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Growth poles and growth centers in regional planning—a review†

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1 Introduction

The terms 'growth pole' and 'growth center' have steadily been accumulating a large literature during the past two decades—a literature which is scattered widely across the journals and which attracts contributions from a wide variety of economic and other viewpoints. The terms have, however, been used in vague, indistinct, and distressingly over-simplified ways, there being almost as many meanings ascribed to them as authors writing about them.

It is the purpose of this paper to unravel some of the immense confusion surrounding the notions of the growth pole and growth center, and to evaluate the concepts in terms of their usefulness and their contribution in explanatory and in normative senses. We shall attempt a sifting of sense from jargon, and in a survey of other literature written under a variety of titles show that in some cases the ideas behind the two concepts have been more rigorously developed elsewhere. Initially, we might ask simply in what tense the terms should be used. Are we speaking of places or phenomena that *have* grown, that *are* growing, that *are predicted* to grow, or that (in the normative sense) *we wish to see* grow in the future? Or are we referring to criteria by which growth centers and poles can be distinguished from non-growth centers and poles, past, present or future? It is indicative of the depth of confusion in the literature that there is no immediate answer to these questions. The terms pole and center have been used in all these senses, often interchangeably and often without explicit definition. The resultant confusion is deep and serious.

2 Growth poles and economic space

The term 'growth pole' was introduced into economic literature in 1949 by François Perroux (1950), since when it has become associated with an enormous variety of indistinct and ill-defined concepts and notions which have arisen partly from the ambiguity of Perroux's initial formulation, partly from mistranslations from French to English and *vice versa*, and partly from the semantic confusion of many authors. Unfortunately, the concept of the 'growth pole' has a powerful intuitive and emotive appeal which has been exploited by French economists to the neglect of informative, descriptive or analytical content. It has become a magic label and, in the 1950's, a guarantee of publication when used at the head of a paper.

Perroux's initial observation about economic growth, from which much of growth pole literature and confusion has sprung, has often been quoted.

> "Le fait grossier mais solide est celui-ci: la croissance n'apparaît pas partout à la fois: elle se manifeste en des points ou des pôles de croissance avec des intensités variables; elle se répond par divers canaux et avec des effets terminaux variables pour l'ensemble de l'économie" (1964a, p.143).

Perroux's meaning in this phrase has caused great confusion. At the outset it must

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be said that he defines growth poles *only* and *specifically* in relation to abstract economic space and *not* in relation to geonomic (or geographic) space, which he dismisses in 1950 as "banal".

Perroux's paper on abstract space defines three types:

1 space as defined by a plan;
2 space as a field of forces;
3 space as a homogenous aggregate.

The growth poles are conceived as existing in relation to the second type of abstract space, and are defined as follows:

> ". . . . centers (poles or focii) from which centrifugal forces emanate and to which centripetal forces are attracted. Each center being a center of attraction and repulsion has its proper field which is set in the field of all other centers" (1950, p.27).

Thus, poles are likely to be firms or industries, or groups of firms or industries. At this stage the definition is necessarily broad, in order to encompass a wide variety of the various meanings attached to the term 'growth pole'. Later, the concept will be narrowed[1]. It is within these poles that growth and change is initiated, while the connections between the poles, in terms of the flows of inputs and outputs, transmit the forces generated. The poles are therefore best regarded simply as sectors of an economy represented by an input-output matrix in which growth effects can be transmitted across the rows and columns.

Growth in the matrix is directly related to the activity of the poles themselves, and also to the degree of interconnection between them. A condition of 'dominance' of many firms by one firm (or of many industries by one industry) is an important feature of the growth pole notion. 'Dominance' is said to occur when the flow of goods and services from industry J to industry I is a greater proportion of J's output than is the flow from I to J of I's output. In this case, firm I is said to be 'dominant' and firm J 'dependent'.

A further feature of the notion is the emphasis placed on the size of the pole (industry). The rate of growth or change is supposedly directly related to the size of the industry, since the bigger it is, the larger will be its field of dominance over other industries which sell to it or buy from it.

A firm or industry characterized by all three of the above features, that is, high interaction with many other firms, a high degree of dominance, and great size, is said to be 'propulsive' and the firms or industries dominated by it, 'mute' (Perroux, 1964a). This loosely defined concept is a major feature of growth pole notions, and one on which most authors lean. Its ambiguity and lack of clarity are, however, responsible for a variety of interpretations as to the situations which might arise in an economy as a result of action initiated by the propulsive firm. The following description of the mechanics of polarization is therefore a generalized one, based on Perroux's initial formulation, but expanded somewhat to cover some of the ideas of other authors, where these are relevant.

2.1 *The mechanics of polarization*

These have been dealt with in theory, though not particularly rigorously, by Perroux (1950 and 1964b), Paelinck (1965 and 1968), Davin (1964 and 1965), Rosenfeld (1962), Boudeville (1966), and others. However, few empirical studies of polarization have ever been made, so the application of theory to reality, in both the explicative and normative modes has been weak. Boudeville's (1957) long paper on the effects of the steel industry on the economy of the province of Minas Gerais (Brazil) is the

[1] The problem of distinction between industry and firm can be conceived of as a question of the degree of disaggregation at which analysis is carried out. A 10 digit S.I.C. code would for instance come close to defining individual firms uniquely.

most ambitious. Another contribution is Rosenfeld's (1964) study of the province of Turin.

Perroux (1950) considers the case in which a propulsive firm in a region dominates 10 other firms in the economy. The propulsive firm is given a high degree of dominance over the others, supplying 60% of their inputs and buying 60% of their outputs. A simple matrix is constructed to illustrate this in some detail. Perroux claims that the growth pole notion departs from equilibrium theory by considering global product to be not only the sum of the products of each of the firms in the matrix, but also a function of the effect on a given firm produced by the input and output flows between this firm and all others. He leans very heavily on Scitovsky's concept of 'pecuniary external economies' here. Scitovsky's (1954) paper distinguishes between 'technological external economies' and 'pecuniary external economies'. The first arise when the output of a firm depends not only on its own factor utilization but on the output and factor utilization of other firms. Scitovsky could find only two examples of this in the literature (for instance, a firm benefitting from a labor pool generated by others). The second, 'pecuniary external economies', arise in economic development, when the output of a firm is affected by the *actions* of other firms. The situation in which the pecuniary external economies occur are described as follows:

> "Expansion in industry A may also give rise to profits (a) in an industry that produces a factor used in industry A, (b) in an industry whose product is complementary in use to the product of industry A, (c) in an industry whose product is a substitute for a factor used in industry A, (d) in an industry whose product is consumed by persons whose incomes are raised by the expansion of industry A" (Scitovsky, 1954, p.149).

Perroux adds little to this concept of external economies in explaining the mechanics of polarization. He considers the effects of firm A on other firms, but in two specific respects: (*a*) the effect of A making anticipation of demand, both correct and incorrect, and (*b*) the effect of A changing the balance of factor inputs in its production function. Thus he shows that an incorrect anticipation of a fall in demand will lead the propulsive firm A to buy less inputs, adversely affecting the smaller firms selling to it; to lay off some employees, causing unemployment, and to raise output prices, affecting firms buying from it. Other effects are also illustrated.

None of this, however, is either precise or rigorous. Moreover it is oversimplified. Perroux assumes that A 'dominates' all other firms, that the regional economy is in a state of full employment of all factors, and that the propulsive firm is very big relative to all others. However, it is not clear what these assumptions add to Scitovsky's concept. Although the assumptions are made, they seem not to be used. They represent differences in degree rather than in kind from those of Scitovsky, in that the effects of firm A on others could occur in a wide variety of economic conditions, and the constraints of dominance, high interconnectivity and large scale merely ensure that the effects will be felt powerfully by the other firms in the economy.

