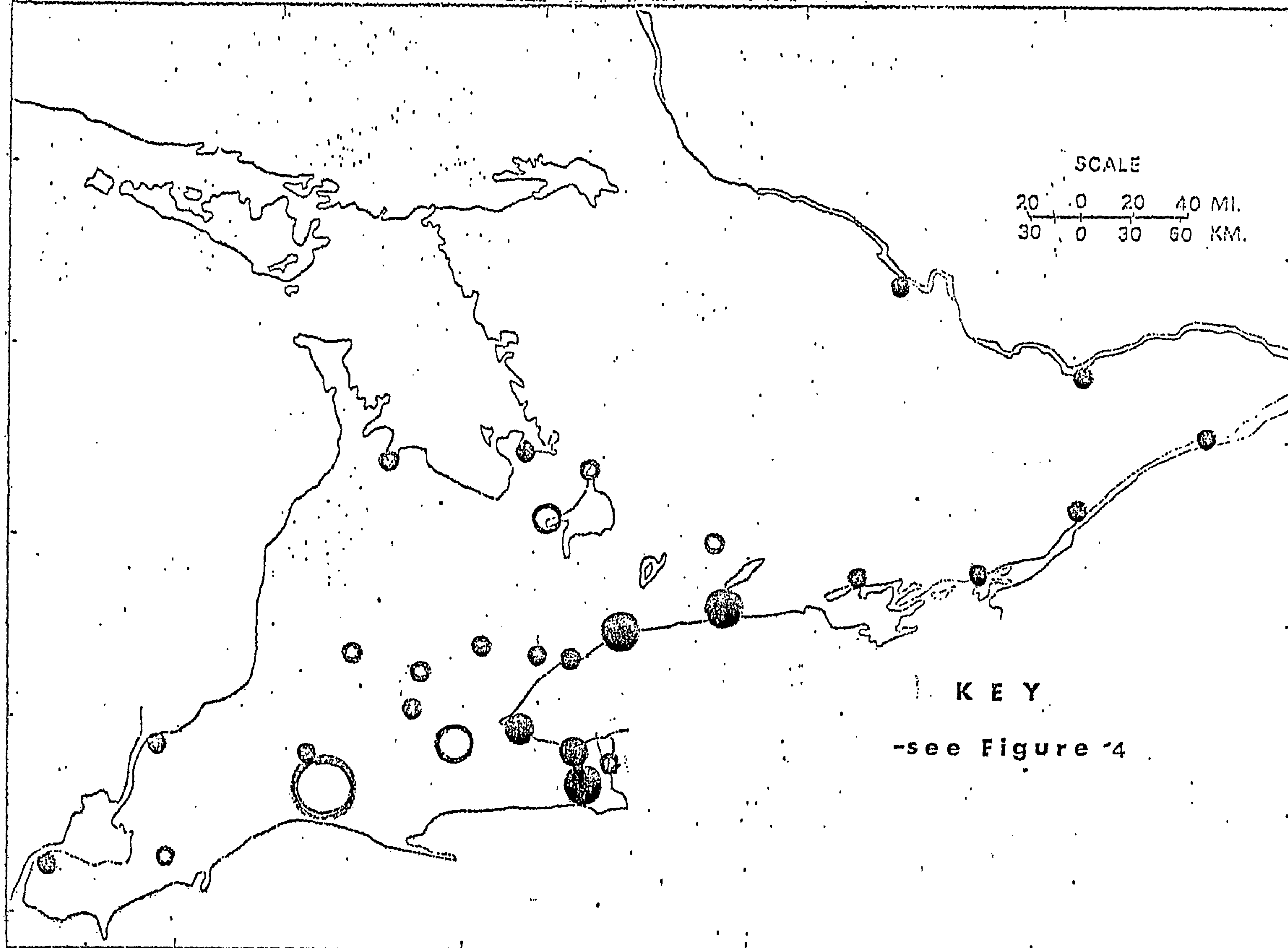


FIGURE 11. INDIVIDUAL CITY COEFFICIENTS ON REFERENCE CURVE THREE' (RC-3')



an increase in employment levels resulting from the increased production in the building up of inventories in anticipation of the auto strike.

2) Analysis II: Decomposition Model

In Analysis II, an attempt is made to decompose seasonally adjusted urban employment time series into a national component, a regional component and a five-year "normal" employment growth trend. The model outlined in the statistical framework was estimated using multiple regression analysis. The 29 regression equations are presented in Table 3. It should be noted again that no lead or lag between the national and local series was used.

The main purpose of Analysis II is to remove the national effect from the local time series and use the refined data in Analysis III. However, two parameters in the model, the R^2 and the a_j coefficients, are of interest since they measure the importance of national factors in local employment levels and, therefore, offer some insight as to the relative importance of regional forces. The a_j coefficient provides a measure of the sensitivity of local employment series to changes in the national employment series. Thus, if $a_j > 1$, the city's fluctuations are more severe than the

Table 3

Regression Equations

(1) City	(2) Slope Intercept a_0	(3) a_1 (t)	(4) a_2 (t^2)	(5) a_j (N)	(6) R^2(100)	(7) $(1.00-R^2) \times 100$
Barrie	-446.84120	-.82342	.00897	4.98050	89.96	10.04
		(-4.90829)	(4.18894)	(10.10140)		
Belleville	-2.91846	.25743	-.00209	.97130	93.84	6.16
		(3.58365)	(-2.27708)	(4.60066)		
Brampton	-82.97631	.76554	-.00587	2.75463	89.46	10.54
		(2.64310)	(-1.58948)	(3.23000)		
Brantford	-336.35960	-.55823	.00024	3.82719	74.69	25.31
		(-3.27216)	(.11245)	(7.63309)		
Brockville	210.37016	.09367	-.00142	.65342	39.54	60.46
		(.63932)	(-.75852)	(-1.51750)		
Chatham	-109.70947	-.52971	.01090	1.99902	86.32	13.68
		(-2.91375)	(4.69767)	(3.74135)		
Cornwall	-232.15763	-.95987	.00666	3.04903	84.26	15.74
		(-8.11207)	(4.41123)	(8.76758)		
Guelph	-34.04266	.12358	-.00666	1.46352	85.57	14.43
		(1.43605)	(-6.06897)	(5.54832)		
Hamilton	109.87042	.14881	-.00112	.07145	49.95	50.05
		(1.28130)	(-.75715)	(.20932)		
Kingston	-108.47919	-.27479	.00006	1.91528	93.41	6.59
		(-7.48353)	(.12847)	(17.74750)		
Kitchener	-163.26112	-.25513	.00393	2.52795	97.59	2.41
		(-4.5007)	(5.48178)	(15.30607)		
London	-47.01378	-.23145	.00262	1.38545	87.34	12.66
		(-4.19378)	(3.71450)	(8.54173)		
Midland	-101.45925	-.50773	.02022	2.04584	97.10	2.90
		(-2.7450)	(8.5640)	(3.763)		

(cont'd)

Table 3 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Niagara Falls	101.40670	.57887	-.00693	.01498	69.68	30.32
		(4.01788)	(-3176675)	(.035371)		
Orillia	-193.98257	.07277	-.00510	2.63586	81.52	18.48
		(.58357)	(-3.20564)	(7.19255)		
Oshawa	-687.04486	-1.69250	.01314	6.76721	54.29	45.71
		(-3.53716)	(2.15178)	(4.81214)		
Ottawa	4.62874	.45750	-.00381	.97962	99.04	0.96
		(12.29593)	(-8.03190)	(8.95834)		
Owen Sound	-347.02620	-.62760	.00022	4.06509	72.15	27.85
		(-3.09498)	(.08422)	(6.82097)		
Pembroke	11.09440	-.75497	.00970	.79238	79.27	20.73
		(-8.80966)	(8.86745)	(3.14605)		
Peterborough	-81.66174	.36361	-.00963	1.74533	91.07	8.93
		(4.93771)	(-10.24796)	(8.06430)		
Port Hope	-194.37783	-.90607	.00485	2.93659	77.69	22.31
		(-5.10813)	(2.14060)	(5.63305)		
Sarnia	-235.01066	-.93348	.00744	3.13061	84.06	15.94
		(-9.25229)	(5.77578)	(10.55787)		
Stratford	-367.75519	-1.16930	.01822	4.20266	93.36	6.64
		(-10.08766)	(12.32053)	(12.33646)		
St. Catharines	-376.61553	-.64639	.00185	4.20679	56.43	43.57
		(-2.21183)	(.49638)	(4.89789)		
St. Thomas	-789.45603	-.56931	.00344	7.90171	78.39	21.61
		(-1.19218)	(.56499)	(5.63009)		
Toronto	-23.97738	.06353	-.00050	1.23658	98.20	1.80
		(2.15989)	(-1.32449)	(14.30429)		
Welland	288.39138	.96610	-.01283	-1.51919	72.54	27.46
		(7.49020)	(-7.79359)	(-4.00797)		
Windsor	-22.39884	-.35384	.00357	1.42384	42.40	57.60
		(-2.23920)	(1.77224)	(3.06580)		
Woodstock	-190.64321	-.61337	.00429	2.82402	63.52	36.47
		(-3.92387)	(2.15040)	(6.14695)		

