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The Postindustrial City in a Regional Context

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In the advanced economy of the United States, cities are so interdependent that their functions and relative contributions can best be portrayed simultaneously, using a "field theory." Such a portrayal, which resembles topographic mapping, shows that urban specialization is occurring. By using a "field theory" the emerging postindustrial role of any city within the national urban field can be surmised.

This article may confound the casual reader. It contributes to the new discipline of regional science, which combines geography, economics and mathematics.

I. THE INTEGRATED ECONOMIC SPACE.

Location takes place on a part of the geographical plane, but it is strongly conditioned by other sets of "universes," especially the economic ones. Thus, it is necessary to integrate the existing economic system and the geographic characteristics—resources and climate—to obtain a valid description of the "locus of possible locations." This is called the economic space.[1] The fundamental variables of the economic space are distance and time, with distance being the "economic distance;" the cost of friction over space, rather than the geometric distance in miles.[2] The economic space in an advanced economy has the following characteristics:

Integration (as opposed to local isolation) is shaping an aggregate demand market, distributed over the national space and also changing the concept of the supply structure. The process of integration is the abolition or reduction of discrimination or friction—tariffs or transfer costs—between economic units.[3] Minimization of distance-cost inputs maximizes accessibility to the market, thus increasing trade and reducing self-sufficiency.

Extension (as opposed to reduced area) introduces the diversity of the geographical characteristics of the group of regions. The process of economic development may regionalize on a continental or subcontinental scale.[4] The reduction of transfer costs tends to increase the market area for each production, whereas the process of integration tends to break the isolation of contiguous regions, in two different but parallel processes.

The larger the size of the integrated economy, the greater the positive production effects will be, through the increasing possibilities of the internal division of labor—sectorial and locational. It has been noticed that economic integration weakens the tendency to (small) national agglomerations and intensifies (large) supernational agglomerations.[5]

Specialization by regions is the result of the extensive and integrated economic space. The division and subdivision of labor is cause and result of the process of economic development. Eric Lampard states that regional specialization is the link between the technological and the spatial conditions of economic development, that it is related to the extension of the market, and in turn creates wider markets; that it raises the production potentiality of the integrated community; that it generates an efficient pattern of land use; and that it results in greater savings of time, effort and resources.[6]

Specialization contributes to the growth of demand and reduces the input coefficients on the production side. A parallel phenomenon to regional specialization is regional interdependence, expressed in increasing trade of the surplus from each specialized region to the other. The process of economic development tends to eliminate "localism," that is, regions at a small self-sufficient level, while it tends to generate regions on a larger scale, with specialization and close interrelationship among them.

Within the context of those regional processes it is postulated that the urban system is subject to changes that affect is basic structure. The following two sections deal with population and income redistribution pattern on a macro scale and with regional specialization of economic activities, while the final section summarizes the hypothetical directions of change that are affecting the urban system. The U.S. is the case study.

II. NATIONAL DISTRIBUTION

The national market is distributed over the country, constituting a spatial variable as its value changes from one unit area to another. The demand model must explain the effects of the total demand structure, formalizing the relations between the different unit markets in space, as the distance factor directly affects the value of the market. In other words, the model must describe the relative accessibility of each area to the national market, since producers are interested not only in their immediate surroundings but in the maximum market that it is feasible to reach.

A potential model that has the dimensions of "field quantity" is suitable to describe the effects of density distribution and accessibility.[7] The potential value at a given point is the integral of the density of each of the differential areas times the area of the differential, over the distance from each differential area to the point that has to be evaluated. The multiplication of density times area is the "mass" of the unit; the ratio of this mass over distance from this unit to the point under consideration introduces the effects of distance. The integration brings together the effects of all the areal units in the plane.

Formally: $_iV = \int \frac{DdA}{_ir}$

where $_iV$=potential value at point i

D=density at each and every differential area dA

$_ir$=distance from i to each and all differential areas

The next step is to pass from the potential value at one area to the estimation of the potentials at all areas into which the country has been divided. It is then possible to map those values and to link with contour lines all points of equal potential value, resulting in a family of isopotential curves.

The mapping obtained is a three-dimensional terrain: the potential surface.