The distinction which it is necessary to preserve in the growth pole notion, between economic space in which poles are defined and geographic space in which they happen to have a location, is a basic and important one which has all too often been neglected. The semantic confusion of attributing to a location the growth characteristics of the pole (industry) which happens to be located there has been made repeatedly. Even when an author does recognize the distinction and define his terms, he often refers to other writers who have defined the term ('pole' in particular) quite differently. The whole of growth pole literature is full of this basic confusion and much of it, in Hansen's (1967, p.723) words, "is badly in need of a thorough semantic reworking".

Paelinck (1965, p.14), in a recent paper, makes the distinction more explicit by considering a region with reference to which poles can be defined. A pole is 'IN' a region when it extends its economic influence over that region (A), and is 'ON' a region when it is physically located somewhere within it (B). Thus, it is perfectly feasible for the industry or firm to be:

A, B (influencing and located in the region);
$\overline{A}$, B (not influencing but located in the region);
A, $\overline{B}$ (influencing but not located in the region);
$\overline{A}$, $\overline{B}$ (neither influencing nor located in the region).

Moreover, the growth pole concept *a priori* does *not* offer any explanations of the location of a propulsive industry in geographic space, nor of the consequences of a pole having a particular location in geographic space. Aydalot (1965c, p.963) has pointed out that, for example, in considering the firm of Renault (automotive engineering) to be a growth pole, the notion of polarization may help one to understand why Renault is a pole, but it says nothing about Paris, which happens to be its location. The process of polarization, says Hansen (1967a, p.718), "is not amenable to unambiguous geographic location",—a viewpoint with which we must concur.

One of the major points of discussion in growth pole literature, and one which illustrates the depth of confusion in it, is of the effects of the discovery of the gas field in Lacq, S.W.France. French (Aydalot, 1965a) and British (Political and Economic Planning, 1963) economists have either proclaimed its success as a 'pole' without giving sound reasons, or, on the other hand, have claimed that it has failed as a pole because it has failed to affect or induce any other industries to its locality. Yet this discussion is almost entirely misconceived. There is nothing in the original growth pole notion to suggest that the exploitation of gas in Lacq should attract growth *at that location*; this notion claims only that the gas field will induce growth in the economy (without reference to geographic space). It so happens that greater external economies exist (associated with agglomerations) in other locations in France and Europe and, because of this, the gas is transported to those locations. Growth has undoubtedly taken place—but not in S.W.France.

2.2 *Further developments in polarization*

Extensions of the growth pole notion as defined without reference to geographic space have been made by Paelinck (1965), Davin (Davin *et al.*, 1959), Derwa (1957), Perroux (1968), Poittier (1963), and others. Paelinck attempts to generalize growth pole notions into a theory. He follows the concept of Perroux discussed above, and then adds a discussion on polarization in fields other than industrial. Paelinck claims that if the propulsive firm induces growth, either backwards or forwards, this growth can be either a 'lateral' or a 'derived' pole. The example used to illustrate this is the nineteenth century textile industry in Lyons, which induced (backwards) a small chemical industry to provide bleach etc. (a derived pole), and this in turn induced a larger chemical industry providing basic heavy chemicals (a lateral pole). This distinction rests, however, on intuitive rather than theoretical grounds.

Lastly, Paelinck (1965) adds to the process of polarization by analogy, considering other fields in which it might operate. He speaks of "polarization des revenues"—by which he refers to the Keynsian income multiplier effect—"polarization psychologique"—an attempt to consider non-economic, chiefly social, factors—and "polarization geographique"—an attempt to give the whole notion some meaning in geographic space. These attempts are, however, not backed up by theory or empirical verification. They have heuristic value at the most.

Davin, Degeer and Paelinck (1959), writing about the Liége industrial region, and more generally elsewhere (Davin, 1961), use the non-geographic definition of the

growth pole in an attempt to produce advice for the solution of Liége's industrial problems. They identify 'poles' as follows:

> "The principal poles are found in heavy capitalized industry and are the domain of large firms; it is essentially a matter of metallurgy involving special types of steel, metal manufacturing industries using the most evolved possible products, chemicals, and activities designed to furnish products for which the demand is in fundamental expansion" (Davin *et al.*, 1959, p.88).

The problem of slow growth (even decline) in Liége is then oversimplified to be a lack of interaction between the major growth poles, which therefore remain potential rather than active. Davin (1961) is not concerned with location:

> "la localisation exacte d'une industrie au sein d'une région de développement perd son importance".

His solution to the lack of growth is therefore to stress the importance of exploiting potential linkages between the poles and developing new linkages between them, and with the rest of the economy. He stresses the value of institutional arrangements such as sub-contracting by which the large poles can cause fundamental change in the firms dominated by them. He is also concerned about the enormous influence which the decision makers in large industry have, not only in their own industry but, because of dominance, over the whole economy. Suggestions are made that the state should therefore educate these decision makers in their regional economic responsibilities. To say the least, this is naive and uninformative, and it raises a host of questions, begged by the author[2]. In particular, while advocating even greater interdependence between two poles in the economy, Davin forgets the obvious dangers of overspecialization. This is despite the fact that Liége's decline from nineteenth century prominance has, like that of many older industrial regions of Europe, been due to overspecialization in directions which were heavily dependent on world markets outside its control.

2.3 *Linkage effects*

It has been seen above that the process of polarization has many connotations, some of them conflicting, but that a fairly common theme through the literature is that of linkage effects, or interconnectivity, between firms. The study of linkage effects has, however, been pursued much more rigorously in a different field in American literature. Hirschman's (1958) formulation expresses lucidly, at a simplified level, many of the confused ideas prevalent in growth pole notions, though some French authors appear to be unaware of this. Hirschman discusses backward and forward linkage effects in relation to his thesis of 'unbalanced growth' and with reference to underdevelopment problems, but using a completely different terminology. (He does use the word polarization, but in a very different context, with different meaning, which will be discussed later.)

Backward linkages are developed by all non-primary activities, and forward linkages can be developed in all sectors other than that supplying final demand. In trying to develop a system by which to weight particular types of backward linkages emanating from a given firm, Hirschman (1958) speaks of the 'strength' and the 'importance' of the link. The total linkage effect can be measured by the product of these two, where 'importance' is the potential net output of industries which might be induced, and 'strength' is the probability of their coming into existence. This latter can be measured by the quantities of different inputs required by the 'master firm' (exactly analogous to Perroux's 'propulsive industry') multiplied by the minimum economic size of a firm producing each input. Minimum economic size is a concept measured in relation to

[2] Yet, curiously, it is this notion of a 'concensus' between government and the major firms in the economy which guides much of French economic planning. Persuasion is more important than coercion.

the local economy taking into account possible foreign competition to supply inputs to the 'master firm'.

In the case of forward linkage, minimum economic size is not a useful concept, "since the size of the markets that might be brought into being through forward linkage does not depend on their suppliers" (Hirschman, 1958, p.102). A guide can be sought in the proportion of the total input to an industry which would come from the 'master firm' (analogous to the concept of 'dominance' in French literature). If this is great, there is a high probability that a small, dependent firm will be induced; if the proportion is small, the probability is low, but the firm will be a larger one (using many other inputs).

In other words, 'strength' and 'importance' are inversely related—where the 'importance' is small the 'strength' will be large, and there will be a high probability of the firm's coming into existence—and this situation characterizes the 'satellite' firm, which is exactly analogous to the 'derived pole' of French authors and has characteristics such as the need for locational proximity to the master industry, the carrying out of only simple transformations and a minimum economic size less than or equal to the 'master'. A good example, given by Hirschman, is the inducement of a multi-walled paper bag producer by a large cement producing unit.

'Non-satellite' industries, in which 'importance' is large and 'strength' weak, are less likely to be induced, since the minimum economic size will be larger and their relationship with the 'master' less dependent. They are analogous to the 'lateral poles'. Thus, it would be improbable that the multi-walled paper bag producer would in its turn induce a pulp and paper mill to supply it with paper. Paelinck's examples, already given, of the nineteenth century textile industry in Lyons are clearly very similar.