nation's (and if a_j 1, then the local fluctuations are less severe). The a_j parameter, therefore, provides an index of urban cyclical instability (see Column 5 in Table 3). The a_j values range from a high of 7.90 for St. Thomas to a low of -1.52 for Welland,[18] with a mean value of 2.40 which indicates that overall cities in Southern Ontario are cyclically unstable. London (1.39), Toronto (1.24) and Ottawa (0.98) in contrast, are cyclically stable thus lending support to Thompson's (1965) contention that large cities closely approximate the cyclical pattern of the nation. These cities also exhibited low coefficients on the timing reference curves. Cities specializing in automobile manufacturing exhibit large values (Oshawa, 6.77, St. Thomas, 7.90 and St. Catharines 4.21). Windsor, however, has a value of only 1.42 which is more representative of larger urban areas. Centres which have a large proportion of their employment in steel and related industries are, generally, less susceptible to national fluctuations (Hamilton, 0.07, Niagara Falls, 0.01, Brockville, -0.65 and Welland, -1.52).

It has been hypothesized in the literature that cities specializing in durable goods manufacturing will be

18. A negative a_j indicates that the cycles in the local time series are opposite to the national cycles.

more sensitive to changes in aggregate demand (that is, in the national cycle) because of the high income elasticities for these products (Thompson, 1965; Jeffrey, 1970). It has also been postulated that local cyclical instability is inversely related to the degree of industrial diversification, overall growth performance and city size.[19] Figures 12, 13, 14 and 15 show the relationship between cyclical stability (the a_j coefficients) and (1) the percentage of total employment in durables,[20] (2) percentage of manufacturing employment in durables, (3) percentage of total employment in manufacturing and (4) 1972 12-month average total employment.[21]

No clear relationship is evident in Figures 12 and 13 and suggests that a distinction between producer and consumer durables should be made. Figure 14 suggests a curvilinear relationship between the degree of cyclical instability and percentage employed in manufacturing. In Figure 15, large urban places tend to replicate the national

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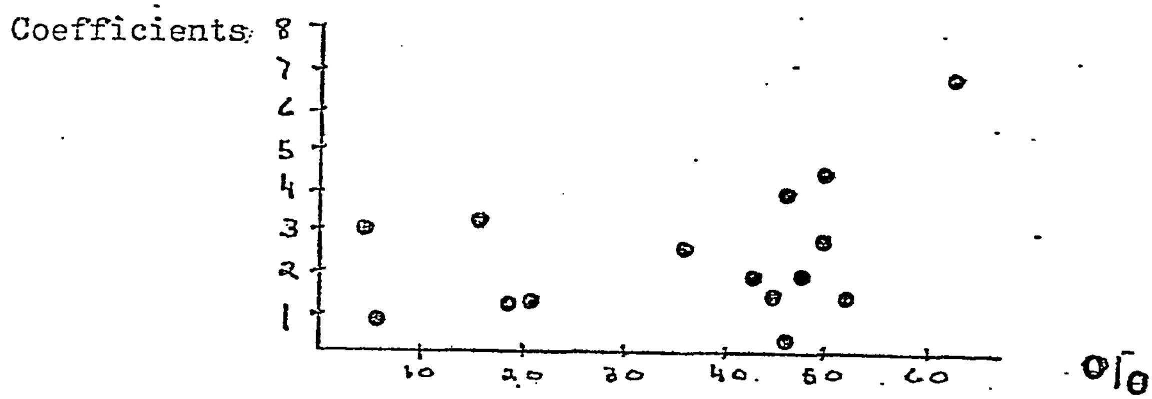
19. See Thompson (1965), Jeffrey (1970), King, Casetti and Jeffrey (1972) and Siegel (1969).

20. Durable goods manufacturing include the following industries: wood, furniture and fixtures, primary metal fabricating, machinery, transportation equipment, electrical products and non-metallic mineral (as defined in the "Employment, Hours and Earnings" publications.)

21. The data used in these figures, and their sources, are presented in Appendix C.

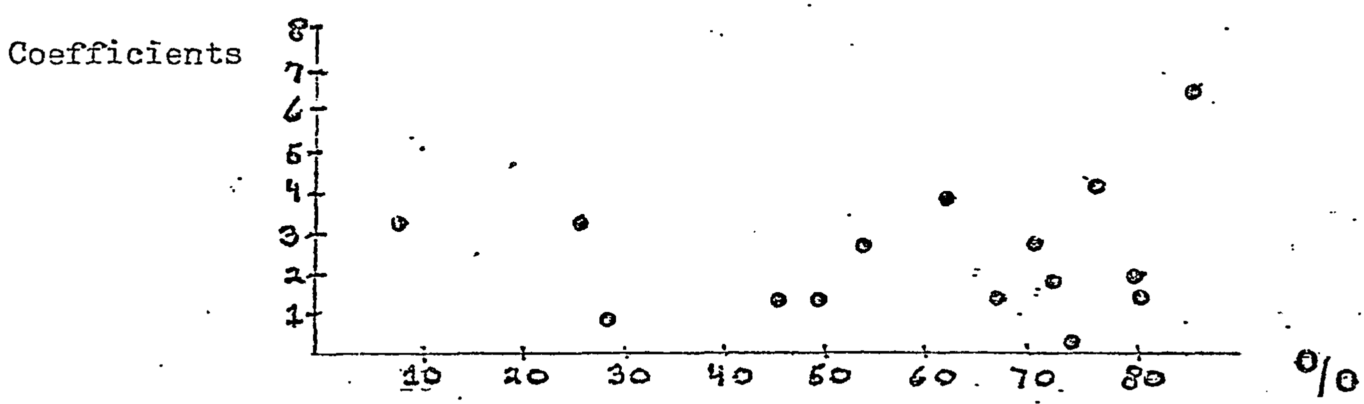


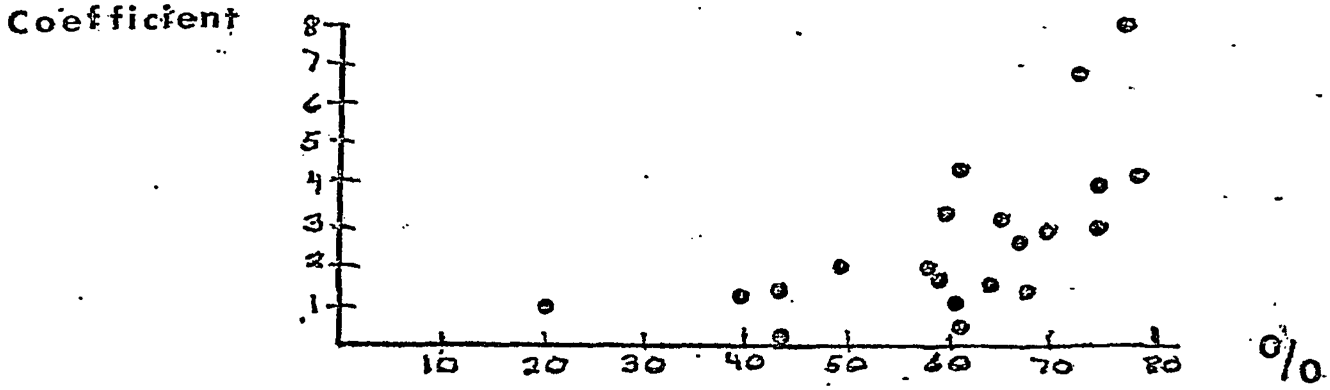
Sensitivity to National Cycle Versus Percentage of Total Employment in Durable Manufacturing

