

"AN ANALYSIS OF SPATIAL PATTERNS OF POLARIZATION IN THE
RANDON AND DAUPHIN AREAS--THE TESTING OF A GROWTH CENTRE HYPOTHESIS"

by

YI-CHUNG HSIUE

dissertation submitted to the Faculty of Graduate Studies of the
University of Manitoba in partial fulfillment of the requirements
of the degree of

Master of Arts

1978

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ABSTRACT:

This thesis represents a methodological investigation of the validity of the growth centre concept against the backdrop of S.W. Manitoba. Theoretically, the growth centre is a very efficient planning instrument for regional development. In this respect, the growth centre can be treated as the cornerstone of an investment strategy involving the spatial concentration of investment and the accompanying reorganization or restructuring of geographic space. Furthermore, growth centre programmes can be used as means for realizing specific policy objectives relating to social welfare servicing.

There is, however, a marked discrepancy between theory and actuality. This is manifested in the following queries: Do spontaneous growth centres exist? Do these growth centres really affect, either positively or negatively, the development of surrounding areas? If they do, then, what spatial patterns, if any, will be formed? The principal purposes of this thesis will be an attempt to unravel these questions in the aforementioned regional context, namely: (1) to examine whether or not 'growth centres' exist at Brandon and Dauphin respectively, (2) to examine the presumed repercussions of two opposing spill-over effects and, then, to consider the degree of growth transmission from Brandon and Dauphin to the surrounding rural areas, (3) to examine the spatial form of polarized growth around Brandon and Dauphin.

In order to compare the effects of different analytic techniques and to get a more precise picture of the development surface in S.W. Manitoba,

twelve different techniques, including unrotated and rotated factoring methods, were employed in this study to analyze the same set of data for S.W. Manitoba. The outputs from these factoring techniques were, in turn, regarded as development indexes for a series of cubic trend-surface analyses which were established to test the polarization hypothesis. Finding provided only equivocal support for the existence of development-response surfaces based on Manitoban spontaneous growth centres.

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Introduction.

The growth-centre concept, introduced by Perroux, has received increasing attention as a tool for regional development in both developed and developing nations. The popularity of the concept was largely due to its basic idea that the growth of the regional economy is oriented, or polarized, towards a specific urban centre which can transmit growth impulses to a surrounding hinterland. In this respect, the growth centre can be treated as the cornerstone of an investment strategy involving the spatial concentration of investment and the accompanying reorganization, or restructuring, of geographic space.

It is the purpose of this thesis to try to investigate the validity of growth-centre concepts set against the backdrop of southwest Manitoba. In particular, the study area will be concerned with the areas around Brandon and Dauphin; the two biggest urban centres in southwest Manitoba.

Brandon, a small yet well-equipped regional city, serves the prosperous farming area of southwest Manitoba. Ever since its establishment, it was destined to be the agricultural and administrative centre of the western part of the Province. It has the necessary facilities and size to perform its regional functions, e.g., transportation depots, banks, manufacturing entrepreneurs, public services, etc. Dauphin is the most important administrative centre and distributing point for the region lying north of Riding Mountain and between Lake Manitoba and the Saskatchewan boundary. It is also a railway division point. The whole area surrounding Brandon and Dauphin is a typical prairie agricultural

region.

This thesis represents a methodological investigation in the field of regional economic development. Fig. 1 is the preferred course of action which will be followed in the study:

(1) Entails measurements of the economic development of the randomly-chosen settlements in the area around Brandon and Dauphin. Then, use of factoring techniques in order to sort out the hinterland development information. *

(2) The construction of maps depicting economic development by means of trend-surface analysis.

