

An Appraisal of Growth Center Theory in Relation to Information Needs

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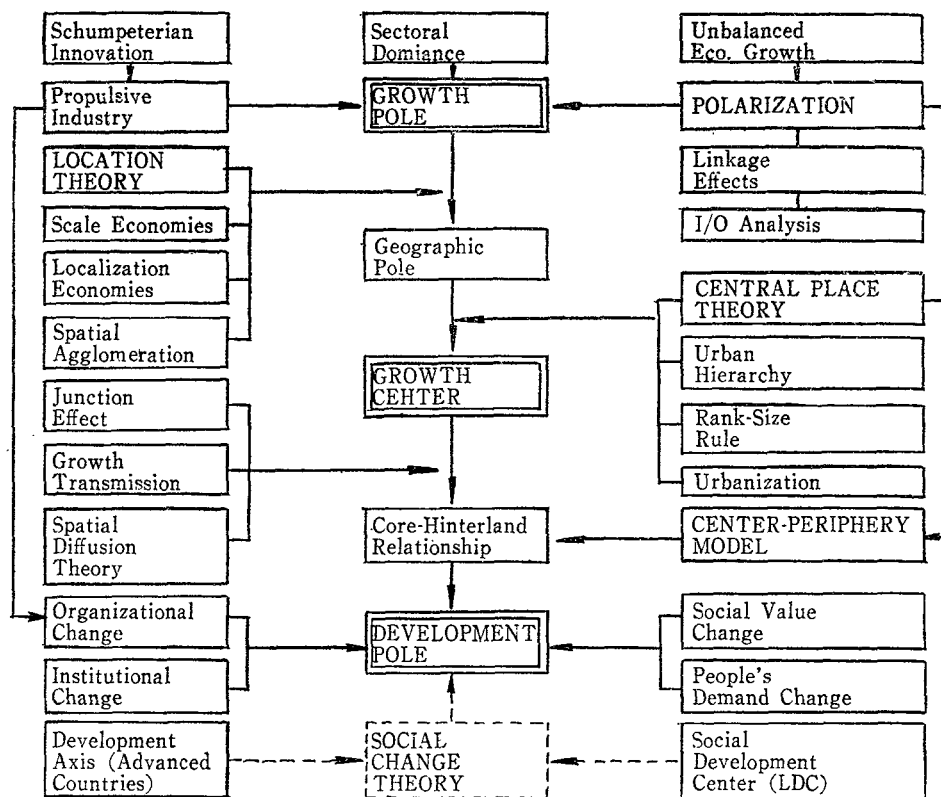
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During the last two decades, growth center theory has gained a wide range of popularity. One of the reasons for this is that growth center policy has been regarded as an intermediate solution between extreme concentration and extreme deconcentration. As illustrated in Figure 1, growth pole has become increasingly an umbrella term, attracting a large number or more specific theories which are related to the problems of regional development. In some countries, it has acquired the status of a partial, if not a general, theory of spatial development strategy.

Recently theorists hoped to include the diffusion process, and in a broad sense, social change as concomitant to economic growth. But the mixture of such untested (or untestable) theories has exposed a Janus-faced situation. Simultaneously, the confusion of concepts and semantics has arisen from the results of the theorists who took into consideration the economic, social, and geographical dimensions or regional development. As Hermansen puts it, the concepts of growth pole have lost much of their original content

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Fig. 1. An Overview of Growth Center Theory



and meaning and thereby have become more elusive and ill-suited for empirical testing and practical application on a specific basis.⁽¹⁾ The difficulties of acquiring needed data aggravated by these problems make growth center theory more a policy framework rather than a practical planning device.

Data search is, however, hampered even further by two as yet unsettled theoretical problems: One is the explanation of how growth centers are generated and the growth impulses spread over space. The other problem which is important from the planning point of view, is the lack of specific criteria for identifying growth centers, determining how big they should be, or deciding what kind of investments should be placed in them.⁽²⁾ These two problems will determine eventually the information needs of growth center policy.