FIGURE 12

FIGURE 13

Sensitivity to National Cycle Versus Percentage of Total Manufacturing Employment in Durables



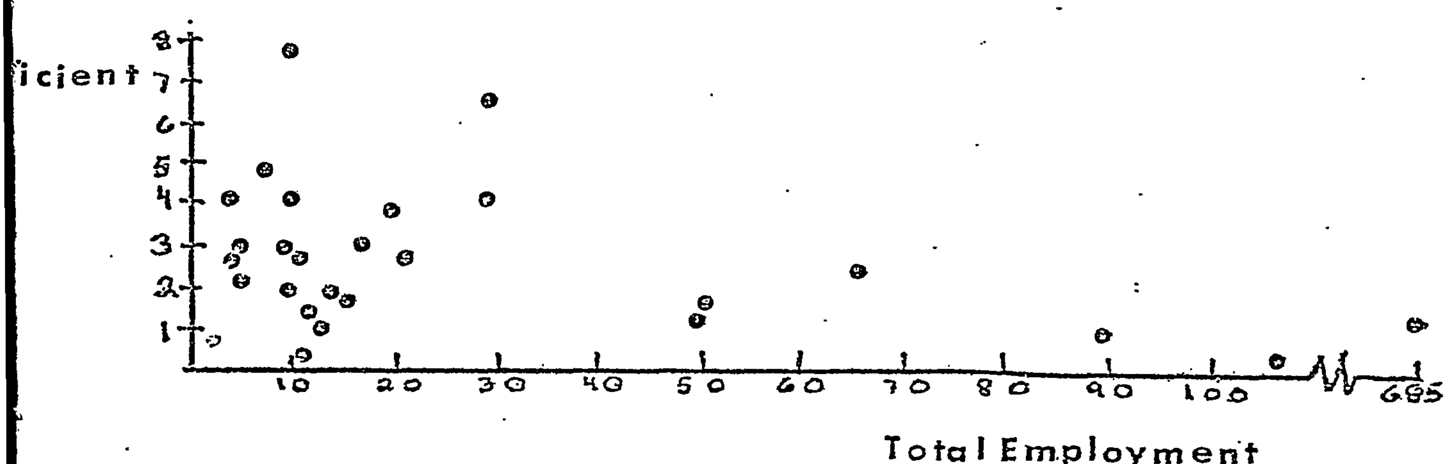


Sensitivity to National Cycle Versus Percentage of Total Employment in Manufacturing

FIGURE 14

FIGURE 15

Sensitivity to National Cycle Versus Total Employment (1972-12 month average)



cyclical behaviour whereas smaller cities exhibit a large range of a_j coefficients as some centres tend to specialize in the more unstable and some in the more stable industries.[22] These findings, however, can only be viewed as preliminary, given the small data sample and simple measures used.

The second measure of the importance of the national business cycle on local time series is the coefficient of determination (R^2). In the regression model, the larger the R^2, the greater the importance of national as opposed to regional forces. Therefore, if the R^2 coefficients are subtracted from 1.00, a measure of the relative importance of regional forces on local time series is obtained. These measures are listed in Column 7 of Table 3. Ottawa with a value of 0.08 has the lowest figure and Brockville (.605) the highest. In view of the large number of cities with small $1.00 - R^2$ measures, it must be kept in mind that the study period embraces part of the 1968 and the entire 1970 recessionary periods. The influence of national developments was quite strong, and, as a result, the strength of regional

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22. Figure 15 is similar to Thompson's (1965, Figure 5, p. 148) graph showing the hypothesized relationship between city size and degree of cyclical stability.

forces may be weaker and hidden.

In general, cities specializing in steel production (Hamilton and Welland) and in automobile production (Oshawa, Windsor, St. Thomas and St. Catharines) are most susceptible to regional forces. In comparison, King, Casetti and Jeffrey (1972) found that the national business cycle found its greatest local expression in the manufacturing region of the Mid-east, centering on the Detroit-Pittsburgh axis (the automobile and steel production centres of the United States). This comparison suggests that the United States economic system (particularly in the manufacturing core area) may be a source for some of the regional cyclical fluctuations observed for some cities in Southern Ontario. It was noted, for example, in one report of the <u>Ontario Manpower Review</u> that production in the auto industry "is partially independent of domestic sales and in which the employment picture is not necessarily coloured by the general economic conditions in Canada itself" (July-August, 1970, p. 5).

Cities with large regional components also exhibited large coefficients on the timing reference curves (RC - 1', RC - 2' and RC - 3'). Conversely, cities with a small regional component, had low parameter values on the three reference curves. The argument made here is that the reference curves identify regional components in the local time series.

3) Intercity Relations and Regional Patterns of Economic Fluctuations: A Simple Grouping of Cities

An ideal analysis of urban short term behaviour would be one which identifies the origin of an economic impulse or shock and follows the spatial diffusion of this shock through the urban system. The study could then focus on the behaviour of centres (intensity and timing of absorption) as the shock is propogated from the source. The local response will be affected by a variety of social, political, economic and geographical boundary effects, such as absorbing, reflecting and partially transmitting ones (Jutila, 1973, p. 303). The various interaction flows (hierarchical and/or distance-decay) could then be directly investigated. Jutila (1973) has developed a model on these dynamic aspects of economic propogation. In the present study, however, it is not possible to follow up on this strategy. Nevertheless, if Jeffrey's (1974, p. 114) argument that "major metropolitan areas, with their intricate industrial, financial, and commercial structures and large local economies, might be expected to play a leading role in generating ... regional cyclical impulses is assumed to be true for Toronto in the Southern Ontario urban system, which is not an unrealistic assumption, some further comments on the transmission of growth impulses may be made, based on the results of Analysis I and II.

This section attempts to identify the dependent variables, intensity and timing of growth and the independent variable, time, for some cities, will display a set of parameters which do not fall into one distinct group. It should also be noted that the study deals at a relatively small spatial scale; as a result, it would not be surprising if distinct regional patterns do not emerge. If the study was applied to the national urban system, regional patterns of variability may be more readily identifiable. In addition, the susceptibility of the local economy to employment fluctuations will be a complex function of distance to nearby centres, industry mix and position in the urban hierarchy. Therefore, depending on the source and type of impulse and the transmission mechanism, cities may display fluctuations which resemble more than one group.

The cities are first grouped into fast or slow growth centres based on their signs on RC - 1. Only the reference curve from the factor analysis of growth rates is used because of its high percentage of explained variance around the mean standardized curve. Within each of the two major groups, the individual parameters on RC -1', RC - 2' and RC - 3' are used to further group the cities. The sign and size of city coefficients are both considered. Finally, the relative importance of regional forces (1.00 - R^2) on local time series is listed for each city. Table 4 presents the final grouping of centres according to the above grouping scheme.

Members of Group 1 display no large parameters ($\gtrless \pm 1.00$) on any of the three timing reference curves and, in comparison to other groups, are the least susceptible to regional forces. The inclusion of a wide range of diverse cities (with respect to the local economic base) and of distant cities (such as Ottawa, Belleville and Toronto), are indicative of hierarchical interaction. Three out of the four cities with the largest total employment (Toronto, Ottawa and Kitchener) are found in this group. The inclusion of Belleville is somewhat unexpected but it does suggest that this centre has strong spatial linkages with the urban system, focussed on Toronto and Ottawa.

Group 2 shows a distinct spatial clustering of cities in the Georgian Bay region. These centres have large parameters on RC - 1' indicative of early growth. Except for Barrie, these centres also exhibited considerable instability in local growth trends as reflected by the RC - 2 parameters. The increased importance of regional forces is also evident. The spatial clustering of cities in Group 2 suggest that proximity to Toronto is an important variable in determining the nature of response to economic fluctuations.