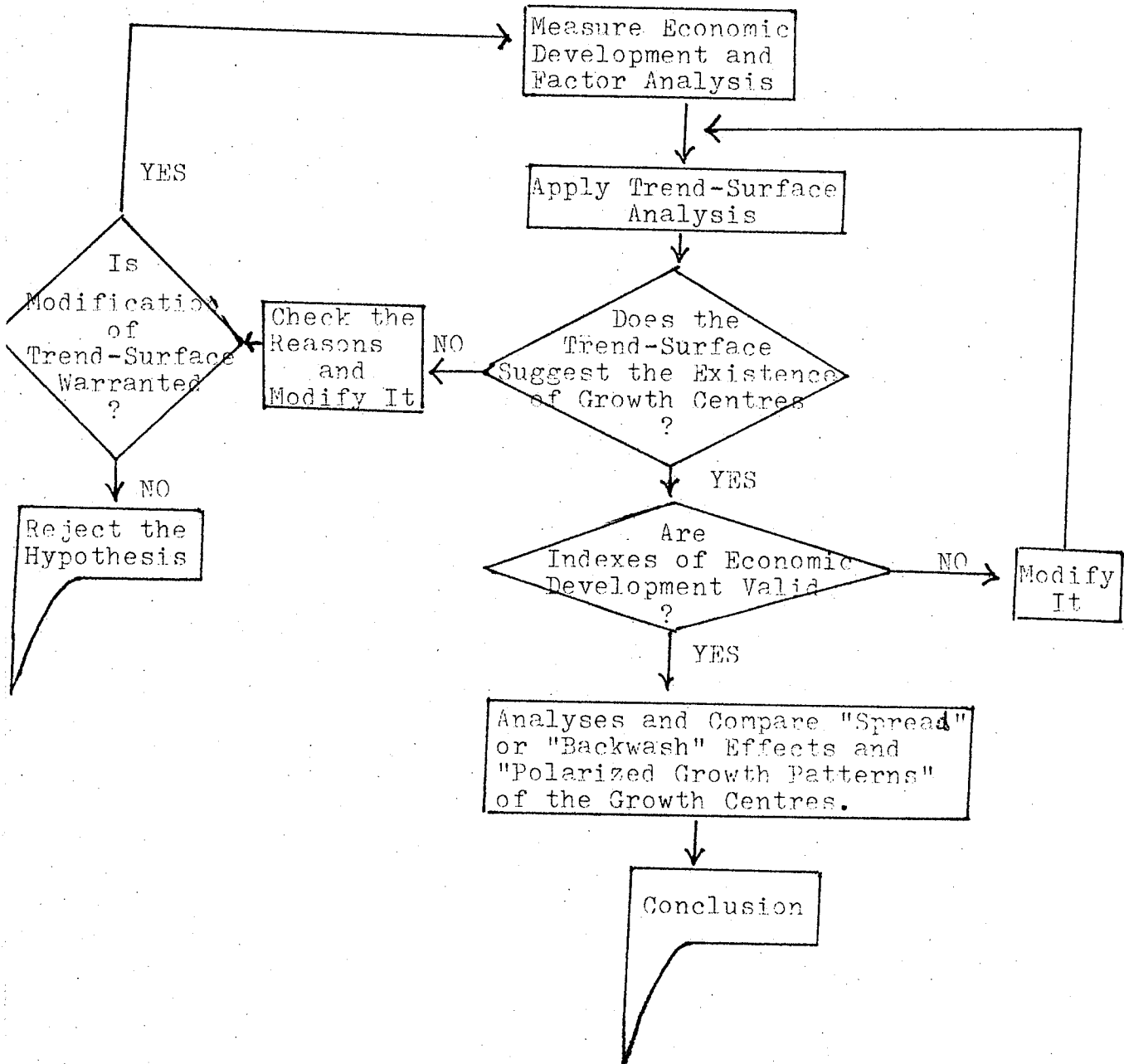
(3) and (4) Checks the existence of spill-over effects from growth centres. If the trend-surface analysis fails to suggest the existence of growth centres, then, investigate the possible influencing factors, such as local topography, communication routes, and use, etc..