(1) T.D. Hermansen, "Development Poles and Related Theories: A Synoptic Review," in N.M. Hansen, ed., *Growth Centers in Regional Economic Planning*, New York: The Free Press, 1972, p. 161.

(2) Hansen, *op. cit.*, p. xiv.

The ostensible purpose of this paper is to review underlying constructs of growth center theory. But considerable weight is given to its data requirements from the standpoint of implementing policy. Unfortunately, growth pole concepts and borrowed models from other disciplines have been developed whose information requirements surpass the capacity of current data acquisition methods. The following sections discuss the identification, and evaluation of growth centers, respectively, and they simultaneously set forth related theories to present data needs.

1. Identification of Growth Poles by Polarization

Some analytic techniques of regional economics (*i. e.*, an input-output framework, location coefficient, shift-share analysis, or even simple graph theory) have been employed in an attempt to identify growth poles within a region or nation. Among these, input-output analysis is frequently used with the aid of polarization concepts.

A. Heavy Use of Input-Output Analysis

From a historical view, as conceptualized by Perroux, growth poles develop in an abstract economic space which contains the process of structural change; this concept has obvious dynamic implications. Such changes can be interpreted in two ways: innovation in the Schumpeterian sense, and the dynamics of industrial interdependence. The influence of the leading firm (analogous to Hirshman's master firm) generates waves of innovations causing structural disequilibrium. At the same time, the propulsive industries induce growth, either by backward or forward linkage effects.

It is well known that the crucial concept of interindustry linkages is derived from static Leontief-type models.⁽³⁾ However, by placing too much emphasis on interindustry linkages in order to identify growth poles, we encounter two problems. One is that any attempt to provide quantitative measures of these linkages, through the use of I/O matrix, requires a tremendous amount of empirical data. A second problem as Lausén pointed out, is that the heavy use of input-output techniques has drained the growth pole concept of its original temporal and dynamic meaning, recharged it with a static and/or comparative static content.⁽⁴⁾ It shifted the school's attention away from the truly dynamic theory characterized by asymmetric, nonlinear, and irreversible change.

(3) The characteristic strengths and weaknesses of input-output models are too well known to require explanation here. Stability of technical coefficients over time is a typical, good example of one direct contradiction.

(4) J.R. Lausén, "On Growth Poles," *Urban Studies*, Vol. 6, 1969, p. 141.

More importantly, according to critics, the heavy use of input-output analysis distorted the original growth pole idea by confining it to *aspatial* polarization. This is not to say that the formulation of an input-output table is ineffective despite its essentially static nature. To be a better policy instrument, the growth pole theory needs a highly disaggregated geographical framework. But we have very little knowledge of the spatial dimensions of the interindustry linkages that are so important in regional development which stresses the significance of induced economic growth. The principal cause of this problem is that induced growth does not necessarily take place within the same region in which the pole is located.

B. Data Needs for Spatial Aspects of Polarization

The concept of polarization states that the rapid growth of the propulsive industries induces the spatial concentration of other economic units. Implicit in this process are the various agglomeration economies.⁽⁵⁾ Therefore, the aforementioned weakness inherent in input-output analysis is expected to be lessened by describing spatial aspects of polarization. These could be widely regarded as urban agglomeration because sectoral polarizations are more efficient when they are concentrated geographically than when they are regionally dispersed.

Locational information concerned with the external economies, first and foremost, describes the territorially agglomerated growth poles. Continuing data collection is necessary as to how the growth of a new industry can generate and transmit innovations that possibly stimulate new spatial interdependencies. With this information, we can determine whether polarization is a sectoral or spatial phenomenon, or a combination of the two.