In terms of dimensions, mass is expressed in the units of the "universe" selected, as a result of multiplying density (universe over area) times area. The potential is universe units over distance units, resulting in, for example, people per mile or dollars per mile. Since the effective market is better described by the inclusion of the income per capita levels, density is expressed in population times income per capita, that is, an income density index. Then mass will be given in dollars and potential in dollars per mile, as shown below:

$$\text{Density} = \frac{\text{People}}{\text{Sq. mile}} \quad \frac{\$}{\text{People}} = \frac{\$}{\text{Sq. mile}}$$

$$\text{Mass} = \frac{\$}{\text{Sq. mile}} \quad \text{Sq. mile} = \$$$

$$\text{Potential} = \frac{\$}{\text{mile}}$$

In the definition of the economic distance lies the problem of adjusting it to the empirical observation of the effect of distance on interaction, to reflect decreases in interaction levels caused by increases in distance beyond lineal proportionality. This leads to the introduction of different exponents for distance.

The possibility of changing the exponential of distance does not basically affect the potential surface, but it does result in models with greater or fewer details. The squared distance tends to show more of the local market influence of cities over the national surface —more local "peaks"—than the simple distance at the first power. Since distance is a stronger factor when raised to the second power, there is a quicker reduction of the national potential, allowing local influences to appear. The use of the squared distance gives potentials in $/sq. mile, the same units of density. The simple distance would instead result in less steep and more unified surfaces, with fewer local peaks. In this case, it is the "gradient" of the surface, given in $/sq. mile, that is comparative to the density units, this being important because the condition for emergence of a local peak is that the local density value be higher than the gradient value of the potential surface at this location. The simple distance model is adopted because it is better suited to the macro analysis of an integrated economy, in which the trend toward reduction of transfer costs would mean a reduction of higher exponentials affecting distance.

The elements of the potential surface mentioned above must now be briefly explained. The gradients or slopes cross the contour lines and have values expressing the change of the potential per unit of distance in the direction selected, that is, $\frac{dV}{dr}$; being their units the same as density:

$/mile. 1/mile=$/sq. mile.

Among the singular points of the potential surface there are "peaks" and "pits," the highest and lowest points in the surrounding area; "saddle points," representing a local maximum and a local minimum at the same time; "ridges" and "courses," the lines that connect peak to peak and the lines that connect pit to pit.

The U.S. Potential model to be used is the one already computed in the American Geographical Society for 1959 with States as basic units (see Map 1). The income population potential values are expressed in 10^6x $/mile to simplify notation, and are assigned at the centroid of each state.

The income population potential surface of the U.S. interprete as a model of the national economic space presents the followin characteristics:

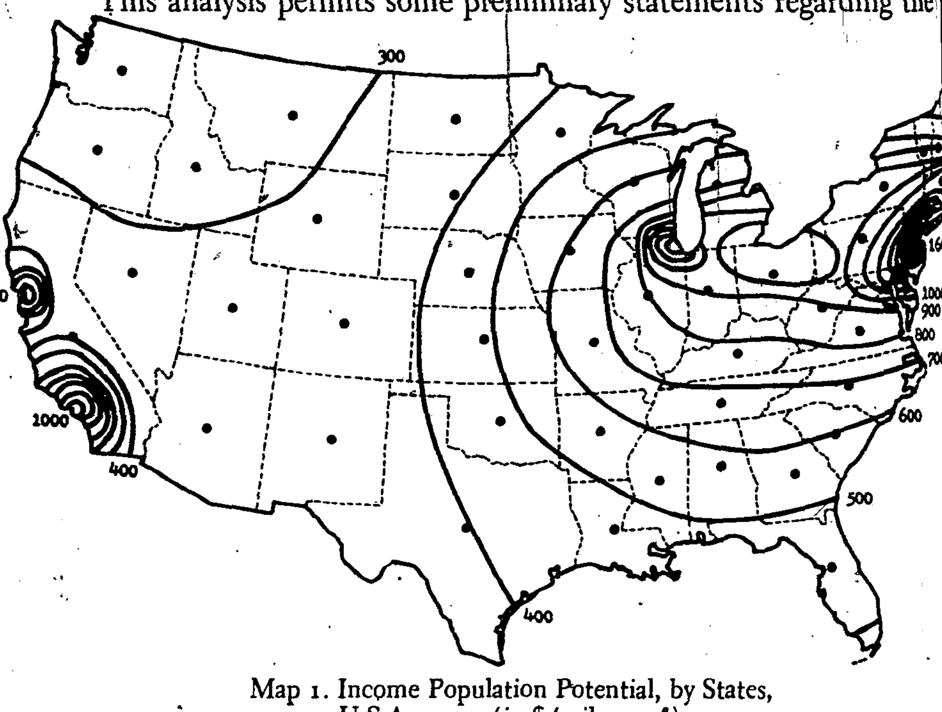
a. The largest concentration of "economic population" is locate in a continuous "urban region," extending from Boston to Washing ton with the peak of potential at New York. It constitutes a linea structure oriented North-South and defined by the ocean to the eas and a steep slope to the west.