Group 3 cities display a similar set of parameters on the timing reference curves but show slow rates of growth. Centres in Group 3 are also relatively cyclically stable and tend to be strongly influenced by national forces. The fact that these centres display similar timing of growth in comparison to Groups 1 and 2 and that some of the cities have important "regional" influence (for example, London, Kingston and Peterborough) implies that position in the urban hierarchy and distance from Toronto are important variables. It should also be noted that Hamilton and Windsor display similar coefficients on the timing reference curves as Group 1 which further indicates the importance of city size or position in the urban hierarchy in affecting the local susceptibility to

Table 4

A Simple Grouping of Cities

A. Fast Growth Rates

City	Coefficients (i) RC-1'	(ii) RC-2'	(iii) RC-3'	(iv) $1.00-R^2$
Group 1				
Toronto	-.04943	.35738	.21174	1.80
Ottawa	-.29442	.38626	.16207	0.96
Brampton	-.91870	.19929	.14922	10.54
Belleville	.14561	.38657	.27780	6.16
Barrie	.45261	.23375	-.04037	10.04
Kitchener	.28593	.07507	-.04037	2.41
Stratford	.00484	-.40050	-.06233	3.64
Group 2				
Midland	1.66325	.25699	.47023	2.90
Orillia	1.44612	.09817	-.10768	18.48
Owen Sound	1.52135	.00253	-.27600	27.85
Others				
St. Thomas	.03465	-.66217	-4.43279	21.61
Chatham	-.75646	-.16404	-.38170	13.68

B. Slow Growth Rates

City	(i) RC-1'	(ii) RC-2'	(iii) RC-3'	(iv) $1.00-R^2$
Group 3				
Guelph	-.55031	.25747	.23289	14.43
London	-.28404	.21614	.26787	12.66
Kingston	.26557	.30651	.05508	6.59
Peterborough	-.54245	.30390	-.22964	8.93
Group 4				
Oshawa	-.13314	-4.24347	1.01427	45.71
St. Catherines	-1.44624	-2.11856	.75999	43.57
Group 4'				
Windsor	-.77888	.07268	.32038	57.60

(cont'd)

Table 4 (continued)

City	Coefficients (i) RC-1'	(ii) RC-2'	(iii) RC-3'	(iv) $1.00-R^2$
Group 5				
Hamilton	-.12725	.84303	.73640	50.05
Welland	-1.45871	1.18461	1.27742	27.46
Brockville	-1.40445	.89837	.08628	60.46
Niagara Falls	-2.00837	.87685	-.41901	30.32
Group 6				
Sarnia	1.48604	.16800	.26361	15.94
Cornwall	1.37171	.07561	.07826	15.74
Woodstock	1.03279	.06325	.17210	36.47
Others				
Pembroke	.40518	.35008	.40030	27.83
Brantford	-.64949	-.25843	-1.22998	25.31
Port Hope	1.28686	.23464	1.03391	22.31

economic fluctuations. However, because of the large size of the regional component, these two centres were excluded from Group 3.

Whereas the first three groups are suggestive of hierarchical interaction, the remaining groups are more readily interpreted in terms of production system linkages. Oshawa and St. Catharines (Group 4) which specialize in the automobile industry emerge as a distinct group. Oshawa's earlier growth may be the result of its closer distance to

Toronto. Windsor does not clearly fall in this group because of its size and sign of the RC - 2' coefficient.

The predominance of the petro-chemical manufacturing industry in Sarnia and Cornwall and of linked industries such as knitting in Woodstock, is evident in Group 5. Group 6 centres have an unique characteristic in that they are the least susceptible to national cyclical forces and that they experience later growth in comparison to other centres in Southern Ontario. Group 6 cities have a large proportion of total employment in the primary metal industry (Hamilton and Welland) or in linked industries such as metal fabricating in Brockville.[23] The major industries in Niagara Falls, however, include glass and glass products and chemical and chemical products manufacturing, which are not strongly linked to the steel industry.[24] This implies that Niagara Falls' close proximity to the slow growing centres of Hamilton and St. Catharines is an important factor in determining its employment fluctuations.

Several cities did not fit clearly into any of the above groups. Brantford and Chatham display negative

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23. See Appendix C.

24. Measures of inter-industry linkages were obtained from the 1965 Ontario Input-Output Table. See Kubursi and Frank, 1972.

coefficients on all three timing reference curves but opposite signs on RC - 1. Brantford's slow growth may be attributed to its specialization in the manufacturing of agricultural implements which has strong backward linkages to the iron and steel industry and to the poor market conditions facing this industry during the study period. St. Thomas exhibited a fast rate of growth even though the Ford Motor Company is a large employer. The city's growth trend may be accounted for by the fact that the automobile industry is a relatively new industry being located in the area just before the reference period. Thus, the fast rate of growth may be the result of the new industry expanding to meet its employment capacities. No attempt is made here to account for the growth patterns found in Pembroke and Port Hope.

In Summary, Groups 1, 2 and 3 are suggestive of hierarchical interaction in the sense that they include the larger sized cities along with nearby smaller centres, as well as cities with varying industrial composition. These centres also tend to have either a fast or average rate of growth. Cities located close to Toronto also showed early growth. The relative importance of regional forces in local time series was small except for a few centres in the Georgian Bay area.

On the other hand, the other groups are more readily interpreted in terms of production system linkages, especially in the iron and steel, transportation equipment, chemical and related industries. Cities in these groups also tend to be more specialized in the sense that they have a large proportion of their employment in one industry (see Appendix C) and have the largest regional component in their time series which may be partially the result of their sensitivity to market developments in the United States. These centres also displayed the slowest rates of growth and, except for cities orientated towards the chemical industry, showed late growth.

It has been shown that the response of urban economies to short term impulses, in terms of intensity and timing of growth, is related to the local industry mix, the relative location of the city, city size, degree of industrial diversification and distance to other centres. Moreover, the results also showed that this relationship is complex.

3) Analysis III: Testing for Polarized Growth

The purpose of the following analysis is to test the hypothesis that employment growth is hierarchically polarized in Southern Ontario. To test this hypothesis, a method developed by Odland, King and Casetti (1973) is used. The analysis focuses directly on the growth of individual centres in Southern Ontario as a response to regional forces during the January 1968 - December 1972 period.

A hierarchy of two distance effects is hypothesized. The first is a Provincial growth pole effect, with the Toronto C.M.A. assumed to be the Provincial growth pole. This effect is assumed to depend on S_1, defined as the Euclidean distance from a city to Toronto.[25]

Regional distance effects with large sized cities or second order/secondary growth poles is also hypothesized. Ottawa, London and Hamilton are assumed to be the given secondary or regional growth poles.[26] Distance to a secondary growth pole is defined as the Euclidean distance between each centre and the nearest assumed second order growth centre. Growth is defined for each centre as

$$Z(t_n, s_1, s_2) = \frac{E\ (t_n, s_1, s_2)}{E\ (t_o, s_1, s_2)}$$

---

25. A digitizer was used to assign the x and y co-ordinates to the 29 cities. Distance between city i and growth centre j is defined as $\left[(x_j - x_i)^2 + (y_j - y_i)^2 \right]^{\frac{1}{2}}$

26. Carol (1966, 1969) has identified Toronto as the highest order growth centre and London, Hamilton and Ottawa as high order growth centres.

where: Z = the growth index

E = adjusted industrial composite employment index (national and seasonal factors removed)

t_o = January, 1968

s_1 = distance to Toronto

s_2 = distance to nearest regional growth centre

The ratios of employment were employed in order to remove the effect of different initial values reflecting growth behaviour prior to 1968. The adjusted time series has both the seasonal (Appendix B) and national (Analysis II) fluctuations removed thereby focussing on regional forces of growth.

Estimation of the parameters of the function,

$Z = a_o + a_1 s_1 + a_2 s_2 + b_o t + b_1 s_1 t + b_2 s_2 t$ (equation 11 in Chapter III) was completed in two ways. The first testing of the model excluded the four given growth centres whereas the four cities were included in the second testing.

With the four given growth centres excluded from the data sample, the estimated regression equation is[27].

$$Z = 95.15478 + .23636\ s_2 - .08506\ s_1 + .01502\ s_2 t - .00404\ s_1 t - .46357\ t$$

27. The independent variables are presented in the same order as in the step wise multiple regression. The F-level for inclusion for all analyses was .01000; and for deletion, (cont'd)

The multiple correlation coefficient, R^2, is only .1228 which is very low but still significant.

For the dependent variable, total employment growth

$$\frac{\delta z}{\delta t} = .01502\ s_2 - .00404\ s_1 - .46357$$

which is positive for plausible values of s_1 and s_2.