Polarization, as a process, also possesses a temporal dimension. Hirschman's polarization,⁽⁶⁾ even if it is a sectorally highly aggregated concept, tends to be more suitable for analysis of growth centers, since it is able to grapple with the temporal changes in the spatial structure. In this respect, Parr's distinction between the polarization effect and agglomeration effect is very suggestive: the former is viewed at a particular point in time, while the latter deals with the clustering of activities over a period of time.⁽⁷⁾ To put it another

(5) For an exhaustive discussion of agglomerative factors, see F. Buttler, *Growth Pole Theory and Economic Development*, Lexington: Saxon House Books, 1975, especially Chapter 2.

(6) A.O. Hirschman, *The Strategy of Economic Development*, Cambridge: Yale University Press, 1958.

(7) John Parr, "Growth Poles, Regional Development, and Central Place Theory," *Papers and Proceedings of Regional Science Association*, Vol. 31, 1973, p. 184.

way, the phenomenon of agglomeration can be seen as the outcome of the process of polarization. Without process-oriented description explained in Chapter II, it would be extremely difficult to distinguish these two factors which determine the spatial concentration of economic activities.

Finally, polarization varies with the type of regional socio-economic structure. According to the polarizing process posited by Myrdal,⁽⁸⁾ it is not merely affected by externalities accruing from economic activities. When his hypothesis of "circular and cumulative" causation is applied to the individual regional level, we need more detailed information about the social dynamics of regional change.

2. Selection of Growth Centers with the Help of Central Place Theory

Boudeville defined the idea of a growth pole, following Perroux's initial formulation, in terms of the location of one or more propulsive industries. He writes:⁽⁹⁾

A regional growth pole is a set of expanding industries located in an urban area and inducing further development of economic activity throughout its zone of influence.

It is worth emphasizing that this definition refers to a region and not a Perrouxian space, indicating that its zone of influence is a contiguous area. This is a turning point, in which the "growth center"⁽¹⁰⁾ concept was derived. And through this conceptual expansion, great semantic confusion has occurred between the pole (=propulsive industry) and the center (=geographical location in banal sense).

This redefinition, however, tells very little about "where" in a region a growth center should be established. For the purpose of planning, we need specific data for determining the location of relevant urban centers in terms of size and spacing. To explain such data requirements, the growth center theory must rely on theories of spatial organization, among which the central place theory is the only one that describes the spatial interde-

(8) Gunnar Myrdal, *Economic Theory and Underdeveloped Regions*, New York: Harper Torch Books, 1971, pp. 3-38.

(9) J.R. Boudeville, *Problems of Regional Economic Planning*, Edinburgh: Edinburgh Univ. Press, 1966, p. 11.

(10) The meaning of the term growth center is equal to a growth pole identified *a posteriori* with spatial connotation. Hereafter, to avoid equivocal meaning, I will use only the term "growth center" as having explicit geographical dimensions unless otherwise the term growth pole is necessary. It is not possible here to go into a discussion about the semantics of growth centers in further detail.

pendencies among economic activities.

However, this aspect of data acquisition for growth center planning involves serious theoretical difficulty in reconciling: a) the deductively derived, static equilibrium theory of central places, with b) the inductive dynamic theory of localized "development poles."⁽¹¹⁾ Such difficulty hinges not on the poor geographical connotation of growth poles, but on the features of data demanded by central place theory.

A. Problems of a Central-Place Inspired Growth Center Theory

Growth pole concepts have been transformed into growth center concepts by central place theory. But central place models of spatial organization have several drawbacks: First, a disadvantage of using central place theory is its inability to be focused on socio-political regulators of regional growth. Central place theory does not explain spatial development phenomena. It is a descriptive theory which only tries to reveal the existence of certain patterns of centers. On the other hand, Friedmann's core-periphery model,⁽¹²⁾ based on the general theory of polarized development, is more dynamic and attempts an explanation of the evolution in spatial structure.

Second, by merging central place theory into growth center theory, a contradiction possibly exists between them. The former, for example, is not really much more than conditions of general spatial equilibrium at a specific point in time. Hence, "dynamization" of its static nature to cope with temporal changes is prerequisite to growth center theory.