This model has considerable heuristic value, as do many of the concepts in growth pole literature. It is, however, far too undeveloped to be of normative value, even in countries of the developing world, and as Hirschman (1958) admits, it is extremely simplified (perhaps over-simplified) in that it deals at most with direct relationships between one firm and a few others. Economic reality is of course much more complex than this, and indirect effects between all firms in a system are of great importance. Moreover, like many growth pole notions this formulation says nothing about location. Chenery and Watanabe (quoted by Hirschman, 1958) extended the idea somewhat by examining interdependency between industries (3 digit S.I.C.) for a number of countries. They were able to rank industries by their degree of inter-dependence and show that some sectors such as iron and steel have a very high combined linkage, forward and backward, and should presumably induce more industries providing inputs and absorbing outputs than would some other sectors. This approximate ranking Hirschman regards as having some normative value, inasmuch as it adds another criterion for economist-planners to use in relation to developing nations.

However, these simple notions of linkage between sectors across the matrix have been developed in much more detail and with greater specifity by Isard (1960) and Isard and Schooler (1959) as a by-product of 'Industrial complex analysis'. Isard and Schooler pose the problem of a major investment in Puerto Rico. What type of industry would be optimal? The first stage in answering this question is to survey local resources, two of which are the supplies of cheap labor and the proximity of Venezuelan crude oil. These narrow the search to some sort of oil-based industrial complex which can capitalize on cheap labor. However, this still leaves a tremendous number of possible combinations of processes, products and by-products, a field which is narrowed further by looking at the available market for oil-based products and assessing Puerto Rico's comparative advantage. This results in the choice of a

complex whose major outputs would be Dacron (for a wide market) and fertilizer (as an import substitute). The choice made, however, is constrained by the need to take advantage of two major factors not previously discussed, namely:

1 economies of scale for each element in the production process;
2 localization economies that might result from agglomerating all or some of the processes at one point—offset by transport cost considerations.

By treating these two factors simultaneously with their cost analysis of 'in what' to invest, Isard and Schooler (1959) are also considering location, and an optimum is a theoretical possibility. Intra-industry linkages are therefore considered explicitly in the analysis, this being achieved by the construction of a precisely quantified inter-activity matrix of inputs and outputs. Moreover, by dealing with the problem at a highly disaggregated scale, the authors approach economic reality much more closely than any of the others reviewed in this paper. They are able to deal with links which are not only direct but, by repeated iteration, those that are much more indirect. The 'growth pole' is therefore born fully fledged, both at a location (or locations) compatible with its functions, and with its appropriate assemblage of satellites and non-satellites. The only major element not covered by this technique appears to be that of urbanization economies which might result from the agglomeration of firms in different industries. (The attraction of existing agglomerations on the proposed complex is covered in the analysis only to the extent that sources of labor and absorbers of output might be located in them.)

We must now move on from this review of the non-spatial concept of the growth pole to ask how authors have looked at the problem of the spatial incidence of growth and the spatial allocation of investments within or between regions of a nation.

3 Growth poles (centers) in geographic space

3.1 *Introduction*

Growth pole notions discussed so far are independent of a spatial context, as are Scitovsky's external economies and Hirschman's linkage effects. The interaction between a propulsive firm or industry and others is seen only in relation to the matrix of a theoretically open economy whose bounds are arbitrarily limited to a nation or a region. Locations in geographic space are not considered.

However, since all units must have a location, and since in regional economic development the question of 'where?' looms large, then despite the fact that poles are independent of geographic space, their existence within it poses complex problems unexplained by growth pole 'theory'. This situation has obviously concerned French authors, and the result has been the emergence of another group of concepts (also referred to in the literature as 'poles') which we will discuss under the name of 'growth centers', defined as locations (usually cities) in geographic space. Propositions and theoretical descriptive studies of growth 'centers', so defined, have multiplied in recent years and have a strong normative element which has in part been harnessed into the provisions of the fifth French "Plan de Développement" (Political and Economic Planning, 1963).

Yet in the whole of French growth pole literature, only one example (Boudeville, 1957) is known to the author of an attempt to make explicit the connection between the conditions for the existence of a 'pole' defined in abstract space, and the conditions for its appearance and location in geographic space, as a 'center'. Even in the American literature, papers on this aspect are not numerous—only Isard and Schooler (1959) treat it adequately. This extraordinary gap can only be explained by the great semantic confusion of many authors between the industry (pole) and its location (center). This confusion has been so profound that explanations of how a link occurs between

the two, have been thought unnecessary, or at least are presumed to be 'understood' by the reader.

Clearly, as soon as we begin to discuss the location of growth poles in geographic space and in particular the conditions for and manner of their growth, we are dealing with a somewhat different set of variables which intersects only marginally the set discussed in the French literature under 'poles'. The location of the propulsive firm is presumably best dealt with in terms of location theory, as are the locations of the dependent firms induced by its growth. However, it would be unreal to expect classical location theory to say much about this without also considering the amorphous field of external economies in both public and private sectors, and the nascent 'theory of agglomeration' (U.S.Dept. of Agriculture, 1966) in which there are advantages to location and growth in a large city over and above the market pull of an agglomerated population which would in any case be considered in the context of location theory.

3.2 *From growth poles to growth centers*

A straight interpretation of pole notions into geographic space would produce naive answers. Firstly, one cannot talk about the location of a propulsive *industry* without assuming that all firms or processes in that industry are agglomerated in one location, which is clearly unrealistic. The optimum location of the propulsive *firm* would (from the firm's point of view) be seen in terms of the location of its sources of inputs and markets for outputs. A simple version of location theory could be envisaged in which optimum location would be a product of the relative transport costs of the different inputs and outputs, weighted by such factors as the firm's labor demands, and the relative closeness of the manufacturing process to the final demand sector. The location of the induced, or dependent, firms would depend on whether forward or backward linkage, and satellite or non-satellite firms, were being considered. In backward linkage, the satellite (defined as being dependent on the propulsive firm as a market for more than 50% of its output) will, depending on the relative weight loss or gain in its manufacturing process, have an optimum location heavily influenced by that of the propulsive firm. Backward linked non-satellites will be less likely to be influenced by the location of the propulsive firm. In the case of forward linkages, similar relationships might be envisaged, with the non-satellites closer to final demand and more oriented towards the market.

This is obviously a very crude statement of locational criteria. However, it illustrates that even at this level the notion of growth pole has very little intrinsic value where location is being considered, and that serious locational considerations would have to be dealt with in terms of location theory, with growth pole notions playing a very small part. In fact, we must turn to Isard and Schooler (1959) for a demonstration of the link between the pole and its location. Again as a by-product of their industrial complex analysis, Isard and Schooler throw valuable light on this issue. By developing the inter-activity input-output matrix for the elements in an industrial complex, they are able to deal with the choice of what to invest in (growth pole), simultaneously with considerations of the optimum size of each of the elements in the complex, the scale economies involved, and the transport costs of each of the inputs and outputs. The linear programming solution to this will give the optimum location for the optimum combination of linked processes in a complex, in terms of the maximization of some objective function—say profits. Scale economies and localization economies are therefore adequately treated. In the case of Puerto Rico, Isard and Schooler were able to produce a solution which also indicated which processes would be best agglomerated to achieve localization economies, and which dispersed (near inputs, or markets) to minimize transportation costs. The analysis, however, as pointed out above, stops short of the consideration of urbanization economies which result from the agglomeration of different industries.