b. The second concentration is a "plateau" ending at the city of Chicago, which is its peak. It constitutes a punctual structure oriented East-West and defined only by a steep slope around its end at Chicago.

c. The third concentration is at the cities of Los Angeles and San Francisco, shaping a punctual structure oriented North-South and limited by the ocean to the west and a steep slope around each urban center.

d. The rest of the country is a relatively flat surface with minimum values at the Rocky Mountains. Only New England shows slightly steeper slopes, emphasizing the rapid reduction in accessibility of a more isolated region.[8]

This analysis permits some preliminary statements regarding the



Map 1. Income Population Potential, by States, U.S.A., 1959 (in $/mile x 10[6])

nature of the urban system in the postindustrial economy. The country is oriented and keyed toward a few urban areas; and, locationally, two urban types can be differentiated: the lineal Urban Region—made by a former metropolis and cities—and the Punctual metropolis. Due to the distance exponent chosen for this model, other urban centers that would otherwise emerge with local peaks are covered by the national potential surface. Furthermore, the universe variable is the spatial distribution of regional incomes, which tends to emphasize the weight of the larger urban centers as opposed to the smaller ones and rural areas.[9]

III. REGIONAL SPECIALIZATION

After this aggregate analysis of the potential model, it is necessary to reach some level of disaggregation and to relate the location of the different economic sectors to the process of regional development. This implies a sectorial macroanalysis.

The analytical method to be used is a transformation of the locational coefficient method. The first step is the selection of a production index, which for industrial (non-agricultural) analysis can be employment. The locational coefficient method is a relative index of production because it indicates the ratio of a given area's relative production (*i.e.*, employment) to the national percentage in that same sector. This assumes that a perfectly distributed activity would show ratios equal to one in all areas of the country, and that any inequality would appear in higher locational coefficients for the area with a larger relative concentration of that economic activity.

Formally: locational coefficient $LC_1^x =$

$$\frac{\text{Area 1 Percentage Employment in Sector x}}{\text{National Percentage Employment in Sector x}}$$

The shortcoming of this index is in not allowing interarea comparisons. It is possible that a small region in the country may show a higher LC value, and a larger area a lower LC value; nevertheless, from the point of view of the effect on the country's economy, the lower index of the larger area may represent a larger absolute level of production. Such a case is apparent in comparing, for example, New Hampshire and New Jersey in the manufacturing sector: LC values are, respectively, 1.45 and 1.29, but New Jersey has a weight in the country's economy eight times greater than that of New Hampshire. It is for this reason that the area's "weight" is introduced, normalizing the indices and making them comparable. The selected weight is the area's share of total employment in the country, which thus becomes a constant coefficient for all sectors under study.

Formally: weight $W_1 = \frac{\text{Area 1 total Employment}}{\text{National total Employment}}$

By affecting the LC with the W value, a total locational distribution value is obtained, providing the absolute level of production of a given sector in an area, and making it comparable to values of different sectors in other areas. The TLD index is also equal to the ratio of the Area's Employment in a sector to the National Employment in the same sector.

Formally: total locational distribution $TLD^x_1 = W_1 \cdot LC^x_1 = \frac{\text{Area 1 sector x Employment}}{\text{National sector x Employment}}$

The next step is to compute indices that show the level of regional specialization for a given sector. It is necessary to postulate that there is a constant per capita consumption in each sector, and that any surplus above the national average production level will be exported to other areas with an LC value below one. This does not consider such problems as product substitution or cross haulings, but for a broad sectorial division it can be valid.

If it is accepted that areas producing a given sector at the same level as the national average would show an LC ratio of one, any area with values over one can be considered as producing a surplus over their own needs, thus being specialized in this sector. The LC value minus one would result in the exportable surplus, or an index of specialization, called the specialized locational coefficient.

Formally: specialized locational coefficient $SLC^x_1 = LC^x_1 - 1$

Following the same steps discussed for the total indices, it is now possible to affect the specialized index with a "weight"—that is, the area's share of total employment—in order to obtain an index allowing interarea comparisons. This is called the specialized locational distribution index.