The hypothesis of positive polarized growth with respect to Toronto is confirmed since

$$\frac{\delta^2 z}{\delta t\, \delta s_1} = -.00404$$

is negative.

Regional positive polarization effects were not present since

$$\frac{\delta^2 z}{\delta t\, \delta s_2} = .01502$$

is greater than zero.

The model was also fitted by including employment growth for the four growth centres in the data sample. The resulting regression equation is

$$z = 102.61179 - .05234\ s_2 + .00263\ s_1 + .00389\ s_1 t - .00835\ s_2 t + .14146\ t$$

with a R^2 of .1752.

The first derivative with respect

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27. (cont'd) .00500. The tolerance level was set at .00100. Table 5 provides a summary for all the tests in this section.

$$\frac{\delta z}{\delta t} = .00389\ s_1 - .00835\ s_2 + .14146$$

In this case, employment growth is not polarized with respect to Toronto since

$$\frac{\delta^2 z}{\delta s_1 \delta t} = .00389$$

is positive but is polarized with respect to secondary growth centres since

$$\frac{\delta^2 z}{\delta s_2 \delta t} = -.00835$$

is less than zero.

The results of the two tests indicate that polarization of employment growth in Southern Ontario is independent of the growth of Metro Toronto itself but dependent on the effects of secondary growth centres. In other words, employment growth tends to be polarized on Toronto when the observations for that city are removed from the data and on the three secondary poles when their data is included.

Another estimation was made in an attempt to improve the R^2 by redefining the independent variable, distance to secondary growth centres. In the above two tests, Toronto was considered only to be a "first-order" growth centre. However, it is more realistic to think of Toronto as functioning also as a secondary growth centre. That is, cities which

Table 5

Summary Table For Three Tests Of Polarized Growth

Test	Step Number	Variable Entered	Multiple R	Multiple R^2	Increase In R^2	F Value To Enter
	1.	dist. to Sec.	.2718	.0739	.0739	119.4548
	2.	dist. to Tor.	.3283	.1078	.0339	56.9276
	3.	dist. Sec.x time	.3347	.1120	.0043	7.1783
1.	4.	dist. Tor.x time	.3472	.1205	.0085	14.4327
	5.	time	.3504	.1228	.0023	3.8659
	1.	dist. to Sec.	.2841	.0807	.0807	142.0478
	2.	dist. to Tor.	.3726	.1388	.0581	109.1024
	3.	dist. Tor.x time	.3845	.1478	.0090	17.1325
2.	4.	dist. Sec.x time	.4171	.1740	.0262	51.1339
	5.	time	.4185	.1752	.0012	2.2702
	1.	dist. to Sec.	.3184	.1014	.1014	182.5456
	2.	dist. to Tor.	.4650	.2162	.1148	236.8558
	3.	dist. Tor.x time	.4743	.2250	.0088	18.3653
3.	4.	dist. Sec.x time	.5166	.2669	.0419	92.2544
	5.	time	.5179	.2682	.0023	2.9273

are located closer to Toronto than to one of the three previously defined secondary growth centres will more likely be influenced by Toronto rather than one of the other secondary growth poles. In view of this argument, distance to secondary growth centres now included Toronto as well as Hamilton, London and Ottawa.

Estimation of the parameters of the modified model including data for the four growth centres, yielded

$$Z = 102.8132 - .09299\ s_2 + .01425\ s_1 + .00548\ s_1 t - .01347\ s_2 t + .13927\ t$$

The first derivative with respect to time,

$$\frac{\delta z}{\delta t} = .00548\ s_1 - .01347\ s_2 + .13927$$

is positive for plausible values. Once again, the hypothesis of polarized growth, with respect to Toronto is not confirmed since

$$\frac{\delta^2 z}{\delta s_1 \delta t} = .00548$$

is positive and with respect to secondary growth centres, is confirmed since

$$\frac{\delta^2 z}{\delta s_2 \delta t} - -.01347$$

is negative. The multiple correlation coefficient (R^2) increased from .1752 to .2682 and the coefficient signs did not change nor did the entry of variables. No test was made excluding the growth centres.

In conclusion, Analysis III has not identified strong patterns of polarization. The problem may lie in the use of aggregate (industrial composite) employment data for it is likely that the spread effects are more subtle and are undoubtedly channelled in certain economic sectors (King, 1973, pp. 13 - 14). The time period analyzed may have also contributed to the poor results obtained. The study period covers only one national business cycle during which national factors tended to constitute the dominant element. The time period was also dominated by a downswing in the economy and uncertain market conditions. As a result, it is reasonable to expect that intra-urban relations would not be as strong and that regionally generated economic impulses would not have as great an influence as it might under normal economic conditions.

CHAPTER V

CONCLUSION

An attempt has been made in this paper to illustrate how an analysis of urban economic time series data can be structured to yield insights into the spatial organization of urban systems and how it can be useful in estimating the functional forms and parameters of the models suggested by growth pole theory. It was argued that the published empirical studies have not satisfactorily investigated the dynamic aspects of spatial growth pole theory. This study focussed on some of the simpler aspects of economic change in an univariate time series and concentrated on the identification of spatial interdependencies and interaction within the Southern Ontario urban system. It was observed that this interaction was conditioned by hierarchical linkages and by economic interdependencies. The results, generally, do not support Crowley's (1971, p. 22; 1973, p. 3) that cities in the Canadian urban system may be largely independent rather than interdependent. [1]

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1. Crowley's conclusion was based on rank correlations between city size and location quotients (used as a measure of industrial specialization).

Most cyclical analyses up to date has been applied to national time series for the purpose of understanding nationwide economic events. However, the fact that groups of cities with similar timing and intensity of employment growth could be identified suggests that their cycles are influenced by distinct subnational (regional) forces. Also, the fact that for some of the groups identified, cities showed a marked tendency to be grouped spatially, indicates the importance of space in conditioning and setting constraints on the transmission of cyclical forces through the urban system.

For the general purpose of understanding change and growth in urban systems, cyclical analysis, when applied to spatial data, may elucidate important problems such as the differential susceptibility of various centres to cyclical swings, their differential sensitivity to government policies and growth instability. Within a growth pole planning framework, such an analysis would facilitate in the identification of potential growth centres (see Chapter II). It has been shown that the responsiveness of urban centres to economic fluctuations is influenced by a complex set of variables, such as city size, industry mix and distance to other centres. Thus, if stable, early and fast growth, for example, are considered to be characteristics that should be displayed by an urban centre before it can be considered as a potential growth centre, then the results found in this study could provide useful information in the selection procedure.

However, there are a number of difficulties which may cast some doubt on the validity of some of the results obtained. First, there exists the entrenched difficulties of spatial and autocorrelation and multicolinearity and the derivative danger of ascribing causation of change in urban conditions to one or few variables. Very little attention was given to these problems in the present study. Further research, however, should explicitly consider these difficulties inherent in time series analysis. Second, the study is based only on one cyclical index, city industrial composite employment, and covers only a short five year period which was strongly influenced by national forces and which was dominated by uncertain and deteriorating market conditions. Further research is called for using different indices and longer time periods. In relation to the time scale, the analysis was based on a fixed five-year time period. It is possible that the relationships obtained are wholly short-term phenomena related to the special character of industrial growth in the reference period. This is especially relevant to cities which have showed rapid build-up in industries partly resulting from planning policies. Such short term changes point to the need of a continuous line of research using new monthly data as it becomes available. Undoubtedly, stronger relationships and co-variations in economic fluctuations would emerge if longer time periods were investigated. Furthermore, the spatial scale of analysis has also limited the study. If the analysis were to be expanded to cover the national urban system, regional forces may be more readily identifiable as well as regional groupings of cities. The Southern Ontario urban system may be considered as a sub-system within the national, and perhaps, North American urban system, and, consequently, by restricting the study to only Southern Ontario the importance of space in conditioning the speed and intensity of economic change may not be clearly evident. Third, there is a more fundamental problem of data availability. Published industrial composite employment data are not by definition, ideal data. The use of larger firm data may hide important cyclical behaviour of certain cities. This is particularly important to cities such as Toronto which has a very large proportion of small sized manufacturing plants [2] (or to centres which have a large service sector). Moreover, there is also the problem of using aggregate employment data for it is likely that spread effects are more subtle and are undoubtedly channelled in certain economic sectors. What is needed is urban time series which are disaggregated temporally, spatially and sectorally. A fourth concern which is related to the second problem discussed above, is the degree to which the American urban economic system is a source of employment fluctuations. The influence of the American economy in Southern Ontario is well known and changes in some centres may be investigated in relation to this frame of reference. The degree to which the national component takes into account this American influence cannot be determined from the results obtained in the present study. A more detailed analysis is required in this area. Finally, the models developed in this study offer greater potential for analytical research than was suggested. For example, if the factor analysis technique

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2. See Collins (1971).