Third, the "growth pole" notion emphasizes mostly industrial production while central place theory analyzes principally the distribution of tertiary activities. The former is largely concerned with market-oriented or market-sensitive activities and the latter is limited to a particular range of economic activities such as the consumer-oriented service sector. As a corollary, central place theory has shown a marked preference for demand analysis at the expense of supply considerations which are basic to a growth center.

Lastly, a churlish criticism about Christaller and L6sch is that they assume a homogeneous landscape with a uniform population density. This basic assumption is at odds with the growth pole concept, since economies of scale encourage the concentration of production at relatively few locations. And polarization is viewed as a treacherous distortion of the central place landscape.

(11) H.W. Richardson, *Regional Growth Theory*, New York: John Wiley and Sons, 1973, p. 19.

(12) In his two major papers he cleared its theoretical underpinnings; see "A General Theory of Polarized Development," in Hansen, ed., *op. cit.*, pp. 82-107.

B. Usefulness of Urban Hierarchy for Selecting Growth Centers

Despite the fact that the roles of central place theory and growth theory are so different, it could be argued that the central place model serves as a branch of growth center policy. This is because "a system of cities", arranged in a hierarchy according to the functions performed by each, is an important tool of selecting growth centers. A theoretical gap is presumably closed from a practical viewpoint, as Lausén⁽¹³⁾ suggests, by directing policy concerns to the system of growth centers rather than a single center within the context of spatial organization.

The spacing of optimum-sized growth centers may be achieved through the observed regularities of the central place type. For operational analysis, the following may be helpful to suggest likely growth center locations: There are a) minimum size constraints; and b) the tributary area of a central place which may be a rough indicator of the zone of influence.⁽¹⁴⁾ Unfortunately, there appear to be no guidelines as to optimum size⁽¹⁵⁾ or even as to threshold size for self-sustaining growth.

Also a certain parallelism exists between the relationship of the central place to its complementary region and the growth center to its zone of influence. The growth of central place is sustained by its hinterland, while the growth of the zone of influence is postulated to be sustained by the growth center. To highlight the contrast between them, it is alleged that the central place model is designed to describe essentially the inverse of the pole-hinterland relationship, *i. e.*, the dependence of urban center upon demand in its tributary area.

Obviously, regional development is closely tied with the emergence of highly developed and interconnected functional hierarchies of cities. At the conceptual level, however, a hierarchy of central places is by no means identical with a hierarchy of growth centers. Central places would be numerous while growth centers would be few, in some cases only one to a region. On the other hand, the idea of a polarized region can be compatible with the central place structure of city systems of ascending hierarchy, with the growth centers normally being the relatively large city or cities in the region.

(13) J.R. Lausén, "Urbanization and Development in Temporal Interaction between Geographical and Sectoral Clusters," *Urban Studies*, Vol. 10, 2, 1973, p. 163.

(14) E.M. Hoover, *An Introduction to Regional Economics*, New York: Alfred E. Knopf, 1971, p. 271.

(15) The theoretical issues involved in optimal size are enormous. I ruled out the possibility of dealing with the optimality of city size.

Growth center is, in a sense, a prescription for backward regions which would stimulate the growth of their largest central places by raising their rank in the national urban hierarchy. For instance, Misra defined a hierarchy of growth centers in terms of their size and function: 1) small service centers, 2) subregional points, 3) regional growth centers, and 4) national growth poles.⁽¹⁶⁾ Despite his clear-cut semantic reworking, the empirical role of central place hierarchies in growth center policy is still unclarified and loudly arguable.

For all these reasons, the controversy over the size of growth centers is not settled. Logan⁽¹⁷⁾ indicates that the city selected as the regional growth center should be relatively large in developing countries. This would minimize leakage and would provide the external economies that are essential for the self-sustaining growth of secondary and tertiary activities. Todd⁽¹⁸⁾ argues that extremes of pole planning at the highest and lowest orders of the urban hierarchy should be avoided in order to provide a suitable basis for agglomerative economies.