Formally: specialized locational distribution $SLD^x_1 = W_1 \cdot SLC^x_1$

In the U.S. empirical study, the unit area selected is the State,

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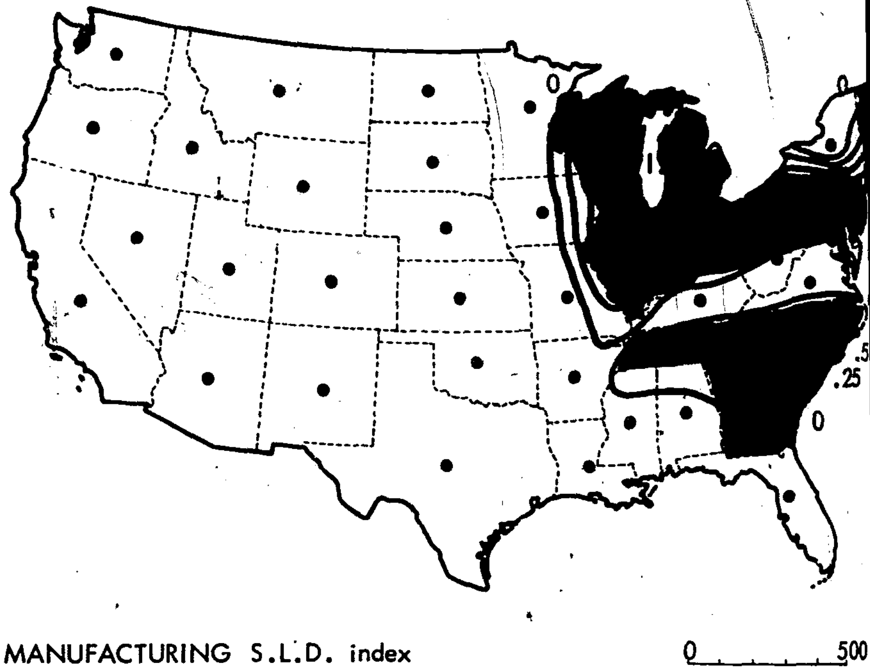
and the sectorial division is the simplest industrial classification of eight groups. For the purpose of a preliminary approximation of the problem, this rough analysis has the advantages of simplicity and it may provide valuable insights into the structure of the case study. Two divisions have been omitted: mining, because it depends primarily on natural resources location, and construction, because it is a representation of regional rates of growth rather than of specialization.

Manufacturing: It is clearly specialized in two areas: one, the "Northern Manufacturing Belt," consisting mainly of New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Illinois, and Wisconsin; the other, the "Southern Manufacturing Belt," consisting of North Carolina, South Carolina, Tennessee, and Georgia. New England, the first industrialized area in the U.S., still shows positive SLD indices but it is not clear whether this is an authentic specialized region since its constant losses in manufacturing employment indicate that it is a vestige of the paleotechnical age.

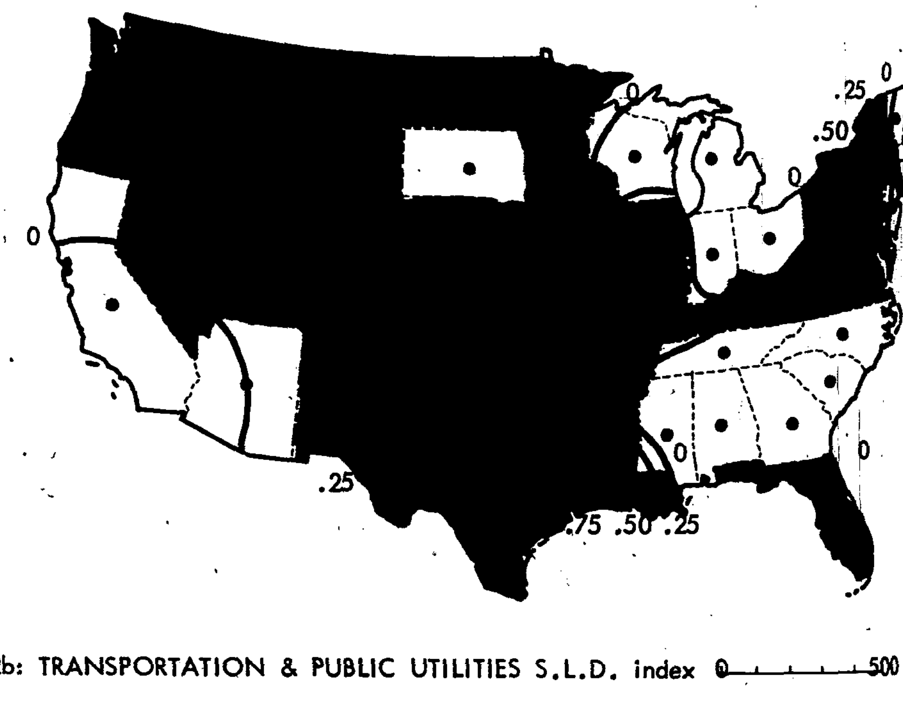
The Northern Manufacturing Belt reaches an impressive total of 8.55, adding their SLD indices (and 10.40 if New England is included), while the Southern Belt reaches a total of 1.55. The highest single value is 1.77 in Indiana. The rest of the country shows no positive indices of specialization.