(Analysis I) were performed on local growth curves from which industry mix, lagged national cyclical and seasonal effects (and, perhaps, a United States component) were removed, competitive or regional share growth curves (to use the terminology of shift analysis) which would be more representative of regional spread processes, could be identified (see Jeffrey, 1974). A lead-lag analysis on the regional component (that is, the residual series obtained from the decomposition model) may also be employed to estimate growth pole effects and inter city relations. Such a statistical framework may also involve an auto regressive component. If the regional time series is used, the level of economic activity in a centre i at time t can be expressed as a function of its own level of economic activity in a previous time period and of the lagged levels of economic activity in other nearby centres, j. For any city i, the model can be written as,

$$E_{it} = a_o + a_1 E_{i,\, t-1} + {}_{j}\; b_j E_{j,\, t + wj}$$

where E is the index of economic activity, w_j is a time lag relating to the effect associated with the j^{th} centre and a_o, a, and b_j are the parameters to be estimated (King, 1973, p. 14; Haggett, 1971, pp. 91 - 92).

Notwithstanding the limitations presented above, it is hoped that this study has contributed to the understanding of the dynamics of the Southern Ontario urban system. The study is but one step in what may be envisioned as the beginning of a much broader research design orientated toward a better understanding of the structural and spatial dynamics of interurban relations.

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APPENDIX A

TABLE 1

NUMBER, WORKERS INVOLVED AND DURATION (IN MAN-DAYS) OF STRIKES AND LOCKOUTS FOR ONTARIO BY SECTOR: 1968-1971

Sector	1968 NO.	1968 Workers Involved	1968 Duration	1969 No.	1969 Workers Involved	1969 Duration	1970 No.	1970 Workers Involved	1970 Durat.	1971 No.	1971 Workers Involved	1971 Duration	TOTAL No.	TOTAL Workers Involved	TOTAL Duration
Mines	5	574	6,430	10	20,887	1,726,350	1	355	7,460	-	-	-	16	21,816	1,740,24
Manufacturing	198	121,458	2,675,830	143	55,579	2,118,350	127	53,251	2,318,570	131	64,439	1,031,980	599	294,727	8,114,73
Construction	42	7,218	157,250	49	44,417	1,360,350	42	22,321	140,030	20	8,541	205,080	153	82,497	1,862,71
Transportation & Utilities	12	534	10,070	11	6,634	70,250	12	2,206	41,590	10	1,626	50,640	45	11,000	172,550
Trade	13	1,353	29,500	12	1,124	18,380	14	1,127	20,880	14	2,424	38,320	53	6,028	107,080
Finance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Service	6	536	7,390	7	1,223	18,830	17	2,279	18,030	9	1,199	25,920	39	5,237	70,170
Public Administration	5	4,332	28,350	3	1,242	2,060	2	53	650	8	2,269	12,600	18	7,896	43,660
TOTAL	281	136,005	2,914,820	235	130,096	5,314,570	215	81,592	2,547,210	192	80,498	1,364,540	923	429,201	12,141,14

Source: "Strikes and Lockouts in Canada," Economics and Research Branch, Labour Canada (1971,"70, '69 & '68)

Table A-2

List Of Strikes And Lockouts Amounting
To 300,000 Or More Man-Days: 1968-1971

Starting Date	Employer	Workers Involved	Duration in Man-Days	Termination Date
Feb. 7, 1968	General Motors of Canada Ltd. (and subsidiaries) - various locations, Ont.	23,626	831,830	Mar. 29, 1968
July 18, 1968	Government of Canada, Post Office Dept. - Canada wide	24,000	360,000	Aug. 8, 1968
May 1, 1969	Toronto Construction Association Metro Toronto	25,000	854,050	Aug. 11, 1969
July 10, 1969	International Nickel Co. of Canada Ltd. - Sudbury Dist.	15,854	1,449,500	Nov. 14, 1969
Aug. 1, 1969	Steel Co. of Canada Ltd. - various locations, Ont.	13,500	771,430	Oct. 20, 1969
Sept. 14, 1970	General Motors of Canada and Subsidiaries - various locations, Ont.	23.500	1,598,600	Dec. 18, 1970

Source: Strikes and Lockouts in Canada, 1971, Economics And Research Branch, Labour Canada, p. 62.

APPENDIX B

since there does not exist a clear exposition of the procedure in the literature. Furthermore, it appears, at least from the reading of the paper, that Jeffrey and Webb (1972) did not use the technique correctly.

First, define 11 dummy variables (since 12 monthly observations are used), D_1, D_2 ... D_{11}, with the property that $D_i = 1$ if the observation falls on the i^{th} month, otherwise $D_i = 0$. In other words, if the published city employment index is January, of any year, then, $D_1 = 1$, $D_2 = 0$, $D_3 = 0$, ... $D_{11} = 0$; if it is February, $D_1 = 0$, $D_2 = 1$, $D_3 = 0$, ... $D_{11} = 0$; and so on. If the monthly observation is December, all 11 dummy variables equal 0. Eleven dummy variables, rather than twelve, are used to insure that the solution of the regression equation will be determinate.[4] Before the seasonal dummy variable parameters can be estimated, a quadratic time trend, $a_1t + a_2t^2$, is defined (Johnston, 1963) which takes into account the long term growth trend (that is, the "equilibrium" or "normal" employment according to Kosters and Welch, 1970). The equation to be estimated for each urban place is,

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4. If quarterly data is used, 3 dummy variables would be defined; if bimonthly data is used, 5 dummy variables would be used (see Jeffrey and Webb, 1972).

$$Y = a_o + a_1t + a_2t^2 + b_1D_1 + b_2D_2 + \ldots + b_{11}D_{11} \quad (1)$$

where Y = observed dependent variable (i.e., the 60 monthly employment indices)

a_o = slope intercept

a_1a_2 = coefficients of the time trend

t = time (in months)

$D_1 \ldots D_{11}$ = dummy variables

$b_1 \ldots b_{11}$ = coefficients to be estimated

For the estimation of the parameters of equation (1), ordinary multiple regression techniques were used.[5]

Because 11 dummy variables are used, their coefficients cannot be obtained directly from (1). If the $b_1 \ldots b_{11}$ parameters are used, seasonally adjusted time series is not obtained since equation 1 only shifts the data relative to the constant December observations (five in this study). Jeffrey and Webb (1972), for example, used 5 dummy variables along with a long term time trend and a national cyclical component in the regression equation. However, true seasonally adjusted is not obtained because of the "shift" of the time series around the constant November/December observations. In order to remove seasonal fluctuations, it is necessary to

5. The least squares multiple regression computer package, BMD 03R, was used. See Dixon, 1968.

perform additional steps before the appropriate parameters can be determined. These additional steps are described below.

Rewriting equation (1),

$$Y = a_o + a_1 t + a_2 t^2 + b_1 D_1 + b_2 D_2 + \ldots + b_{11} D_{11} + e \qquad (1)$$

$$\text{Since,} \quad D_1 + D_2 + \ldots + D_{11} = 1 \qquad (2)$$

$$\text{Therefore, } Y = (a_o + b_{12}) + a_1 t + a_2 t^2 + (b_1 - b_{12})$$

$$D_1 + (b_2 - b_{12})\, D_2 + \ldots + (b_{11} - b_{12})\, D_{11} + e \qquad (3)$$

where B_{12} is the parameter for the undefined December dummy variable, (e is the residual).

Taking a 12-month average,

$$\overline{Y} = (a_o + b_{12}) + a_1 (\overline{t}) + a_2 (\overline{t^2}) + (b_1 - b_{12})$$

$$\overline{D}_1 + (b_2 - b_{12})\, \overline{D}_2 + \ldots + (b_{11} - b_{12})\, \overline{D}_{11} \qquad (4)$$

Note, $\overline{e} = 0$ if equation (1) is fitted by least squares.

$$\text{But, } \overline{D}_1 = \overline{D}_2 = \ldots = \overline{D}_{11} = \overline{D}_{12} = \frac{n/12}{n} = 1/12 \qquad (5)$$

if there are no part years.