Boudeville (1957) attempted an empirical demonstration of growth pole notions, and of the location of a growth pole in geographic space, by measuring the impact of the steel smelting industry on the economy of the province of Minas Gerais, Brazil. This measurement of 'forward linkage effect' is based on relating the increase in steel fabrication output to a 1% increase through time in steel output in Minas Gerais, and of relating output in the two industries for all Brazilian states at one moment in time. The results indicate that while there appears to be a temporal relationship between steel smelting and steel fabrication, the spatial distribution of the latter is more closely correlated with the size of the population of the largest agglomeration in each state. In effect, while Minas Gerais had one of the largest and fastest growing steel smelter outputs in the nation, its output of steel fabrication products was small. This was correlated with the small size of the state capital, Bello Horizonte (300000) compared to San Paolo (2000000) and Rio de Janeiro (2300000), which had the largest steel fabrication industries.

This attempt to separate the 'agglomeration effect' from the 'polarization effect' is thus not very successful, since it is not possible to induce causal connections from correlations and regressions. In particular, even if we accept Boudeville's multiplier effects as evidence of a causal relationship, it is difficult to see how the polarization effect is separately identified. The existence of a steel fabricating industry is obviously dependent on two major criteria—the existence of a market and a supply of steel. Thus it may well be, since steel fabrication was more closely related to the former than to the latter, that a steel fabrication industry would arise even if steel were not produced in Brazil, but imported. Boudeville's consideration of backward linkages are equally inconclusive in this respect.

There are few empirical papers in the literature and since they do not add much to the above we must conclude that not only does the notion of 'pole' have limited theoretical value in a locational context, but that empirical demonstration of the 'inducement' effects hypothesized by Hirschman has not as yet been satisfactory.

3.3 *Growth centers and the polarized region*

Despite the flimsy theoretical background and the lack of empirical verification, there is nonetheless a great deal of intuitive appeal in the notion of a growth center in which economic and social development is initiated and transmitted to an area around it. Moreover, the most important normative questions of regional economic development, those concerned with the regional allocation of investments in both time and space, can be given some clearer direction if this intuitive notion is adopted. Thus, for example, such a notion would imply that investment is best concentrated in growth centers rather than scattered around in some vague quest for 'balance' or 'equity'. It might also imply that the existing central place structure of a nation could somehow be adapted to serve specific goals of growth initiation and transmission.

Because of the above consideration, the notion of the growth center has been of interest to many economists. This has been so especially in France, where the system of national and now regional economic planning calls for definition of regions, and advice on the spatial as well as sectoral distribution of investments. This interest in the normative has also broadened the basis of growth center notions to include variables other than economic—such as social, political, cultural, and psychological.

Much of the work in this general direction centers around Boudeville's (1961c and 1968b) conception of three types of region—homogeneous, polarised, and planning or programming, regions. The homogeneous region, beloved by geographers, has maximum internal homogeneity and maximum external heterogeneity in whatever factor is being measured. Polarized regions are defined to be that collection of geographic spaces in which connections and flows of, for instance, goods, services and political

allegiance are predominantly in one direction—towards a central point, or 'pole', which dominates the region. The boundary of a polarized region is therefore that line beyond which flows and connections are predominantly in some other direction, towards some other pole. This concept is very similar to Derwent Whittlesley's 'nodal region' (Centre des Études et Recherches Economiques et Sociales, 1959) and has many features in common with John Friedmann's 'center-periphery' model. The polarized region can exist at any scale, and smaller ones, polarized around smaller centers, will tend to 'nest' within larger ones. The idea of the polarized region is therefore compatible with the central-place structure of a hierarchy of cities of ascending size and function, with the 'growth centers' normally being the larger city or cities in the region, at whatever scale is being discussed.

This concept has been incorporated into French regional planning, which has three homogeneous regions—Paris, West and East—nine polarized regions each with a center called a 'metropole d'équilibrium' (excluding Paris), and 21 programming regions for short term allocation of resources. The eight 'metropoles' outside Paris have been chosen on the basis of their size (some consist of several cities, such as Lille–Roubaix–Tourcoing), with the aim of decentralizing some of the regional functions from Paris. The goal is to solve the problem of 'Paris et le désert français' which arises because Paris taps off most of the regional functions of the other regions and their centers, so that the small provincial towns are only feebly dependent on the regional centers, and Paris's influence spreads through the nation. The policy is to concentrate investment in the eight regional metropoles, each of a minimum target size of one million, and develop an appropriate 'armature urbaine', that is, a central place structure, which will maximize the interdependency of the peripheries of each polarized region with its respective center by gathering flows from the periphery and directing them up through the hierarchy, and by bringing the benefits of urban life down to the smaller centers. The smallest villages and hamlets in the most depressed areas will be encouraged to decline through out-migration, thus cutting off the 'tail' of the hierarchy. In Friedmann's terms, this is a policy of encouraging spatial integration between core and periphery, at the *intra*-regional scale—the level of the polarized region—while correcting the imbalance evident between Paris (as a core) and the rest of France (as a periphery) at the *inter*-regional scale.

The 'growth center' is, in this normative sense, a somewhat wider concept than we have previously seen, and is not closely related to Perroux's initial 'growth pole' notion. In this sense the growth center has been extended somewhat by other French authors.

Lebret (1961) attempts to link agglomerations with growth poles. He sees agglomerations as composed of one or more 'unité motrice'—assemblies of capital or resources, which by their size and growth can be termed growth poles. Most large French agglomerations have several poles located in them and are able to generate growth by their size, which releases valuable external economies. Growth, however, is considered not merely in terms of the market, but also in terms of the functions and services which the agglomeration can provide. A strategy of development for the economic space dominated by the center is then based on the organization of the 'unités motrices' in such a way that they lead to maximum development at minimum cost, and this will be best achieved if they are complementary and generate a large number of interlinkages and multiplier effects. Lebret considers that this policy is viable at any geographic scale, but principally at the level of the metropoles.

Antoine *et al.* (1968) see the metropoles as being propulsive on account of their well developed tertiary sector, since this is the fastest growing part of the economy. They advocate a policy of investment in the service sector located in each of the metropoles, and argue that this will help, not hinder, the smaller towns of the regions, by generating multiplier effects. The aim is to build up the functions and

level of services of the metropoles so that the regions become oriented fully towards them. Hautreux (1966) agrees with the above view, but stresses that since the central government rarely has much control over the location of commercial services, policy should be concentrated on building up public sector services such as education and administration, which, by increasing the flow of customers to the agglomeration, will encourage in time the development of commercial services. This is also consistent with the French policy of decentralizing public sector services from Paris. Labasse (1968) also stresses the tertiary sector as a basis for growth, in that a highly specialized agglomeration with many services is likely to attract and retain the elites necessary for the decision making process in economic development. The presence of 'rare services' can thus be looked upon as both a cause and an effect of polarization and the integration of economic space around the growth center.

This line of thought has been extended by considering the interaction between polarized regions, in terms of their growth centers, and the poles which form these centers. Perroux (1961) attempts to demonstrate the interaction between Region A with a propulsive firm and Region B without one, but he does this without reference to geographic space, so his speculations are of limited value. Boudeville (1969c), on the other hand, has looked at the relationships between the eight French provincial metropoles in theoretical and empirical terms, and devised a matrix of their bilateral interaction measured by the total number of employees controlled by one city's decision makers in the other seven cities. This produces a picture of relative dominance in which Lyons emerges at the top. (Paris, which dominates all the other cities, is excluded from the matrix.) Boudeville speculates on the possibilities of extending this approach to the social, institutional and political fields by means of various surrogate measurements based on data collected in surveys. By this means it would be possible to identify the groups which, by their power and influence, have some control of the polarization process. Friedmann (1967) has amplified this in a recent paper based on 'center-periphery', discussed below.