Transportation and Public Utilities: At first glance there is no clear distributional pattern of specialization, and the highest state value is only a modest 1.10 in Texas. For this sector an historical perspective is as necessary as the structural viewpoint. The United States has been populated by a demographic movement which advanced westward, occupying bands of territory at certain periods. Thus a spatial analysis of the U.S. following the direction of the meridians reveals that there is consistency in the pattern of the specialization in transportation activities because each stage in the movement to the west originated nodes to handle the flow of people and commodities. This is not unlike the way tidal waters leave imprints on rocks.

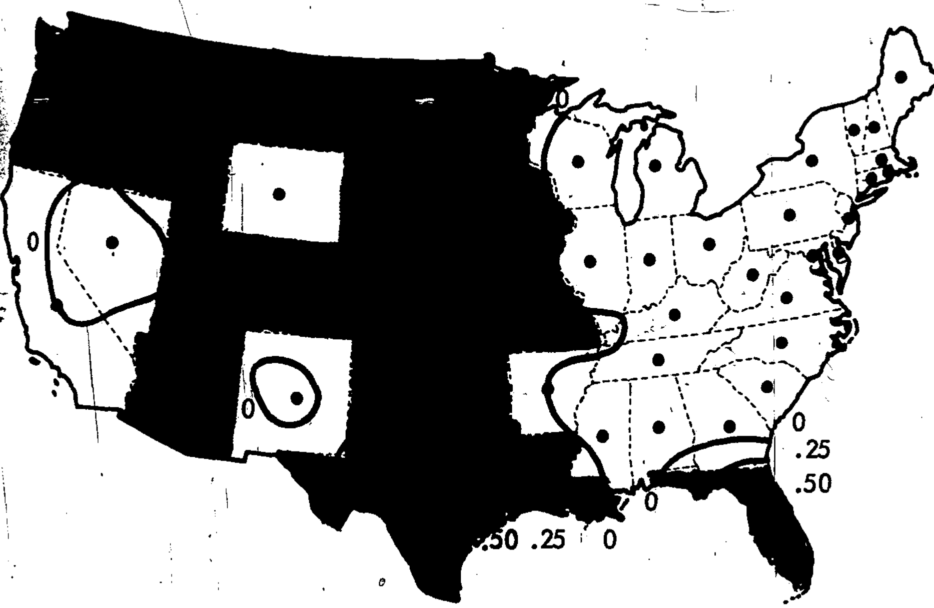
The first N-S band is along the Atlantic states, where New York, Pennsylvania, Maryland, Virginia, and West Virginia add up to 1.31 in their SLD indices. The second band occurs along the Mississippi River, covering Minnesota, Iowa, Illinois, Missouri, Tennessee, Arkansas, and Louisiana, with a total SLD value of 2.13. (Clearly, the eastern part of Texas could be included in the area, due to its orientation to the Gulf movements, but the level of aggregation of the spatial units does not allow for further analysis.)