Therefore,

$$\overline{Y} = (a_o + b_{12}) + a_1(\overline{t}) + a_2(\overline{t^2}) + 1/12 \quad (b_1 - b_{12})$$

$$+ \ldots + (b_{11} - b_{12}) \qquad (6)$$

$$\overline{Y} = (a_o + b_{12}) + a_1(\overline{t}) + a_2(\overline{t^2}) + 1/12 \quad b_1 + b_2$$

$$+ \ldots + b_{11} - 11 b_{12} \qquad (7)$$

Since, $b_1 + b_2 + \ldots + b_{11} + b_{12} = 0$, or

$$b_1 + \ldots + b_{11} = \quad - b_{12} \tag{8}$$

Therefore,

$$Y = (a_o + b_{12}) + a_1(\bar{t}) + a_2(\bar{t^2}) - 1/12(-12b_{12}) \tag{9}$$

$$= a + a(\bar{t}) + a(\bar{t^2}) \tag{10}$$

$$= \bar{Y} - a_1(\bar{t}) - a_2(\bar{t^2}) \tag{11}$$

Then, the seasonally adjusted time series, SA, is calculated according to the following,

$$YSA = \quad - (b_1D_1 + b_2D_2 + \ldots + b_{11}D_{11} + b_{12}D_{12}) \tag{12}$$

$$= a_o + a_1t + a_2t^2 \div e \tag{13}$$

$$= \left[Y - a_1(\bar{t}) - a_2(\bar{t^2}) \right] + a_1t + a_2t^2 + e \tag{14}$$

Equation (14) then, is used to calculate the seasonally adjusted data. As an illustration of the above procedure, the time series data for Peterborough is described below. The 60 monthly employment indices (Jan. 68 to Dec. 72) were fitted to equation (1) which yielded [6]

$$a_o = 137.62000 - .76116\ (30.50) - .01251\ (1230.16667)$$

$$\text{(substituting into (14))} = 130.0348$$

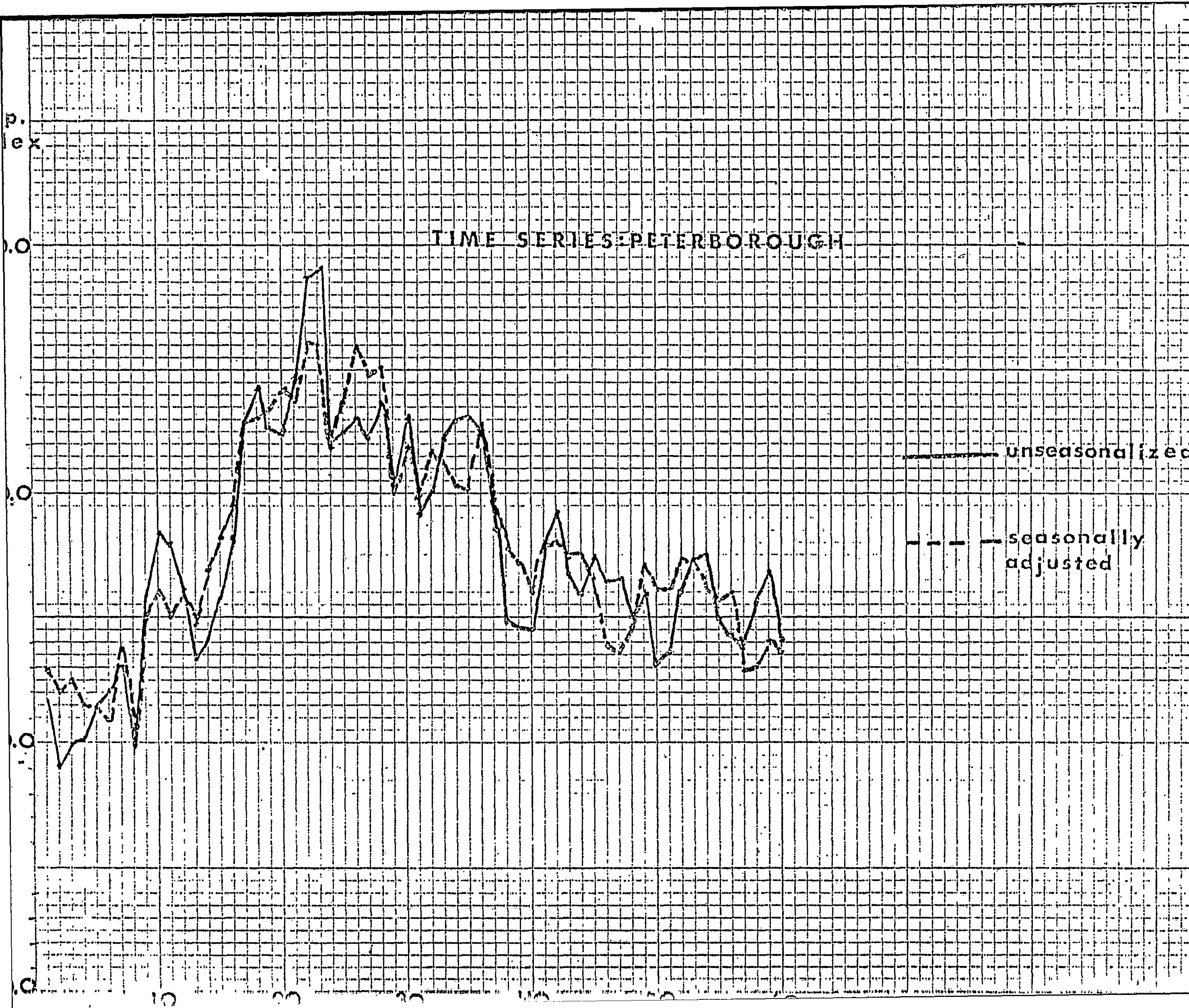
Equation (14) becomes

$$YSA = 130.0348 + \quad .76116\ (t) \quad + \quad - .01251(t^2) \quad + e$$

---

6. The computed t-values are shown in brackets.

By substituting $t = 1, \ldots 60$ and $t^2 = 1, \ldots 3600$, and the corresponding residual series, e, obtained from estimating equation 1, the seasonally adjusted time series can be calculated. The original published series and the seasonally adjusted series for Peterborough are shown in the following graph.


TIME SERIES: PETERBOROUGH
unseasonalized
seasonally adjusted
10

APPENDIX C

Selected Data on Industry Mix
for Cities Used in the Study

Selected Data on Industry Mix for Cities Used in the Study

Table C-1

1972 Average Total Employment (in hundreds)[1]

Barrie	7.4	Oshawa	29.3
Belleville	13.2	Ottawa	90.2
Brampton	21.2	Owen Sound	4.5
Brantford	19.1	Pembroke	2.5
Brockville	7.6	Peterborough	15.4
Chatham	9.4	Port Hope	4.5
Cornwall	9.2	Sarnia	17.2
Guelph	12.1	Stratford	9.2
Hamilton	102.7	St. Catharines	29.9
Kingston	14.6	St. Thomas	10.0
Kitchener	66.2	Toronto	685.2
London	50.7	Welland	14.7
Midland	5.1	Windsor	51.0
Niagara Falls	11.2	Woodstock	10.6
Orillia	4.2		

(1) Calculated by summing industrial composite employment for all 12 months in 1972 and dividing by 12.

Source: Employment earnings and hours, Statistics Canada, January through December, 1972.

Table C-2

Percentage of Industrial Composite in Durable, Manufacturing and Percentage of Manufacturing Employment in Durables, by City, January 1971 (1)

City	% of Ind. Comp. in Durable	% of Ind. Comp. in Manufacturing	% of Total Manufacturing Emp. in Durables
Barrie	–	–	–
Belleville	–	61.4	–
Brampton	49.6	69.6	71.1
Brantford	46.3	74.6	62.0
Brockville	54.5	76.6	71.2
Chatham	48.0	59.3	81.0
Cornwall	5.4	65.2	8.3
Guelph	45.3	68.0	66.7
Hamilton	46.0	61.4	75.0
Kingston	–	49.0	–
Kitchener	36.2	66.6	54.3
London	21.4	43.4	49.5
Midland	–	–	–
Niagara Falls	–	45.1	–
Orillia	–	–	–
Oshawa	63.3	73.0	86.8
Ottawa	5.8	20.2	28.6
Owen Sound	–	–	–
Pembroke	–	–	–
Peterborough	43.3	59.3	73.0
Port Hope	–	–	–
Sarnia	15.6	59.5	26.2
Stratford	–	78.9	–
St. Catharines	46.9	60.8	77.1
St. Thomas	–	77.5	–
Toronto	18.7	40.1	45.7
Welland	59.3	81.3	73.0
Windsor	52.4	64.8	80.9
Woodstock	–	75.0	–

(1) Calculated by taking available data for January, 1971.