To summarize, the common denominator of optimal growth center strategies would be the selection of intermediate centers as targets, as it is frequently asserted by Hansen. One of the supporting reasons is that *middle-rank cities*⁽¹⁹⁾ in the national urban system tend to generate flows of people, capital, commodities and information both *up* and *down* the hierarchy—that is, they play a dual role.

C. Data Acquisition for Spatial Linkages

Growth center theory combined with central place involves the two basic notions: functional hierarchy and spatial interdependence. These could be major guidelines in selecting regional information pertaining to the designation of growth centers. More specifically, functional hierarchy is expressed in terms of stock aggregates, and spatial interdependence in terms of dynamic flows. The latter can be calculated in spatial linkage analysis, which will become the most important information account of a regional data base.

As a beginning point, consider the methodological problem in determining the functional

(16) R.P. Misra, *Growth Poles and Growth Centers in Urban and Regional Planning in India*, India: Univ. of Mysore, Institute of Development Studies, 1971, p. 19.

(17) M.I. Logan, "The Spatial System and Planning Strategies in Developing Countries," *Geographical Review*, Vol. 72, 3, 1972, p. 244.

(18) D. Todd, "An Appraisal of the Development Pole Concept in Regional Analysis," *Environment and Planning A*, Vol. 5, 1974, p. 303.

(19) Presumably these intermediate cities can be the place of division, so as to differentiate "hierarchical effect" from "neighborhood effect" in diffusion models.

hierarchy. A rigid vertical hierarchy based on functional complexity is a major limitation to its applicability.⁽²⁰⁾ The interaction between two centers of different size is assumed to be unidirectional, and therefore not reciprocal. Neither are there any lateral relationships (or cross-hierarchy) among the same size level of urban centers. On the contrary, a model equipped with two-way trade information would be more realistic and relevant to growth center planning.

In order to rank the level of hierarchy, a functional assessment of each city has been commonly taken.⁽²¹⁾ Its key concept is "centrality which embraces all commercial, social and administrative activities pertinent to central place functions. However, doubts are still raised about the subjective (even arbitrary) weight score system. Data gathering is undertaken by the assumption that all functions are commensurable (albeit not a realistic assumption).

Another even more significant data problem is that the polarization flows due to spatial interdependence will be more intense and of a wider character around a growth center than a central place. The former is a dominant regional innovation center which is inter-related in such a way that interdependencies govern the economy and size of individual central places under its influence. Moving along this line of thought, Wood⁽²²⁾ illustrates four typologies of spatial linkages even though they are purely economic:

- 1) process spatial linkages,
- 2) service spatial linkages,
- 3) market spatial linkages, and
- 4) financial spatial linkages.

In growth center planning, spatial linkage analysis must be comprehensive enough to involve the acquisition of data which also pertain to spatial interaction of non-economic activities.

The flow information connected with spatial linkages would be conducive to the strategy of selecting both "effective" and "affective" growth centers. It is apparent that the information on spatial interdependence, is therefore, crucial to implementing growth programs.

(20) For a strong criticism against a rigid vertical hierarchy, see Allen Pred's recent article, "The Interurban Transmission of Growth in Advanced Economies: Empirical Findings versus Regional Planning Assumptions," *Regional Studies*, Vol. 10, 1976, pp. 151-171.

(21) Ordering urban hierarchy is of practical importance also in the national urban development policy.

(22) P.A. Wood, "Industrial Location and Linkage," *Area*, Vol. 1, 1969, pp. 32-39.

For example, Nichols' analysis⁽²³⁾ of the propulsive effect of growth poles suggests that investments be concentrated in those urban centers with the strongest linkages to their hinterlands.

The paucity of empirical work relating to the spatial linkages outlined above largely stems from the costliness of data collection or data preparation. Even the less demanding notions of dominance, functional regions, and distance decay in spatial interaction cannot be tested because of a shortage of good data.⁽²⁴⁾ It may be enormously time-consuming to obtain the flow data with more detailed spatial coverage, regardless of improvements in the administrative areal reporting units. For the purpose of reducing cost, preferable remedial action would be to limit "process-oriented activity description" to a group of sampled firms and households, *etc.* Naturally, a careful data acquisition plan should be framed to deal with the hydra-headed measurement problem of such flow data.

