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A Dissenting View

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Theories of Intraurban Spatial Structure: A Dissenting View

THE OVERWHELMING problems created by the phenomenal growth of contemporary urban areas have generated increasing efforts to gain a scientific understanding of the organization and distribution of human activities in space, their interlinkages, and the flows of people, goods—and information between them. Researchers from various disciplines have searched for means with which to comprehend the complexities marking the inner workings of the metropolis with the hope that an improved understanding of this city-system will lead to a firmer foundation upon which to base policy decisions designed to effect willful change within it. In short, investigators of urban phenomena have become keenly concerned with the spatial structure of metropolitan areas.

The theory of urban spatial structure is concerned with the disposition of human socio-economic activities in urban areas. Its goals are to discover, explain, and ultimately predict the regularities that exist in man's adaptation to city space. Contributions toward its development have suggested a number of distinct orientations and approaches, each of which attempts to provide a framework of empirically sound and logically consistent propositions. As Walter Firey has so very eloquently pointed out, however, these give little recognition to social values and focus rather on space as a determinate influence on the distribution of human activities.¹

Two main streams of thought underlie the voluminous literature on the subject. The basic distinction lies in the orientation with which the fundamental problem is approached. The first point of view is macro and *system-oriented*, focusing on the phenomena of urban growth and change and on the regulative forces acting to promote orderly development. The second, on the other hand, is micro and *process-oriented*, concerning itself rather with the factors that give rise to the phenomena by their collective influence on the decision making of societal units.

A system-oriented approach toward the analysis of urban form and structure is fundamentally one which interprets the spatial pattern of a city in terms of the dynamics of natural, social and economic forces acting within an urban environment. The primary concern of such theories has been to describe and explain why a particular activity is carried on at a given site and how it is spatially related to all other activities of the system. The statement of the problem is presented in a system context and the method of analysis reflects this macro orientation. Typically, the emphasis of such theories lies in the development of a set of general principles which accounts for the urban pattern by reference to factors—such as the role of the city within its hinterland; the social forces which interact to produce segregation; and, most commonly, the land market operating through the medium of rents to promote a greater efficiency in the arrangement of activities in urban space.

A process-oriented approach, on the other hand, focuses on "the events that lead to growth and change in the urban framework."² It views these events as the consequences of actions by decision-makers interacting in the urban field. The active role of human volition replaces societal adaption to space as the principal referent. The locational behavior of decision units is examined as it responds to different environmental conditions. Spatial preferences, cost and profit considerations, competition, and accessibility are typical principles which are used to account for observed phenomena.

¹ Walter Firey, *Land Use in Central Boston* (Cambridge, Massachusetts: Harvard University Press, 1947), pp. 30–38.

² Britton Harris, "Some Problems in Theory of Intra-Urban Location," *Operations Research*, September–October 1961, p. 701. Harris suggests a different division of theory. His classification identifies three main streams of thought: the design of urban form, the description of urban form, and the explanation of urban form.

(A) *The System-Oriented Approach.* Brief reflection upon the two principal main streams of theoretical thought on the subject of urban spatial structure suggests that their fundamental difference rests on the way in which the phenomenon is viewed. The system-oriented approach focuses on a particular *site* within an overall pattern and is concerned with the forces which determine the activity which will be carried on at that location. The process-oriented approach, on the other hand, focuses instead on a particular *activity* and analyzes the behavior of decision units which seek for it the appropriate location. Both approaches have provided significant insights and understanding concerning urban form and growth. The system-oriented approach, however, in its preoccupation with natural, social and economic forces of change supplies insights which are very general and does not provide the basis for quantitative prediction. The problem is viewed mechanistically. Typically, supply, demand, income and capital are viewed as the principal factors with which spatial structure is concerned. The "behavior of the land market" and the "behavior of rent" are studied as if these are the actors influencing developments and not the human beings who act in the land market or set the rents. "As a result, these concepts are powerless to deal with the prediction of changes resulting from changed conditions; they can in the main only assess the probabilities resulting from a continuation of trends. Thus they are not fully prepared to assist in distinguishing the effects of alternative policy decisions."³

Any non-random decision must be based on a prediction and evaluation of the probable effects of alternative actions (inaction being one of them) which are available to the decision maker. The success of such policies is dependent in a large measure on the accuracy of the predicted effects. In short, what is necessary for rational policy making in matters pertaining to urban growth is a reliable theory connecting "instrumental" policy variables with outcome variables by means of a set of relationships between these variables. These typically are specified by means of a model which allows forecasts to be made about particular output variables as a consequence of

the manipulation of the "decision" variables included in the input set. Thus, it seems apparent that the principal objective for the development of a theory of urban spatial structure is to provide means of predicting the probable consequences of alternative courses of action in public policy-making. The theory must supply the basis from which planners can establish, with a sufficient degree of accuracy, the implications of various policy "mixes" which may be adopted by governmental authorities.