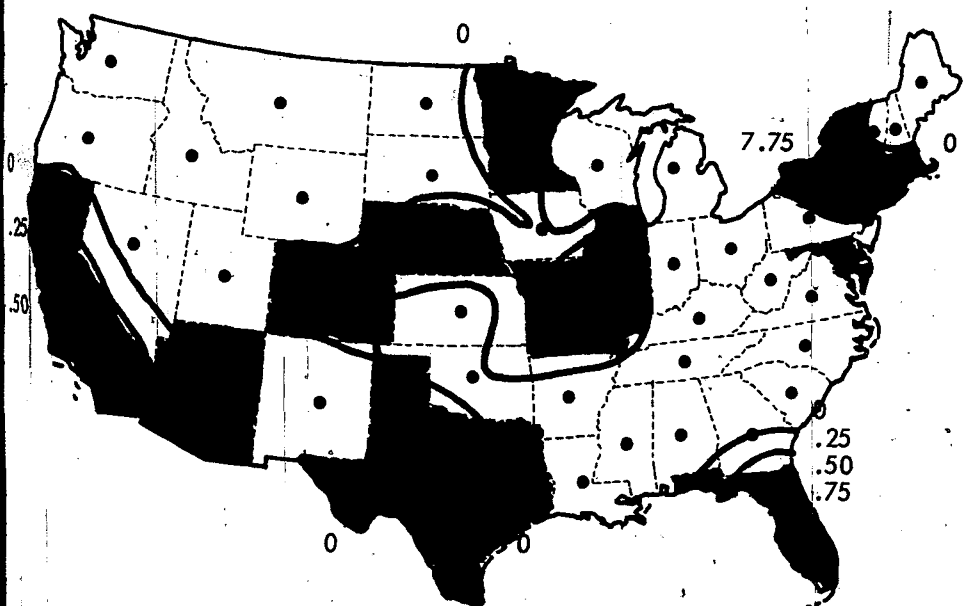
Map 2a: MANUFACTURING S.L.D. index



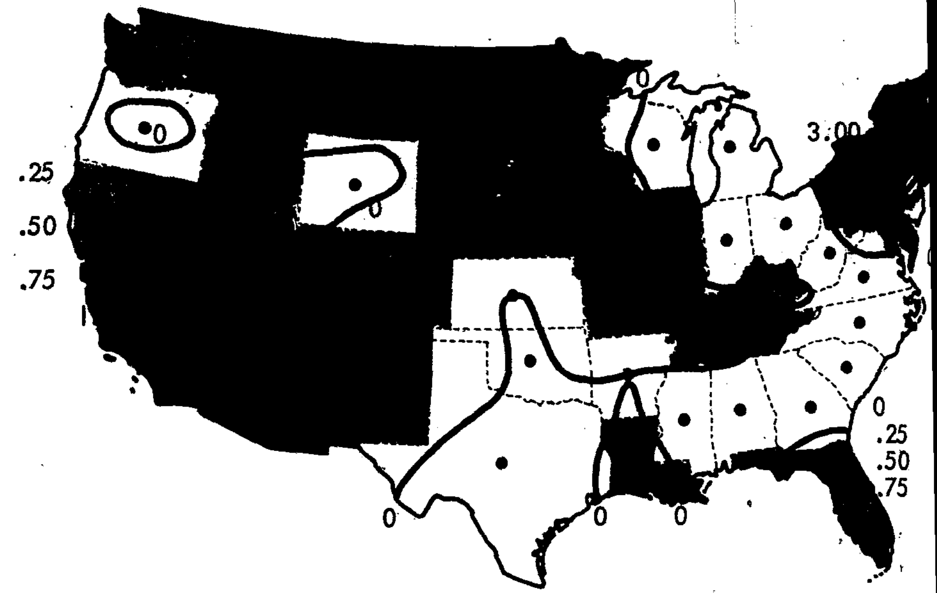
Map 2b: TRANSPORTATION & PUBLIC UTILITIES S.L.D. index



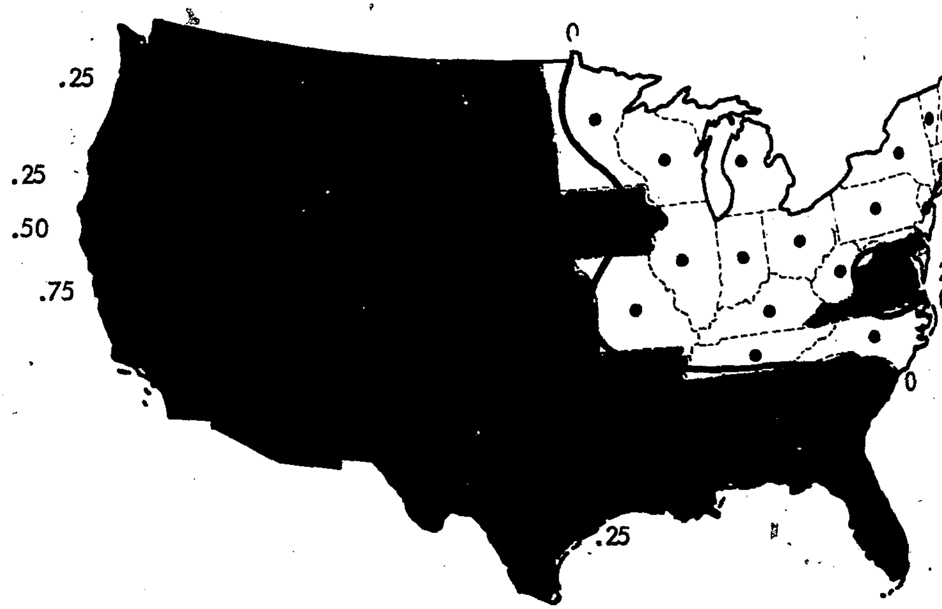
3a: WHOLESALE & RETAIL TRADE S.L.D. index 0 500 miles