3. Evaluation of Growth Centers via Pole-Hinterland Relationships

A third important aspect of data collection is concerned with the analysis of relationships between the growth center and its surrounding region. It is widely recognized that the spatial influence of the growth center on its hinterland can be an important factor, whether positive or negative, in a region's development. From the very nature of our subject, two sets of opposing effects are generally considered: backwash and spread. If both effects can be measured successfully, it is possible to evaluate the impact of growth center policy.

A. Backwash Effects

The naive theory of growth center argued for a symbiotic relation between a pole and its hinterland. The key industries (or probably "export" industries) would function to accelerate growth within a region. The growth center would contribute to its surrounding area by providing the population of that area with supplies of goods and services.

In reality, it is frequently observed that sizable growth centers have shown more backwash effects than spread effects. Backwash is, by and large, an outcome of a dominant-subdominant relationship between flourishing centers and exploited peripheries. The most

(23) Vida Nichols, "Growth Poles: An Evaluation of Their Propulsive Effect," *Environment and Planning*, Vol. 1, 1969, pp. 193-208.

(24) Derek Thompton, "Review Article—Spatial Interaction Data," *Annals of Association of American Geographers*, Vol. 64, No. 4, p. 561.

harmful backwash effect is denudation of the hinterland's population and capital through highly selective migration. In this respect, it may not maximize the long-run rate of regional growth because capital deprivation results in a drastic fall in the level of economic activity in the "neglected" areas.⁽²⁵⁾

Another problem is that the spontaneous growth forces in the hinterland may be disrupted by establishing a growth center. Acknowledging that the growth center is a spatial manifestation of regional growth, existing "residential" growth potentials in the hinterland can be viewed as the primary source for the emergence of secondary poles. However, the flow of manufactured goods from the center is likely to discourage the setting up of new firms in the periphery. Also, the industries of the hinterland can be depressed as a result of competition from the growth center, particularly as transportation facilities become improved. While in the short run, this effect may be unfavorable, in the long run, overall regional economic efficiency and well-being may be enhanced. Salvatore⁽²⁶⁾ thus defined backwash effect as anything traceable *only* in the richer and more dynamic region.

For these reasons, it is necessary for most developing countries to give careful attention to the role of growth centers as stimulators of development *within* their hinterlands. Even growth centers have been successful from other points of view, such as the location of large scale industrial complexes that serve national sectoral objectives, their failure as a regional growth instrument has been conspicuous and indeed often aggravated.⁽²⁷⁾ Aside from *de facto* "pollution pole," many have functioned as "foreign enclaves" with closer links outside the region.

B. Spread Effects

As said before, the backbone of growth pole theory is that propulsive industry can be infused into an urban center so that there is "spread" of economic growth from that center. Spread, in a spatial sense, is defined as the set of processes whereby the absolute levels of development of a peripheral area increase due to diffusion from

(25) G.C. Cameron, "Growth Areas, Growth Centers and Regional Conversion," *Scottish Journal of Political Economy*, Vol. 21, 1970, p. 33.

(26) D. Salvatore, "The Operation of the Market Mechanism and Regional Inequality," *Kyklos*, Vol. 25, 1972, p. 524.

(27) H.W. Richardson, "Growth Pole Spillover: The Dynamics of Backwash and Spread," *Regional Studies*, Vol. 10, 1976, p. 1.

a core area.⁽²⁸⁾ One good example can be found in what Berry terms “hierarchical filtering” at the national level:⁽²⁹⁾

...impulses of economic change are transmitted in order from higher to lower centers in the urban hierarchy, in a sizable-ratchet sequence.