Source: <u>Employment Hours and Earnings</u>, January, 1971, Statistics Canada.

TABLE C-3

MAJOR EMPLOYERS BY INDUSTRY[1]

City[2]	Industry[3]	S.I.C. Code[4]	Employment[5]	Percentage[6] of Industrial Composite
Barrie	-Canadian General Electric	331	607	8.1
	-Mansfield Denman General Co. Ltd.	162	595	8.0
Belleville	-Northern Electric Co.	335	1,050	7.9
	-AOCO Ltd.	383	516	3.9
Brampton[7]	-Northern Electric Co.	335	2,105	9.9
	-American Motors	323	1,300	6.1
	-Dominion Glass Co.	356	600	2.8
Brantford	-Massey Ferguson	311	3,499	18.3
	-Harding Carpets Ltd.	186	727	3.8
	-White Motor Corporation	311	594	3.1
Brockville	-G.T.E. Automatic Electric (Canada) Ltd.	335	1,700	22.5
	-Phillips Cables	305	1,647	21.8
Chatham	-International Harvester Co. of Canada Ltd.	323	1,158	12.3
	-Motor Wheel Corporation of Canada Ltd.	325	507	5.4
Cornwall	-Domtar Fine Products Ltd.	271	1,680	18.4
	-Courtlands Ltd.	373	908	9.9
Guelph	-Canadian General Electric Co. Ltd.	336	737	6.1
	-Imperial Tobacco Products		723	6.0

TABLE C-3 (cont'd)

Hamilton	-Stelco & Dofasco	291	22,791 (total)	20.3
Kingston	-Alcan Products	296	1,735	11.9
	-Millhaven Fibres Ltd.	378	1,378	9.5
London	-Northern Electric Co.	335	1,385	2.7
	-EMCO Ltd.	309	1,381	2.7
	-Minnesota Mining & Manufacturing of Canada Ltd.	357/358	1,304	2.6
	-General Motors of Canada Ltd.	336	1,200	2.4
Midland	-Decor Metal Products	Misc.	862	17.0
	-RCA	334	985	19.4
	-Motorola	334	438	8.6
Niagara Falls	-Norton Co.	356	1,474	13.2
	-Cyanamid of Canada Ltd[8]	378	534	4.8
Orillia	-Dorr-Oliver	315	600	14.5
	-Fahralloy Canada Ltd.	291	513	12.4
Oshawa[9]	-General Motors of Canada	323	25,000(aprox.)	51.1
Ottawa[10]	-The E.B. Eddy Co.	271	2,491	2.8
	-Computing Devices of Canada Ltd.	335	1,520	1.7
	-Microsystems International Ltd.	335	1,042	1.2
Owen Sound	-RCA Ltd.	335	549	12.2
	-Richardson Bond & Wright	286	450	10.1
	-Canadian Pittsburgh Industries Ltd.	356/324	450	10.1
Pembroke	-Eddy Match Co. Ltd.	271	227	22.4
Peterborough	-Canadian General Electric Co. Ltd.	336/339	5,180	33.6
	-Outboard Marine Corporation of Canada Ltd.	315	1,728	11.2

TABLE C-3 (cont'd)

Port Hope	-General Foods Ltd.		824	18.2
Sarnia	-Dow Chemical of Canada Ltd.	378	2,812	17.0
	-Polymer Corporation Ltd.	373/378	2,660	15.5
	-Imperial Oil Ltd.	365/369	2,383	13.9
Stratford	-Standard Products Ltd.	325	595	8.0
	-Fag Bearings Ltd.	315	500	5.4
St. Catherines	-General Motors of Canada Ltd.	325	7,941	27.6
	-Thompson Products	325	1,400	4.7
St. Thomas	-Ford Motor Company of Canada	323	2,900	29.0
	-Canadian Tinken Ltd.	315	500	5.0
Welland	-Steel Co. of Canada Ltd.	291	1,414	9.6
	-Union Carbide Canada Ltd.	291/339	1,000	6.8
	-Cyanamid (Welland) Ltd.	378	751	5.1
Windsor	-Chrysler Canada Ltd.	323	10,692	21.0
	-Ford of Canada	323	4,500	8.8
	-General Motors of Canada	323	2,474	4.9
Woodstock	-Harvey Woods Ltd.	clothing	900	8.5
	-Standard Tube of Canada Ltd.	292	880	8.3

Notes:

1. Data on the industry mix of individual cities was collected from Scott's Industrial Survey: Ontario (1971-1972 edition: Oakville-1972). Only the largest employers in each city are listed (usually the two largest with at least 500 employees). It should be noted that, due to the data limitations the list is by no means accurate or complete. For each industry, the 1968 edition of Scott's was checked to ensure that none of the industries located in the city during the study period.

2. Data for Toronto and Kitchener-Waterloo-Cambridge were not collected because of their large number of industries.

3. The names of industries are available in Scott's Industrial Directory.

4. Based on the "Standard Industrial Classification Manual, Revised 1970" (Cat. 12-501). Several industries manufacture more than one product; in these cases, intuitive judgement was used to select the most important products. The S.I.C. codes are defined below.

5. Total employment was obtained from Scott's consisting of both production and office workers.

6. Calculated by dividing the total employment (see above) by the 1972 average total employment (see TABLE C-1)

7. Brampton includes Chingacousy Township (Bramalea).

8. This industry experienced considerable decrease in total employment since 1968 when it employed 1,285 people.

9. Only General Motors was considered for Oshawa .

10. Excludes employment figures for Hull (Quebec).

S.I.C. Code (3-digit)	Industry Group	Industry
162	Rubber & Plastics Products	-rubber products
186	Textile	-carpets, mats & rugs
271	Paper & Allied	-pulp & paper
236	Printing, Publishing & Allied	-commercial printing
291	Primary Metal	-iron & steel mills
292	"	-steel, pipe & tube mills
296	"	-aluminum rolling, casting etc.
305	Metal Fabricating	-wire & wire products
309	"	-miscellaneous

311	Machinery	-agricultural implements
315	"	-misc.
323	Transportation Equipment	-motor vehicle manufactures
324	"	-truck body and trailer manuf.
325	"	-motor vehicle parts & accessories
331	Electrical Products	-small electrical appliances
335	"	-communications equipment
336	"	-electrical industrial equipment
339	"	-misc.
356	Non-metallic Mineral Products	-glass & glass products
357	"	-abrasives
358	"	-lime manufacturing
365	Petroleum and Coal Products	-petroleum refineries
369	"	-misc.
373	Chemical and Chemical Products	-plastics & synthetic resins
378	"	-industrial chemicals

APPENDIX D

Table D1

Larger Firm Employment as a Percentage of Total Estimated Employment, by Industry Division, for Ontario, 1970, Annual Averages (1)

Industry	Per Cent
Forestry	81.7
Mining	95.1
Manufacturing	91.9
Durable Goods	93.1
Non-durable Goods	90.5
Construction	61.3
Transportation, Communication & other utilities	87.6
Trade	63.4
Finance, insurance & Real estate	85.1
Service (2)	21.3
Industrial Composite(3)	59.9

(1) Total estimated employment is derived by adding together data from the employment and payrolls survey of larger-firms and data from a sample survey of smaller firms plus supplementary surveys.

(2) These percentages are exceptionally small because non-commercial services, including education and related services,

health and welfare services, religious organizations and private households, are included in total estimated employment but are not part of the larger-firm employment survey.

(3) These percentages are smaller than might be expected as both non-commercial services and public administration and defence are included in total estimated employment but are not part of the larger-firm employment survey.

Source: Employment Earnings and Hours, March - June, 1971, Statistics Canada, p. 105.