(5) If the results of (4) can validate the existence of growth centres, examine the relevance of the indices of economic development. Some economic development in the hinterlands is created independently from the influences of the growth centres. These must be separated from the polarization impulses.

* The initial intention was to perform a truly dynamic analysis of development, but the absence of change variables precluded even the use of a comparative-static framework. As a result, one had to make do with a static picture of polarization.

Fig. 1

Preferred Format for Polarization Study



(6) Analysis and comparison of the implications of polarized growth patterns on the southwest Manitoba subject region.

(7) General conclusion relating the results to growth centre theory.

There will be seven chapters in this thesis and they will approximate the outline given above. Chapter 1, "Summary of polarization", will deal with the different contexts of polarization. Chapter 2 is entitled "Some attempts at determining the spatial impact of growth centres", and its content is self-explanatory. Chapter 3 "Methodologies", mainly discusses the mathematical concepts of factoring techniques, including Principal Components Analysis (PCA) and Principal Factor Analysis (PFA), and Trend-Surface Analysis. Chapter 4 is "The evidence for spontaneous growth centres in Southwest Manitoba", and consists of a series of analyses of industrial structure, functional index and infrastructure. Chapter 5, "Towards an index of development", will discuss the mathematical concepts of a series of rotation techniques including Maximum Likelihood Factor Analysis (MLFA), Varimax method, Quartimax method (QRMAX), Quartimin method (QRMIN), Direct Quartimin (DQUART), Biquartimin method (BQMIN), and Little Jiffy (or Image) Factor Analysis, etc.. Chapter 6, "Development surface: configurations and implications", will analyze the results of each analytic technique. The last chapter, Chapter 7, is "Validity of polarization: concluding comments", and sums up the findings of the thesis.

Chapter 1. Summary of Polarization.

1.1) Introduction

Polarization is a phenomenon composed of the configuration of a domination system, wherein growth centres override their boundaries and advance towards surrounding hinterlands. Theoretically, polarization not only can be reproduced at will, e.g. by means of planning, but also can be adapted to any spatial level; local, regional, national, or even continental. The ideas of polarization are based on Perroux's assumption that "development does not appear everywhere and all at once; it appears in points or development poles with variable intensities; it spreads along diverse channels and has varying terminal effects for the whole of the economy " (Perroux, 1955, p. 94).

This conception of the process of development as polarized, i.e. involving a formation of clusters and/or peaks of development and the attendant gradation of development away from there, is an essential point of departure in growth centre theory. As a result, polarization is, from a technical point of view, a dynamic process whereby activities, including economic, sociological and institutional, are diffusing from development poles to surrounding hinterlands. However, there are no agreed viewpoints as to how the process of polarization takes place. Broadly speaking, three different contexts of polarization can be classified, i.e., sectoral, spatial, and temporal contexts.

1.2) Sectoral Process

The theory of development poles was first propounded by Perroux, and has since been very prominent in the writings of most French regional

economists (Hansen, 1968, p. 105). The concept suggested by Perroux is closely related to his particular notion of abstract economic space as a field of forces consisting of centres, from which centrifugal forces emanate, and to which centripetal forces are attracted. Consequently, each centre, being a node of attraction and repulsion, has its own field of force. This controlling field is the basis for the concept of dominance. For Perroux, the effect of domination "consists of an irreversible or partially reversible influence exercised by one unit (i.e. centre) upon another. An economic unit exercises this effect by reason of its dimension, its negotiating strength, the nature of its activity, or because it belongs to a zone of dominant activity" (Hansen, 1968, p. 110). Such a concept of economic dominance plays a major role in Perroux's explanatory framework for his growth pole model.