In his book on regional planning, Boudeville (1966, p.108) deals with regional models, one of which is based on the polarized region. He develops a model which makes possible the definition of boundaries of regions polarized around major cities by application of a modified gravity model of the information-flow type whose inputs are population and distance only. Modifications are made for particular products and functions based on distance elasticities. An application of the model considers three polarized regions of the Rio Grande de Sul, Brazil. A proposal to relax customs dues implies that the boundaries of the three polarized regions will change. Boudeville predicts the redistribution of population needed to retain the boundaries in their original position, and the required number of extra jobs implied. This is then related to a given amount of investment in manufacturing, and the 'optimum' allocation between the three regions is indicated. This model has very limited applications, however, as the somewhat esoteric example might indicate.

Hirschman (1958) and Myrdal (1957) have also contributed to this aspect of growth center literature. Independently, they both talk of a process whereby one region (called 'North' by Hirschman) is the growth center, being advanced and developed, which influences or controls the rest of the nation ('South') by two processes—'polarization' and 'trickling down'. Myrdal's terms, exactly analogous to these, are 'backwash' and 'spread' respectively. 'Polarization' effects exercised by the North on the South tend to be to the South's disadvantage, and are due to the North's stronger economic position. They include severe competition from the South's relatively inefficient industries, and a tendency for selective migration of the young, skilled, educated people from South to North in search of the greater opportunities and apparently higher salaries available in the latter. Because the North's industry is

productive, what little capital South possesses is also likely to migrate to the North, where interest rates are high and security guaranteed. The favorable 'trickling down' effects from North to South are the increase of Northern purchases and investments in the South and the absorption by the North of some of the South's underemployed, thereby raising per capita incomes in the South. Hirschman shows, however, that these effects are likely to be balanced in favor of the North (the 'center') and against the South ('periphery'), and that this situation of imbalance will tend to continue up to the point where the lagging of the South begins to affect the North's growth, or where the South will seek to redeem the balance by political action or revolution. Hirschman's use of the term 'polarization' is thus rather different from that of French authors, but he is clearly expanding the notion of the growth center into a more broadly based concept of regional economic development compatible with his notion of 'unbalanced' growth. This has been taken up by Friedmann and Hansen.

A somewhat different direction has been taken by Fox (1966) and his associates. Fox defines and discusses growth centers in a very restricted sense. His definition is a normative one, "an urban place which can act as a focal point for development planning", and is related only to the development regions and districts as defined by the U.S. government's Economic Development Act. In this context, "a growth center is typically an urban place of less than 250000 population which acts as the vital heart of its development district". Fox goes on to discuss criteria by which a distinction might be made between urban areas which are growth centers, and those which are not. Yet even in the very restricted sense which Fox uses, the criteria fall far short of enabling such a distinction to be made. The criteria mentioned by Fox include strong linkage to the national economy, the center of a labor market, a major retail trade area, high level tertiary functions, a large volume of wholesale trade, and good communications, none of which is specific enough to help us separate a growth center from a non-growth center—they are characteristic of most urban areas.

Further discussion by Fox concentrates on identifying the size and rate of growth of a center with the population density of its hinterland. A clear, positive relationship is hypothesized similar in many respects to Chaineau's (1965) model. Normative prescriptions for the induction of growth include various methods of reviewing regional productivity and for reducing the regional capital output ratio by investment in the growth center, and the establishment of policies which will lead to the reduction of differences in the marginal rate of return of factors, the assuring of economically efficient locations for every enterprise, and the concentration of public investment in areas of maximum growth potential. The potential incompatibilities involved here seem not to concern Fox.

3.4 *Center-periphery*

The need to answer the question 'where?' in explanations of the occurrence of economic growth and in problems of regional allocation of investment has been expanded by the work of John Friedmann (1966, 1967a, 1968). In developing the center–periphery model, and in increasing its specificity and level of detail to cover variations within the periphery, Friedmann stays close to the real problems of regional development, the normative questions. His work has very little relationship to the rather confused, ill-defined, vague and often barren discussions of growth poles in French literature viewed above. Indeed, although Friedmann claims the opposite, it is difficult to see in what respects his work owes anything but the name 'growth pole', and its intuitive connotations, to the French authors preceding him. The distance separating Friedmann from other authors is so great that in a recent review of the growth pole concept (Hansen, 1965), his work was not mentioned.

Friedmann's major contribution to growth pole and growth center concepts is to show how deficient these concepts are in most respects. He does this by developing a richer and more satisfying descriptive and normative model of the spatial incidence of regional economic development. Specifically, Friedmann's work is outside the problem of the inter-sectoral distribution of resources, which has been shown above to be the main source from which growth pole notions have sprung. He addresses himself squarely to the real problems of regional development in geographic space, and via his 'center-periphery' formulation emerges with a nascent theory of 'polarized development' which will ultimately cover not only the narrow range of economic variables, but also explicitly social, political and cultural developments in geographic space.

In his book on Venezuela, Friedmann (1966) begins by describing the 'regional policy problem' as an issue of applying national policy in a spatial dimension, and indicates that it emerges as an issue particularly in the second of the four phases of national development:

1 pre-industrial; 2 transitional;
3 industrial; 4 post-industrial.

He is concerned with the integration of what have, in the pre-industrial phase, been independent regional economies of a colonial nature, usually on a coast and tied economically more closely to their master-country abroad than to each other. Regional policy becomes a necessity when such a nation gains independence and is faced with the problem of integrating these regional economies. It is here that Friedmann introduces his 'center-periphery' model. The independent economies usually have a single center on the coast, and a periphery, loosely tied to this center, from which produce is extracted for export to the master-country (colonial) abroad. Relationships between the center and the periphery will be minimal, and those that are developed will tend to be one-sided, supporting the center at the expense of the periphery, which remains a backward, exploited area unable to grow because it is feeding the growth of the center. This 'dual' notion of the economy becomes imprinted on the national economic space.

Limited evidence is available elsewhere that a center-periphery structure can exist at different geographic and time scales, and at different phases of development. An attempt has been made to view the Western Europe–Eastern Seaboard U.S.A. area as a world 'growth center' until recently living off the periphery, the rest of the world (Chisholm, 1964). Modern France, with its extreme centralization on Paris as a 'center', to the great disadvantage of the 'periphery', can also be thought of in these terms.

Friedmann discusses the interaction of the core and the periphery under eight propositions concerning the incidence of economic growth with spatial implications. These propositions amount to the view that regional economies are essentially 'open' and because of this economic growth is usually induced externally, initial impetus being the export of a primary product or resource to other areas or nations. Successful translation of this export-sector growth into 'residentiary' growth (internal to the region, and serving local markets) depends on the socio-political structure and the distribution of incomes and expenditures in the region. Within a given region, the growth of residentiary activities will be enhanced if local investment and government infrastructure are encouraged. However, all this is dependent on local leadership which, unfortunately, is also a product of the region's development experience. This will be encouraged by a decentralized administration providing opportunities for local decision makers.

In spatial terms, economic growth as seen in these propositions would occur in a matrix of urban regions which are the building blocks around which economic space

is constructed, and evolve in the direction of ever greater integration. In effect Friedmann generalizes his 'location points' (locations in economic space) into cities and towns which, because of their valuable urbanization and localization economies, tend to be favored as points of growth. There emerges a hierarchical system of cities, and thus also of urban fields, which is held to be evidence of increasing spatial integration, and therefore development.

Economic growth is related to this system in specific ways such that the population of the sphere of influence of a city will be proportional to the size of that city, economic growth will be a function of distance from the central city, growth potential between two cities will be a product of their size divided by their distance apart, and economic change will tend to be transmitted from higher to lower orders in the hierarchy. Friedmann implies that economic development is closely related to the emergence of a highly developed and interconnected functional hierarchy of cities of the Christaller type, and that growth is in some way proportional to the size of an agglomeration (modified by imperfect labor mobility). In terms of encouraging overall development he therefore advocates such a hierarchy of cities as a means of integrating the periphery with the center, or core. This is in many ways similar to the French notion of the 'armature urbaine' discussed above, and to Lloyd Rodwin's (1961) 'concentrated decentralization'. However, Friedmann goes further than this.