3b: FINANCE-INSURANCE-REAL ESTATE S.L.D. index 0 500 miles



Map 4a: SERVICES & MISCELLANEOUS S.L.D. index 0 500



Map 4b : GOVERNMENT S.L.D. index 0 500

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The third band is in the midwest, occupying North Dakota, Nebraska, Kansas, Oklahoma, and Texas, reaching an SLD value of 1.89. In the far west, Montana, Colorado, Wyoming and New Mexico reach 0.53; and finally Washington, Oregon, Idaho, Nevada, and Utah have a total of 0.31.

The aggregate total values of SLD indices increase from the Atlantic to the Mississippi, and then decrease continuously to the Pacific.

Wholesale and Retail Trade: This sector shows a random distribution over the area west of the Mississippi River. It is logical that no conclusion on the locational distribution of specialized activities can be obtained because wholesale and retail trade establishments are not oriented to serve the total country, but rather a local market. The consistency found in positive values in the western states might not be a real index of specialization but only of "inefficiency." The sparse population and low densities of these states would force a higher ratio of employees to dollar sales.

Finance, Insurance, and Real Estate: The analysis indicates that this sector is overwhelmingly located in New York, with a very high SLD index of 7.72—the highest in all sectors. Furthermore, the addition of smaller specialized concentrations in Massachusetts, Connecticut, and the District of Columbia results in a total 8.72 index for the Atlantic seaboard.

The rest of the country shows only relatively small values—in Florida (real estate?) 0.8; California 0.56; Illinois 0.52; Missouri 0.34; and a few other states with insignificant indices.

Service and Miscellaneous: The pattern of the previous sector is repeated again, with the Atlantic Seaboard having a 5.05 index, as a result of the addition of New York (3.04), Pennsylvania, Massachusetts, Maryland-D.C., Vermont, and Rhode Island. In the rest of the country, only California 1.03, Florida 0.78, Nevada 0.35 (recreation?), and Missouri 0.23, need be mentioned.

Government: As may be expected, the D.C. area shows the largest concentration, with an index of 2.06 (and 2.38 if Virginia is added). In the west, California has a value of 1.03, while most of the western and southern states have a low positive index of specialization.

It is necessary now to bring back the results of the aggregate analysis of the previous section, where it was found that there are two physical types of urban areas: the Lineal Urban Region—the Atlantic seaboard—and the Metropolis.

The Lineal Urban Region specializes mainly in Finance-Insurance-Real Estate, in Services-Miscellaneous, and in Government—sectors that serve the whole country. It has specialization in Transportation and Utilities, although it is not the national dominant concentration. Finally, there is a small index of specialization in Manufacturing, although the aggregation level of the analysis does not clarify whether this means a simple orientation to the regional demand or production along a narrow specialized subsector oriented to a wider market.

The Metropolis can be defined as an Industrial Metropolis if it is specialized in Manufacturing oriented to the national market—Pittsburgh, Detroit, Cleveland, Chicago—or as a Regional Metropolis if it is specialized in Transportation, becoming a center for the hinterland or a node along a movement flow—Chicago, St. Louis, New Orleans, Kansas City. This type may also show a small index in Finance-Insurance-Real Estate, in Service, or in Government, but oriented, of course, to the nearby region.

It is possible that in some cases an Industrial-Regional Metropolis may be combined—as it is, for example, in Chicago.

IV. ROLE AND TYPOLOGY OF URBAN AREAS

The previous empirical studies suggest that, demographically and economically, there are two urban types emerging: the Lineal Urban Region and the Metropolis. Functionally, these studies show that there is a locational specialization of economic sectors over the country, with a clear correlation between urban types and specialized functions. Both our analyses lead to a preliminary recognition of at least the following urban typology: Lineal Urban Region, Industrial Metropolis, and Regional Metropolis. Also, it is now possible to make explicit the three variables that define the "Role" of an urban area: *spatial location, economic function,* and *area of influence.*

The concept of the role of urban areas permits, for example, the recognition of the differences between specialization in specific sectors of production oriented towards a range of areas of influence (national or regional) and between locations with variable accessibility to the national market. An evaluation of urban areas with different roles would probably show that they also have different characteristics in terms of urban structure and of the direction, rate, and composition of the processes of urban growth and change. This implies that different roles would create different urban characteristics and that no longer would one city be like another. Specialization is creating urban types to satisfy the emerging roles in the developed economic space; thus the postindustrial city appears.