For Perroux, the main problem confronting growth theory is to explain the nature of the structural changes in the economy (Blaug, 1964, p. 559). Perroux used the concept of 'key firm or industry', as an instigator of structural change. He maintained that the key industry is an industry which "has the quality, when it increases its output (and productive input), of increasing the output (and input) of another or of several other industries" (Perroux, 1955, p. 99). In other words, Perroux tried to use the input-output linkages of firms to explain his concept of economic dominance and polarization effect. For example, if A_{ij} represents sales from industry i to industry j , and A_{ji} sales from industry j to industry i , then j is said to dominate i if $(A_{ij} / P_i) > (A_{ji} / P_j)$, where P_i and P_j are, respectively, the total sales of i and j .

Through this process of backward-forward linkage, when a propulsive industry raises its output (e.g. industry j), it induces expansion in the output of other industries. In this sense, polarization, according to Aydalot, can also be defined as "the process by which the growth of an economic activity termed propulsive, sets in motion that of other economic activities by the channel of external economies" (Hansen, 1967, p. 718).

One of the most distinguished characteristics of the French school's approach has been that polarization takes place in an abstract economic space. Although Perroux did not exclude the geographical aspect of economic growth, he seemed to put the emphasis on functional economic relationships between a number of economic (i.e. aspatial) elements. The term economic space can be compared with the topological space used by mathematicians to denote certain relationships. Perroux discarded the concept of geographical space, because, in his opinion, it was "a passive rigid container which conditions the dynamic evolution of the economic forces, and that this was only a partial, limiting and dangerous perspective " (Lasuen, 1969, p. 138). In a word, geography rigidly limits the economic forces. On the contrary, by using the concept of abstract economic space, it is possible to distinguish as "many economic spaces as there are constituent structures of abstract relations that define each object of economic science " (Hermansen, 1972, p. 169). Hence, 'space', in Perroux's view, is just the set of different relations that define an object. Since there may be many systems of relations to define an object, so any one object may have

different topological spaces.

Perroux was concerned with three types of economic spaces: economic space as defined by a plan; economic space as a field of forces; and economic space as a homogeneous aggregate. The first of these spaces is defined by the set of relations which exist between the firm and, on the one hand, the suppliers of input and, on the other hand, the buyers of the output. The second type of space can be considered as an economic space consists of centres from which centrifugal forces emanate and to which centripetal forces are attracted. Finally, economic space as a homogeneous aggregate, is concerned with a firm having a structure more or less common with those of other firms which are its neighbours topographically or economically--it belongs to a space where, roughly speaking, one price reigns (Hansen, 1968, p. 107). Obviously, it is the second type of economic space, i.e. economic space as a field of forces which is most relevant to the conception of polarization.

Because of the prevailing concern with abstract economic space, the effects of distance on polarization were overlooked by Perroux. His analysis, as mentioned above, is confined to structural changes (e.g. the emergence and disappearance of economic activities), changes in mutual production relationships, difference in the rate of growth of the various economic sectors, and the diffusion of growth from one sector to the other. Perhaps, this is Perroux's reaction to the over-emphasis on distance by classical economists such as von Thünen, Weber, Lösch, Palander, etc. For

those classical economists, distance is an overwhelming factor in deciding their minimum-cost or maximum-profit strategic locations. However, in Perroux's viewpoint, distance has little, if any, effect on polarization. That is, 'polarization' may occur at any place, no matter how far from growth centres, instead of just in geographically surrounding areas of growth centres. The development of the gas industry at Lacq, southwestern France, is a good example. The discovery of large natural gas deposits at Lacq aroused great hopes that industrialization of the relatively undeveloped Southwest would be assured by the presence of this energy source. In reality, however, the Lacq complex has been essentially a local phenomenon which has done little to modify the general economic situation of the Southwest. Instead, it did stimulate the industrial development of the established industrial cities far away from Lacq (Hansen, 1967, p. 721). The same story has happened in most of the oil-rich countries in the Middle East. The development of oil industries there over the past two or three decades has a great impact on the development of industry in western Europe and the United States, but little on that of Arabian countries themselves.