At the regional level, the concept of spread effects states that the dynamic growth impulses radiate outward into the surrounding space. Hilhorst⁽³⁰⁾ thus differentiates regional and local spread effects from interregional spread effects known as “hierarchical diffusion.”

Favorable spread effects depend largely on the existence of “complementaries” between the industries in a growth center and its hinterlands:

- a) creation of new demand for industrial raw materials from the surrounding region,
- b) attraction of new population to cities, thereby increasing the demand for food from the countryside, and
- c) generation of “growth mentality” across the hinterland by psycho-social growth pole functions.

It is also conceivable that spatial diffusion process are under way from the growth center to outlying areas transforming the whole region into something akin to a magnetic field.

However, a key question cannot yet be answered for lack of data: Do spread effects ever materialize? Some regional theorists have cast doubt on their validity. An optimistic view is that an imbalance in the pole-hinterland relationship may eventually be extrapolated into a Williamson type curve.⁽³¹⁾ In actuality, many favorable effects are spilled over beyond the region, whereas most unfavorable effects are confined and ultimately internalized within the region. Under certain conditions, this pay-off appears to be a zero-sum game among regions within the closed national economy.

Without concrete information, there is thus only “impressionistic” evidence that induced growth centers generate spread effects on their economically lagging hinterlands. Also it is not always clear what is being transmitted through the urban hierarchy. Even Hansen⁽³²⁾

(28) G.L. Gaile, “Testing Growth-Center Hypotheses,” *Environment and Planning*, Vol. 6, 1974, p. 185.

(29) B.J.L. Berry, “Relationships between Regional Development and the Urban System,” *Tijdschrift voor Econ. en Soc. Geografie*, 1969, p. 288.

(30) J.G.M. Hilhorst, “Development Axes and the Diffusion of Innovation,” *Development and Change*, Vol. IV, 1, 1972, p. 3.

(31) J.G. Williamson, “Regional Inequality and the Process of National Development: A Description of the Patterns,” *Economic Development and Cultural Change*, Vol. XIII, 4, 1965, pp. 3-45.

(32) N.M. Hansen, “An Evaluation of Growth-Center Theory and Practice,” *Environment and*

recently argued that it is difficult to justify *economically* a growth-center strategy on the basis of spread effects. Instead, he noted the spread of *social parameters* such as human resources, in addition to information circulation. This is not to say that growth centers in general do not generate spread effects. For example, in an advanced economy, journey-to-work linkages seem to be factual... *i.e.*, hinterland residents commute to the center, gradually expanding its urban fields.

C. Data Search for the Evidence of "Spread"

A theory which has no empirically measurable content is not a very useful theory. The crucial point here is that "spread" behaves like swimming against the current of natural growth, and consequently data search has faced the same difficulty. Thus, basic criteria are lacking about what is to be understood by a favorable or unfavorable effect. It should be noted that what one chooses to call spread effect often depends on the particular perspective of observation.

Despite this difficulty, attempts have been made to measure the spatial impact of growth centers mostly with published secondary data. For example, in the U.S. Hale⁽³³⁾ suggested a broad set of measures for the possible transmission of growth impulses: the transportation system, the geographical separation of economic functions of business firms, wage differentials, commuting, migration, local industrial development zoning, urban development and zoning, and investment in social overhead at the local level. (It is interesting, above all, that public policy, e.g., allocation of social overhead expenditures in the lagging region, itself is a spread mechanism.)

A common method of employing secondary data sources is to measure the size of spread effects by the rise in the region's average real per capita income. Gaile⁽³⁴⁾ introduced median family income and median years of education as surrogate for an index of development. On the other hand, Odland (*et al.*)⁽³⁵⁾ examined the growth of retail activities which, in my view, are associated with the changes in consumers' income. Hansen⁽³⁶⁾ proposed the induced generation of "secondary job," value added, and personal consumption in the hinterland.

Planning A. Vol. 7, 1975, p. 828.

(33) C.W. Hale, "The Mechanism of the Spread Effect in Regional Development," *Land Economics*, Vol. 43, 1967, pp. 434-44.