Along with Perroux and Boudeville, Friedmann defines his own sets of regions, called 'homogeneous' (analogous to Boudeville's use of the term) and 'interdependent'. The latter are close to the 'polarized regions' discussed above, being areas in which flows of goods and communications are predominantly towards a center, or core. For planning purposes, Friedmann divides up the periphery of the polarized region into several parts, to give the following:

core	'center';
upward transitional downward transitional resource frontier special problem	'periphery'.

The core region has the characteristics of the center but on a larger scale. Upward transitional regions are settled areas with growth potential, and like cores have net immigration. They are growing and have problems of capitalization. Downward transitional regions are old rural (or industrial?) economies in decline, whose resources suggest less intensive development than in the past, and where emigration is characteristic. Resource frontiers are zones of new settlement in which growth is potentially large in either agriculture or in mineral working associated with immigration and small new towns. Special problem regions are a category for areas that pose policy difficulties other than those above.

The main value of this simplified structure lies in three directions—its general applicability, its independence of scale, and its normative value. Being a generalized description, it has little explanatory value. In all the first three respects, however, it has certain advantages over the simple notion of a growth pole and growth center. In particular it deals with the whole of economic space, since the regions proposed are mutually exclusive and exhaustive. Moreover, as a normative framework it can distinguish between geographic areas in terms of necessary policies, while ensuring that regional problems are not dealt with in isolation, since solutions are possible only by considering the system as a whole.

Friedmann goes on to consider goals for spatial organization, and methods of implementation related to the regions specified above. The goals are related to the system as a whole and have two main requirements—that they must be adapted to the current phase of the system, and that they must be consistent with 'dominant

regional aspirations'. This distinguishes Friedmann from the majority of authors who are content to name criteria over which performance is to be optimized. He argues that one must use historically and *spatially* specific goals with elements outside the field of economics to create a reality in regional planning. By simulation, it would be possible to set up goals and to test criteria and policies by their relevance in achieving these goals.

The main issues of allocation of investments in space are discussed under the three polarities of:
growth versus welfare; imbalance versus balance; concentration versus dispersal. In many respects these are similar to each other, and raise the old issues of whether to emphasize growth at the expense of welfare and to concentrate investments in large agglomerations which will produce most multiplier effects, rather than scattering investment around in search of 'equity' or 'balance'. The choice in sectoral and social terms between balance and imbalance is expressed spatially in that between dispersal and concentration. However, the implication of such choices become clearer when seen against Friedmann's regions than when seen in Lloyd Rodwin's terms. For example, Rodwin (1961) advocates a policy of 'concentrated decentralization' when faced with the choices above. In this, small centers or cores are set up in the periphery, thus to some extent distributing investment but also taking some advantage of urbanization economies. This, however, is not a sufficient criterion for dealing with spatial investment problems, nor does it give much help when we are faced with different scales of problem. Obviously large scale concentrated decentralization (say from Paris to the metropoles) becomes merely 'centralization' if we look at the smaller region around a particular metropole, and so on. Friedmann's regions are a valuable substitute for this, since they allow the prescription of policies addressed to particular problems, in regions which are defined in relation to those problems. And because the polarized region can be thought of at any scale, the whole structure is not dependent on scale as is Rodwin's.

Goals for a society in the transitional phase are thus related to the removal of the periphery by substituting for it (dependent on the subregional structure above) a "single, interdependent system of urban regions" (Friedmann, 1966, p.54), and to the extension of a national system of factor and commodity markets. Friedmann concludes by specifying in great detail the kinds of action and policy that should be devised to deal with each of his types of region, sufficiently general to be applicable to any nation in the 'transitional' phase of development.

Friedmann thus presents us with a general model of the spatial aspects of regional economic growth, expressed chiefly in the descriptive and the normative, which goes further than the simple notions of growth pole and growth center. Moreover, his more recent work has attempted to expand the center–periphery formulation by making it applicable to all four phases of development, by considering explicitly cultural and political trends, and by extending the notion in an explanatory sense. The "General Theory of Polarized Development" (Friedmann, 1967) attempts to explain how the development process in its economic, social, and political aspects expresses itself in space, and how the resultant structuring of space changes through time.

4 Evaluation

4.1 *A spatial theory of growth?*

A theory may be thought of as a set of related definitions and hypotheses that attempts to explain a given phenomenon. Some of the hypotheses will be accepted on the basis of existing evidence, others will present a challenge to research. To what extent do growth pole and growth center notions constitute a 'theory' by this definition?

A theory of the spatial incidence of development—economic, and perhaps socio-cultural, and political—will have to relate a number of previously unrelated theories, hypotheses, and observed empirical regularities. The idea of a process of polarization taking place without reference to geographic space is a suitable starting point, even though it is confined, in the works reviewed above, to the economic field. However, in order to account for observed regularities, such as the appearance of a hierarchical structure of central places, we shall expect such a theory to embrace location economics and spatial organization theory, and in particular to account for strong tendencies towards agglomeration, which are apparent in society, possibly via theories of external economies. Moreover, we shall expect such a theory to account for these observed regularities, and hypothetical processes, both through space at one moment in time, and through time in a given space, such as a region or nation. We have seen in the literature various elements or components of such a theory presented in a number of unrelated, simplified, and non-rigorous formulations. We have seen attempts at using the concepts of growth pole and growth center in a normative sense, despite the lack of a full explanatory theory on which to base planning actions and policies. (The exigencies of the regional development problem are such that daily decisions must be made despite the lack of an adequate explanatory theory or model.) However, our expectations of a theory of the spatial incidence of growth would include the criterion that any explanations of existing distributions shall by the same formulation be applicable in a normative sense to the solution of planning problems. In other words, the explanatory sense of the theory should be sufficient to identify and quantify the specific areas in which the present structure of economic space falls short of that structure needed to implement the goals of the society under consideration, and to lead to the formulation of policies which will help the society to achieve the optimum distribution of population, industry, investment and urban equipment consistent with the achievement of its goals.

Clearly the notions of growth poles and growth centers reviewed do not constitute a 'theory' as defined above, although they do provide some basic elements of such a theory. We can, therefore, evaluate the literature in two main respects: firstly by reviewing the degree of rigor with which it deals with those areas that it purports to cover, and secondly by asking in what respects it falls short of our theoretical expectations, and indicating the three main directions in which research might proceed to fill in the gaps.

4.2 *The positive contribution*

Most authors on growth poles agree that in order to act as a pole the industry under consideration must satisfy the three criteria of large size (and economic dominance), a rate of growth faster than that of the economy in which it is embedded, and a high degree of interlinkage with other sectors. By satisfying these criteria, it will thus be termed 'propulsive'. However, while this may be a sufficient condition to distinguish those sectors that will *transmit* growth (and this is doubtful), it says little of the way in which growth is *initiated*, and to this extent begs an important question. The process of polarization 'explains' the transmission of growth via interlinkages and external economies between one sector and all others, and, if the sector happens to be a fast growing one, the process would lead us to expect growth elsewhere in the economy. Hirschman's 'linkage effects' are a demonstration of this highly simplistic idea. It has been noted, however, that empirical demonstrations of the effects of polarization have, to date, not been able to distinguish between polarization effects and other effects, such as the influence of the market or the appearance of agglomeration economies. In other words, empirical demonstration has yet to show the strength of the polarization effect in relation to any of the other effects which can be claimed to

be 'growth inducing'. We must note that Isard's approach, using detailed input-output data in industrial complex analysis, is much closer to economic reality since it attempts to deal with many of the indirect interrelations between sectors, which the simple notions of growth poles and linkage do not, or can not.