1.3) Spatial Process

Notwithstanding Perroux's non-geographical orientation, development pole theory has come to be applied mainly in a regional context, i.e. in geographical space. The reason is quite obvious; since all economic activities necessarily occur in geographical space, the structural changes and the diffusion of growth in Perroux's functional space

can be projected into geographical space. Consequently, as well as shedding light on transformations in functional space, growth pole concepts may also shed light on the transformations taking place in geographical space during the same process of economic growth.

Boudeville, in contrast to Perroux's approach, put emphasis on the regional character of economic space. He maintained that the theory of economic space is "the application of a mathematical space on or in a geographic space" (Thomas, 1972, p. 57). Following Perroux, Boudeville also classified the space into three types: i.e. homogeneous, polarized, and planning (or program) spaces. A homogeneous space corresponds to a continuous space wherein each of the constituent parts or zones has relevant characteristics as close as possible to those of the others. A polarized space, on the other hand, is a heterogeneous space whose different parts complement and support one another, and where these parts have more exchanges of goods and services with a dominant intra-regional urban centre than with neighbouring regions. Finally, a planning space can be defined as a space whose various parts depend on the same planning objective function. It is the concept of polarized space which is most relevant to our discussions.

Compared to Perroux's topological space concept, Boudeville's geographical polarized notion is more limited in explaining the polarization of growth centres. This is due to the fact that Perroux's polarization concept is more versatile implicitly, being capable of occurrence in geographical as well as in functional (economic) spaces. Both functional and geographical polarizations are, however, based on

the same assumption that economic growth is polarized in all spaces, no matter whether it is topological or geographical space.

Boudeville's geographically polarized space is closely related to the notion of hierarchy. He defined three types of polarization, according to the different sizes of areas, i.e., national, regional, and local (Hansen, 1968, p. 108). Therefore, the concept of polarized space is also suited to the study of urban centres and their inter-relations. As a result, Boudeville's concept of geographically polarized space provides a bridge to the other spatial or locational theories, especially 'central place theory'.

There are some fundamental differences between 'growth centre theory' and 'central place theory': first of all, central place theory is essentially a static paradigm, dealing with the distribution of different ranks of central places. Growth centre theory, on the contrary, is a dynamic process, explaining the functional changes and polarization of growth centres. Secondly, central place theory is mainly concerned with services, while growth centre theory emphasizes industrial activities. Thirdly, growth centre theory uses "inductive" reasoning to study the mechanisms underlying the formation and growth of centres, whereas both central place theorists Christaller and Lössch employed 'deductive' reasoning, basing their ideas on the assumption that man tries to organize his activities over geographical space in an efficient manner (Hermansen, 1972, p. 165). Fourthly, in central place theory, places of the same rank are supposed to be independent of each other with no interaction between them. Even the flows between different ranks (sizes) of central places are limited to only one-way

flows from higher ranks of central places to lower ranks of central places. However, the flows between growth centres are conceptually unconstrained and, thus, are more realistic than those expected between different ranks of central places. Finally, central places are numerous and arranged in a hierarchy with a homogeneous hinterland, while few growth centres are located in homogeneous areas. Furthermore, in central place theory, the growth of a central place is sustained by its complementary region, while in growth centre theory, the situation is inverse, i.e., the growth of the zone of influence is sustained by the growth centre.

Although Boudeville's growth centre theory is concerned with polarization in geographical space, it is by no means itself a locational theory. It has failed to explain where the growth centres are or where they will be located in future. This is because growth centre theory takes economic growth as its point of departure, i.e., it starts from optimum production conditions. Consequently, central place theory can be used to provide a framework for explaining the location of growth centres. Central place theory serves "as a point of departure for analyzing the impact of development in a given centre on the other centres, problems of how to direct changes in the system of centres, and problems of urban growth control" (Hermansen, 1972, p. 179). Admittedly, major central places are often the key centres of growth in their region and determine the rate of economic development over the region as a whole, due to their high market potential and their being socially and culturally more attractive to managers. So, a growth centre will normally be either a substantial population centre or capable of rapid population

expansion.