All this has important implications for the planning process:

a. Forecasting is not only dependent on metropolitan or regional data but also on national data, if and where there is a relevant national role.

b. Forecasting cannot extrapolate the existing urban structure because there may be an emerging (and different) urban structure, conditioned by the urban role.

c. Forecasting cannot isolate a city if it is part of a larger concentration, such as the Lineal Urban Region.

The recognition of the emergence of the postindustrial city does not mean an eventual transformation of all urban areas. Historical processes tend to overlap and to allow the survival of previous systems that have adapted to the new environment. Moreover, the schematic analysis of the previous sections shows that only selected areas are experiencing a radical transformation—the Lineal Urban Region, for example. Others are experiencing only limited transformations—the Industrial and Regional Metropolis. The process of change has to be selective in order to be effective.

The market town of the preindustrial age became the Regional Center of the industrial age, and only a few areas saw the emergence of the Metropolis. Similarly, in the postindustrial age, some Regional Centers are becoming Regional Metropolises, some old metropolises are becoming exclusively Industrial Metropolises, and finally the Lineal Urban Region, made up of selected existing urban areas and new additions, is now emerging.

The Lineal Urban Region can be theoretically interpreted as one sector of high activity in the Losch locational scheme.[10] The similarity with this becomes obvious by studying a map of the Atlantic seaboard—the "Megalopolis." This map shows a lineal structure, with centers along it where distance and size are inversely correlated, and with a hexagonal system of roads linking it to the rest of the region (half of the system is eliminated by the ocean). There are several advantages in this urban prototype of the Lineal Urban Region.

First are the economies of concentration, relevant for the specialized sectors, and especially important in terms of the so-called "urban" and "interfirm" economies. It is clear that this urban region is specializing in the most sophisticated sectors of production; that is, where the economies of concentration have more weight. It also happens that the tertiary sectors are experiencing a more rapid rate of growth, as is to be expected in a postindustrial society.

Second are the possibilities of internal specialization among the nuclei of the urban region. This would increase the efficiency of production by potentiating the economies of concentration.

Third is the possibility of disjointed growth and change. Each nucleus—that is, old city or metropolis—can experience its own process of growth and change; but also the total system can grow by adding new nuclei. The independence of these processes does not mean isolation but flexibility. On the other hand, the interdependence of the total system is indicated by the effect of the change of one element on the rest.

Fourth is the maximization of "centrality." Since there is no single center any more, as in the isolated metropolis, the emergence of several centers is possible. The hierarchy of centers would then not only be expressed by size but also by quality, due to the trend to internal specialization.

NOTES

1. This concept was developed by François Perroux; see his "Economic Space: Theory and Applications," in *Regional Development and Planning*, Friedmann and Alonso, eds., (Cambridge: MIT Press, 1964).
2. William Warntz, *Toward a Geography of Price* (Philadelphia: University of Pennsylvania Press, 1959).
3. Adapted from Bela Balassa, *Theory of Economic Integration* (Homewood, Illinois: Irwin, 1961).
4. In Norton Ginsburgh, *Atlas of Economic Development* (Chicago: University of Chicago Press, 1961).
5. Giersch, "Economic Union between Nations and the Location of Industry," *Review of Economic Studies*, No. 2.
6. Eric Lampard, "History of Cities in the Economically Advanced Areas," *Economic Development and Cultural Change* (Chicago: University of Chicago Press, 1955), p. 3. This has been corroborated for the agricultural production in the U.S.A.; see my *Location and Regions: Agricultural Land Use in an Integrated Economy*, Papers in Theoretical Geography, Harvard University, 1968.
7. See specially: J. Q. Stewart and William Warntz, "Physics of Population Distribution," *Journal of Regional Science*, Summer, 1958; William Warntz, "The Topology of a Socio-Economic Terrain and Spatial Flows," *Regional Science Association Papers*, Nov. 1965; and Walter Isard, *Methods of Regional Analysis* (Cambridge: MIT Press, 1960), chapter 11.
8. This is extensively discussed in my *Location and Region: Agricultural Land Use in an Integrated Economy, op. cit.*
9. This is due in part to the "unequal" per capita income distribution in the country's regions. Among the many works, see specially William Warntz, *Macrogeography and Income Fronts* (Philadelphia: Regional Science Research Institute, 1965).
10. August Losch, *Economics of Location* (New Haven: Yale University Press, 1954).