Growth pole notions seem to stress the thesis of unbalanced growth developed by Hirschman. The prescription for progress which emerges from the pole notions is, however, somewhat undeveloped, since it relies simply on maximizing flows between sectors of the economy in the hope that this will generate multiplier effects which will, of course, be beneficial. However, this is not, nor can it be, related to specific policy objectives, and so its normative value is limited. We cannot agree, therefore, with Paelinck (1968), who maintains that the growth pole notion is "valuable chiefly to the extent that it clearly indicates the conditions under which accelerated regional development can occur". It does provide a set of conditions under which transmission of growth can be optimized, but these are by no means incontrovertible or exhaustive. Moreover, the concept says nothing about the initiation of growth and very little about the location and spatial distribution which might optimize growth.

What of the concepts which have been reviewed under the name 'growth center'? This concept specifically purports to deal with the distribution of growth, and allocation of investment, in real space. It has been shown that there have been few attempts to translate the ideas of propulsion, as developed with reference to firms in abstract space, into structures and distributions in geographic space; and indeed we have found this to be the major omission of the growth pole notions. Despite this, however, the growth center idea, particularly as generalized by Friedmann into the center-periphery structure, has great value. This lies in two main areas. Firstly, it provides what promises to be a dynamic theory of growth and development which can greatly enhance our static models, such as central place theory, and, as a corollary, it provides a basis for giving to development theory a spatial dimension. Secondly, growth center ideas are robust, if not rigorous; that is, they are addressed squarely to planning problems, and while they do not by any means answer these problems, they do provide the directions in which further research can proceed.

The explanatory value of the growth center idea is thus as yet limited and tends to be eclipsed by its normative value. Yet even the latter is more heuristic than specific. We gain from the literature at most certain normative preferences for action, such as: "it is better to concentrate investment in centers, than scatter it around", "bigger centers will be better than smaller ones in the amount of growth produced from a given level of investment", "there are a number of sub-optimum structures for generating and transmitting growth at all phases in the development of a polarized region—and the central place hierarchy should be modified to this extent", and "development, in spatial terms, will consist of promoting integration of the periphery, by a single interdependent system of cities".

One of the most valuable aspects of the idea of the growth center is that it gets away from the reliance of growth poles on the big firm or big industry as a basis for growth. Several authors have stressed the importance of the tertiary sector, and of the existence in an agglomeration of many smaller firms providing the specialized services on which the external economies of agglomerations are hypothesized to be based.

Attempts have also been made to generalize the notion of the center into the socio-cultural and political fields. While these attempts have not yet produced results, their existence is encouraging as representation of the awareness now common that explanations of and prescriptions for growth and development in spatial terms must cover many non-economic variables if they are to claim success.

Perhaps the most satisfactory explanations in the literature are those developed by Friedmann, directed at the spatial incidence of growth as related to the stages of national development. This is one of the criteria mentioned above by which we would recognize a 'theory'. Friedmann's center–periphery structure is, it is true, a highly generalized one which does not approach specific cases, other than that of Venezuela. However, we would defend this quest for general applicability, even at the expense of rigor, as being most appropriate and relevant to the development of a satisfactory theory. The 'style' of growth center literature has necessarily been somewhat generalized, since it seeks to incorporate variables which are difficult to conceptualize and quantify.

The most serious omissions in the literature concern the absence of explicit statements about the relationship between polarization and empirically observed regularities on the ground, and the inadequate treatment of the whole of external economies and the pronounced tendencies towards agglomeration. These are the main areas in which growth pole and growth center notions fall short of our expectations in terms of a theory of the spatial incidence of economic growth. A brief discussion of them can, therefore, provide a suitable conclusion to this review by pointing in significant directions for further research.

4.3 *The major deficiencies*

4.3.1 *Agglomeration and externalities.* There is general agreement that growth center and growth pole notions will prove of use only if they treat adequately the tendency of economic, social and political processes to produce agglomerated phenomena. Much has been written of the role of external economies in the growth of urban areas and centers, and most of this has been on the basis of economic variables. It is not the purpose of this paper to review the literature on externalities, but some of the distinctions and contradictions within it must be established in order to view more clearly the relationship between agglomeration and the processes of polarization.

> Most authors appeal to 'external economies' in order to 'explain' agglomeration. ". . . . any adequate treatment of this phenomenon (of polarization) should take account of the pronounced tendency for industrial growth to be oriented primarily towards industrial areas because of the external economies which the latter generate . . . . " (Hansen, 1967, p.718).

It seems intuitively obvious that cities or central places can, by their agglomeration, provide certain advantages which are not to be found either in smaller agglomerations or in dispersed distributions.

In his classical formulation, Hoover (1968) discusses the three types of external economies which he holds to be important in the growth of large agglomerations. The first, the 'principle of multiples', refers to the possibility of increased specialization by firms. Certain operations that would normally have to be carried out by a firm can be contracted to other firms specializing in such operations, and this at lower cost. The second principle, 'massing of reserves', means that in a large city firms can carry proportionally smaller stocks of materials than they can in an isolated location, since they are able to depend on their ability to secure more at short notice. The third principle is that of 'bulk transactions', referring to the economies of large-scale transfer, and the reduction in unit cost which occurs when many firms are consuming large quantities of basic materials such as electricity.

Alonso (1968), discussing industrial location in relation to economic development, adds more 'economies' to this growing list. He points out that in transitional societies, conditions in the large agglomeration tend to be better known than do conditions in the rural periphery, and that businessmen making investment decisions

are attracted to the place in which uncertainty is minimized. This is a rational basis for investment decision, and is comparable to Hirschman's homily in explaining the continued growth of agglomerations—"nothing succeeds like success". Hirschman, however, claims (unlike Alonso) that this is an irrational decision and urges investors to look to the periphery. Other advantages of agglomeration in transitional societies discussed by Alonso include the need for personal contact in a society in which communication systems are scarce or unreliable, and the importance in these societies of the ritual of social contact, much of which has been replaced by standardized methods of business in developed economies. All this pull in favor of the big city is magnified by the concentration there of entrepreneurial and managerial resources. This tends to emphasize the distinction between center and periphery and to underline the appearance of 'primacy'—the domination of a single, big city in economies which are going through the transitional stage of industrialization, followed by a decline of primacy in favor of a more fully developed central-place system, manifesting the increasing integration of economic space.

Von Boventer (1964) points to other forces in agglomeration. Because of higher costs, nominal wages are also higher in the urban area than outside it. This offsets the advantages of the agglomeration. However, as labor mobility grows and agglomeration economies increase, the urban areas will still tend to have a balanced advantage, though they may become suburbanized. Friedmann (1955), however, claims that as development occurs there is a shift from labor and material-oriented industry to market-oriented industry and this confirms the trend towards agglomeration. Friedmann could not find evidence to support this, however, since *all* types of industry tended to be strongly oriented toward the agglomerations (in the T.V.A. study).

Both Von Boventer (1964) and Marcus (1965) have looked at agglomeration economies in two subsets—localization economies, which occur when several firms within an industry are agglomerated, and urbanization economies, which result from the general agglomeration of labor and market and operate in different industries. Marcus, looking at New Jersey, shows that a number of industries are growing faster than one would expect from their national growth rates, weighted by the growth of population in the area. He attributes the 'extra' growth to the two sets of economies mentioned.

From the above, it seems that there is no clear agreement on what constitutes external economies or agglomeration economies and, even worse, the various ideas are often non-comparable. Further, Speigelman (U.S. Department of Agriculture, 1966, p.13) claims that although agglomeration and external economies appear to be correlated in their spatial incidence, there "is almost no quantitative evidence as to the role of external economies in the agglomerating process". This is undoubtedly true, for since there is almost no agreement on how external economies are defined, there is little hope of quantification.