Richardson insists that most of the external economies that make some areas preferable to others are, in effect, localization economies and urbanization economies (Richardson, 1973, p. 104). It is clear, then, that an urban centre which is populous and has substantial positive externalities will tend to be the focus of growth. Therefore, the spatial and size distribution of urban centres will be a vital element in finding possible growth centres. For this purpose, central place theory presents the most obvious model for explaining the growth of the urban hierarchy.

On the other hand, since central place theory is essentially static, it only explains the existence of certain patterns of centres, but fails to explain how the pattern came into being or how the pattern underwent changes. To explain these dynamic phenomena it is necessary to look at growth theories, among which Boudeville's modification of Perroux's growth pole theory to make it applicable to geographical space seems a most promising one.

In addition, growth centre theory can employ the concept of the services function of central place theory in order to highlight the centre-periphery relationships. Both Perroux's and Boudeville's growth centre theories emphasized primary or secondary industries, but seldomly dealt with the service function (i.e. tertiary industry). In an economically advanced society, however, the services function has become one of the important factors of agglomeration economies. As a consequence, the provision of central services will be the cause of one of the major agglomeration economies concentrated at the growth centre.

The incorporation of scale economies and urbanization economies adds to growth centre theory the notion of 'economic threshold'. Are there any minimum or maximum critical thresholds of growth centres? Richardson admitted that "growth centres have a critical minimum size necessary to promote expansion over the growth area as a whole, they also reach a limit beyond which net diseconomies are realized. These include urban congestion costs and the overloading of transport facilities, rising per capita costs of providing urban government services, and rising factor prices" (Richardson, 1973, p. 105).

The notion of urban hierarchy and its rank-size relation, therefore, is a valuable complement to growth centre theory. Shindman insists that cities have always formed parts of larger, functionally interrelated systems. So that, instead of determining the optimum size of single cities, the problem should be formulated as one of finding the optimum size of the various cities according to their functions and situation in the hierarchy of cities (Shindman, 1955). Dun went even further and indicated that there is a positive correlation between city size, the frequency of innovations and the spread of cultural diffusion (Hermansen, 1972, p. 193). If this is the case, then, the economies of city size will play an important role in the polarization of the growth centre.

1.4) Temporal Process

So far we have centred our discussions on polarization either in abstract or geographical space and little has been mentioned either about the interplay between these two spaces, or the relationships between growth centres and peripheral areas.

The impacts of growth centres on hinterlands, albeit in abstract or geographical space, have two opposite effects: positive and negative. The positive effect is that where the growth of centres stimulates the economic development of peripheral areas, whereas the negative effect means that the growth of centres occurs at the expense of the economic development of their peripheral areas. The terminologies used for positive and negative effects are varied and sometimes ambiguous. The most popular terminologies used are: 'spread-effect' and 'trickling-down effect' for positive effect; and 'backwash' and 'polarization' for negative effect. Since these two opposite effects exist simultaneously, then, in the long run, what will the resultant outcomes be? The answers to this question are far from clear.

Using the same assumption of Perroux's and Boudeville's that economic development is an essentially unbalanced process propagated through chains of disequilibria, Hirschman argued that, at the initial stage of development, the process of the growth centre may have unfavourable polarization effects on the hinterlands, resulting in the depression of industries there. However, in the long run, Hirschman believed that the trickling down effect and external diseconomies of growth centres will assure a spontaneous spread of development from growth centres to hinterlands. Here one must not confuse the term "polarization" used by Hirschman with that used by Perroux and Boudeville. To Hirschman, the term 'polarization' just means the widening gap between two extremes, namely between rich (e.g. growth centres) and poor (e.g. hinterlands) (Chorley and Haggett, 1968, p. 260).

Hirschman's optimistic view was derived from the assumption