(34) G.L. Gaile, *op. cit.*, p. 187.

(35) J. Odland, E. Casetti and L.J. King, "Testing Hypotheses of Polarized Growth within a Central Place Hierarchy," *Economic Geography*, Vol. 49, 1973, pp. 74-79.

(36) Hansen, *op. cit.*, p. 827.

Alternatively, the spread of economic growth can be measured by means of a comparison of structures or structural characteristics every two or more years. Included in this category may be the increasing division of labor and specialization, and communication networks.

However, as mentioned before, the most important yard stick for the transmission of growth in space seems to be the expansion of inter-and intra-regional trade of people, goods and services. We could regard increased migration from surrounding settlements, in response to people's increased mobility, as a spread effect. Increased production of food and raw materials is a kind of spread from a growth center. Sometimes, the value of the inflow of capital or even remittance from the growth center is of particular interest. Also the growth center's hinterland benefits from the spread of various services such as development expertise (e.g., agricultural extension officer) from the center.

Furthermore, Richardson has emphasized the "socio-economic factors" of a growth center. Workers in its zone of influence become "productivity minded,"⁽³⁷⁾ through incentives of higher wages and provisions of new job opportunities

Methodologically all these secondary data, which are concerned with upgrading the quality of life in a region, could be fed into a factor analysis program and then hopefully their spatial implications would be reduced to regional indicators. In this connection, several models for the spread of economic growth investigated the impact on the surface of development *via* trend surface analysis.⁽³⁸⁾

Leinbach⁽³⁹⁾ studied the effect of distance upon the patterns of information flows. Casetti (*et al.*)⁽⁴⁰⁾ tested the impact of growth poles using urban employment data in a given spatial-temporal context, validating the distance decay of such influence. Harvey⁽⁴¹⁾ employed principal component analysis in his study on development regions of Sierra Leone. In his study, the variables included are numbers of primary and secondary schools, hospitals, gas stations, post offices, commercial banks, amounts of water and electricity supply.

(37) H.W. Richardson, *Regional Economics*, New York: The Praeger Publishers, 1969, p. 425.

(38) For a general treatment of trend surface analysis, see Robinson and Salth (1971), Semple *et al.* (1972), and more detailed description of method in Robinson and Salih (1973).

(39) Thomas B. Leinbach, "Distance, Information Flows, and Modernization: Some Observations from West Malasia," *The Professional Geographer*, Vol. 28, 1, 1973, pp. 7-11.

(40) E. Casetti *et al.*, "The Formalization and Testing of Concepts of Growth Poles in a Spatial Contest," *Environment and Planning*, Vol. 3, 1971, pp. 377-82.

(41) Milton E. Harvey, "The Identification of Development Regions in Developing Countries," *Economic Geography*, Vol. 48, 3, 1972, pp. 229-43.

Very similar but different in its interpretation the study by Weinland⁽⁴²⁾ devised "development surfaces" in Nigeria which measure the spread and the backwash effect independently. Most variables, subject to principal component analysis, measure government policy in spreading infrastructure and public services to rural areas. Ten measures of development were chosen from the broad categories of *social overhead capital* (SOC) and indices of entrepreneurial activities: health facilities, number of primary school classes, road density, electric supplies, urban water supplies, number of motor vehicles, working telephone lines, banking facilities, wholesale-retail activities, and index of traditional market activity. Among them, the last five variables are employed as the expected measure of backwash, representing entrepreneurship and ability to consume.

In conclusion, the hypothesis about concentric propagation of growth impulses from growth centers is still conceptually appealing. To test this, data search has as yet been too much oriented to economic phenomena. Non-economic data (e.g., social attitudes), derived from direct regional surveys, must be taken into consideration. With the intelligent use of such primary data, valuable understanding can be gained.

(42) Herbert C. Weinland, "Some Spatial Aspects of Economic Development in Nigeria," *The Journal of Developing Areas*, Vol. 7, 1973, pp. 247-64.