For growth center notions, this lack of evidence is serious since it means that while we observe that cities grow, and because of their growth attract more firms, investment and people, and while we have some idea about how this growth is transmitted, we have little evidence except *post facto* to indicate how growth is best initiated, nor even why some agglomerations grow faster and larger than others. We therefore have no firm theoretical grounds for planning growth at particular locations. Despite this, growth center notions have proliferated, based on two concepts—the growth pole (industry) discussed above, and, the only really quantified aspect of external economies, the number and kinds of services and functions performed by cities of various sizes.

From central place studies, theoretical and empirical, we have a foundation on which to discuss the ability of different locations to provide local services, which

themselves can operate as growth generators. It is no accident that much of the growth center work incorporated in the fifth French plan concentrates on the analysis and development of tertiary services.

4.3.2 *Size and scale of growth centers.* There is also little agreement on the size of growth centers, and in the planning field, on the optimum size, given a set of goals and constraints. Clearly, if a theory of the spatial incidence of growth is to be developed, it must include some postulates about the size of growth centers, and the relationship between size and rate of growth, at a given state of development and in a given socio-cultural system. Unfortunately, this is very close to the issue of the optimum size of a city, which is a problem replete with hypotheses, many of them ill-founded, and notably lacking in evidence.

Advocates have claimed sizes between 10000 and 1000000 to be optimum, but in general they consider only the cost aspects of size and ignore the fact that we are dealing with an urban system of a hierarchical nature in which cities are of very different sizes, so that a single optimum size is infeasible in any case, unless the whole system is somehow changed. Most authors writing on size have some intuitive notion that average and marginal costs will at first fall and then rise as a center grows in size, appealing to the costs of congestion and of commuting in 'evidence'. However, as Alonso points out, the size of a city must be considered also in relation to its productivity, measured say in terms of disposable income per head, from which costs per head can be subtracted. This produces a more realistic concept of the 'optimum', since productivity and costs will vary presumably in some consistent fashion with size. However, as Alonso (1966, p.8) puts it, despite many assertions by many authors: "the fact of the matter is that there is no reliable knowledge of relevant urban sizes". Certainly there is no evidence that there exists a city size beyond which marginal costs outrun marginal productivity, and in this respect there are no indications that an agglomeration is 'too big', despite the attempts being made in Western European countries to decentralize their major capital cities. Indeed, there is accumulating a body of evidence to suggest that per capita income, productivity in manufacturing, wholesale sales per employee, and some other measures, all continue to rise, without apparent limit, with increase in the size of agglomeration (measured, admittedly, in a cross-sectional sense).

Again, this paucity of evidence is somewhat serious for growth center concepts, since there appear to be no guidelines as to optimum size or even as to threshold size for growth to be self-sustaining, and rarely in the literature have attempts been made to relate such measures of size to the state of economic development under consideration.

4.3.3 *Growth centers, and the central-place hierarchy, through time.* A final major area of deficiency, and therefore a topic of future research, is the relationship of growth center and growth pole concepts to the observed empirical regularities of the central-place type, and to the phenomenon of primacy in countries of the developing world.

In the survey of the literature, there are noticeable areas of compatibility between some authors. In particular, Berry (1964, p.129) stresses the relationship between the development of the central-place system and a state of entropy in the socio-economic system, "achieved in the steady state of a stochastic process . . . . at its maximum if this process is unconstrained", and "if the rank size rule for cities obtains". Hirschman (1958) hypothesizes, and to a limited extent demonstrates, that a major characteristic of differences between 'stages' of economic development is the degree or complexity of interlinkages between sectors of the economy. As the nation or region becomes more developed, the interlinkages and interdependencies are maximized. Similarly, Friedmann (1966) sees the spatial aspect of economic

development as one in which the region under consideration progressively replaces its center–periphery structure with a single system of cities extending throughout the economic space under consideration.

All this suggests therefore that 'primacy' is somehow related to the 'phase of development' and that the central-place structure is a spatial state manifesting the achievement of an equilibrium in socio–economic development. Fortunately, early conclusions claiming to demonstrate the invalidity of this relationship, notably by Berry, have themselves been shown to be invalid, and in fact, while primacy is very rare in truly underdeveloped countries, it begins to appear in the 'take-off' stage, and then declines as further development takes place (El Shaks, 1965). Thus, primacy is a normal aspect of the early stages of development characterized by a state of negentropy, and is corrected by the progress of the system towards its entropic, complex state of equilibrium.

Growth center concepts must be related to the state of this system if they are to be developed into a theory. Is the notion of a center and periphery merely another way of describing a negentropic state of primacy? Will the development of intersectoral linkages between industries encourage, therefore, the development of a central-place system which will integrate the periphery? Is there an optimum central-place structure at a given level of development? Is such a structure in some way a cause or an effect of the degree of interlinkage between sectors? All these questions are begged by the growth center concept, and imply that there will be different rates of growth and different optimum sizes of center at different stages of development, and that their optimum locations will vary due to this.

5 Conclusion

Precise conclusions are difficult to draw from a field so ill-defined and confused as the one reviewed in this paper. Nonetheless, certain prevailing characteristics can be pointed out.

Firstly, it is evident that the explanatory value of the growth pole and growth center notions is limited. This is undoubtedly because both notions deal with only a limited concept which is part of a much more complex system described more realistically by the detailed input-output table on the one hand and by the notions of the central-place system on the other. Growth pole discussions have tended to be somewhat myopic, concentrating on the direct links between a hypothetical industry and a few others in an economy assumed to be closed, to the total neglect of the enormous amount of background variation and indirect linkage taking place. Similarly, growth center notions tend to concentrate on a particular aspect of the central-place system and attempt to treat it in isolation. It is for this reason that the extraordinary gap discovered in the literature—namely, the lack of any satisfactory explanation of how the existence of a growth pole and the process of polarization in economic space appear on the ground in terms of the distribution of industries and agglomerations—is so obvious.

The hypothesized process of polarization has heuristic attraction but, again, because of the over-simplified framework in which it is discussed, its value as an explanatory model is not great. The absence of any development of the idea into a set of precisely related equations linking sectoral to spatial development, and of any empirical study which separates the process of polarization from other effects, is noteworthy in this respect, and the process thus begs many more questions than it answers.

As a description of the realities of the occurrence and spatial distribution of development, economic and social, the notions of pole and center are of limited help. We cannot agree that they form in any way a conditional theory of economic growth,

since the conditions hypothesized are insufficient to distinguish a growth from a non-growth situation, and the criteria developed are inadequate to distinguish between a growth center and a non-growth center, either in the present or in the (normative) future. Moreover, the notions do not treat adequately either the influence of external economies or the phenomenon of agglomerations.

It is in the normative that the notions have their greatest contribution to make. The center–periphery concept in particular, as described by Friedmann and discussed by others, is the most promising direction reviewed. By dealing with the whole of economic space in a given region, rather than particular points or areas of it, and by defining sub-regions of the periphery in terms of the problems for which solutions are sought, it is a valuable step towards the prescription of policies for the distribution of economic and social development given a set of goals. The links developed between the model and the empirical regularities observed at different states of economic development are attractive as a theory of the spatial distribution of development through time. Attempts to consider other than economic variables in this context are moves in the right direction.

The value of the center–periphery model in particular cases is limited as yet by its relative lack of development. Nonetheless, by treating the system as a system rather than by picking up and isolating parts of it, it will be a valuable tool in regional planning. The French notion of the 'armature urbaine', which shows features in common with the center–periphery concept, is being put into practice through the regionalization of the French budget. The effect on growth, both regional and national, of concentrating investment in certain sectors of the economy, at the eight 'metropoles d'equilibre', each of one million population, should yield valuable feed-back by which the notion can be evaluated. The development of a series of regional statistics by the French government should make such an evaluation a possibility in the near future.

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Note: The works cited in this bibliography include only those which deal specifically with growth pole or growth center concepts, external economies, agglomeration, optimum size, and certain aspects of regional development. Except for certain less well known French sources, works dealing generally with regional planning have been excluded.