The system-oriented approach does not offer much promise in ultimately meeting the requirements set forth in the preceding paragraphs. Urban spatial structure is principally influenced by the locational decisions of private and public groups and individuals. These decision units interact in the urban field and create the "events" which lead to change in the metropolitan fabric. Thus, a theory which seeks to cope with the factors leading to growth and change in urban communities must ultimately deal with the behavior patterns of these individual decision units. The process-oriented approach does just that. However, it too suffers from too strict an adherence to the "conventional wisdoms" of parent disciplines.

(B) *The Process-Oriented Approach.* The body of theoretical work under the process-oriented approach suffers from the implicit belief that methods of analysis which have been so eminently successful in the physical sciences might be applied with equal success to problems in the social field. Two principal tendencies appear in these theoretical attempts to account for the observed regularities in the spatial patterns of urban areas. Both stem from the premise that methods which have explained the behavior of the physical world can be effectively transferred over into the area of human behavior. The first basic tendency is the search for an overall unifying principle which can be used to account for the observed patterns of behavior. The second is the deterministic method of analysis which begins with the definition of quantities considered as overtly observed magnitudes and proceeds to the discovery of the relevant interactive laws of behavior relat-

³ Harris, *op. cit.*, p. 700.

ing these quantities one to another.

Reductionism. It has become the fashion among process-oriented theorists of urban spatial structure to attempt to deduce all locational behavior in terms of some single all-unifying principle. Like the classical physicists seeking to reduce the explanation of all natural phenomena to the simple laws of mechanics, the investigators of urban structure continue to seek a fundamental *modus operandi* by which people and activities are channeled into their appropriate niches in urban space. Typically, these ultimate determinants of locational choice are expressed as some form of minimization or maximization. Thus "minimization of costs," "maximization of market area," "maximization of profits," and so on, have been postulated as the ultimate unifying principle for a theory of urban spatial structure.

This search for unifying principles of great generality, analogous to those which have had such success in the physical sciences, seems much too premature. The premise that patterns of social behavior may be effectively explained by principles of least or most of something-or-other has been challenged in recent literature. Kendall, for example, in an article on laws in the social sciences offers the following suggestive remark:

"The point, for present purposes, is that it may be (and probably is) chasing a will-o'-the-wisp to suppose that social behavior is determined by principles of least something-or-other. Zipf made a gallant attempt, and in the same category I would place efforts by economists to explain business behaviour on the principle of maximizing profits or the tendency on the part of model-fitters to assume that Nature is obliging enough to minimize their errors. Some such principles may, indeed, exist. But if they are to be discovered, I think we must achieve them by synthesis at a later stage and not be over-ambitious about the generality of the patterns which we are studying at the present time. The pathway of knowledge is littered with the wreckage of premature generalization."⁴

The long-standing belief that the explanation of all natural phenomena ultimately rests within the principles of mechanics has steadily declined since the middle of the nineteenth century. The difficulties of extending mechanics into new

domains such as electro-magnetic phenomena came to be acknowledged as insuperable and new approaches were proposed. It seems abundantly clear that analogous difficulties, stemming from the overwhelming complexities inherent in human behavior, will ultimately produce the same kind of reaction in the social sciences.

Determinism. There is little doubt that observable regularities exist in urban spatial patterns and may be expressed in quantifiable form. There does, however, seem to be justification for legitimate doubt whether these regularities can be accounted for by methods such as have been used in the physical sciences. Most of the laws of physics may be expressed in terms of fundamental units such as length, mass and time. The behavior of these fundamental observed magnitudes can be studied only by discovering the interactive laws which establish the dependencies of one quantity upon another. The tendency in the social sciences has been to follow this pattern of viewing quantities as overtly observed magnitudes and then proceeding to seek out their interactive laws. Thus, in urban spatial structure, basic conceptual variables have been defined and the search for the laws describing their interaction continues.

The question, therefore, is whether the complex forces, interacting to produce the systematic regularities which have been detected in urban spatial patterns, can ever be explained by deterministic formulations of the kind used in classical physics. Physical processes generally take into account only a few variables between which a functional relationship may be established experimentally. They commonly involve two or three variable situations which are essentially simple in structure. Thus, scientists have been able to develop, with relatively little difficulty, analytical techniques which measure the dependence of one quantity, say gas pressure, on another, say volume. Their essentially simple character has led Warren Weaver to define them as "problems of simplicity."⁵ In the studies of

⁴ M. G. Kendall, "Natural Law in the Social Sciences," *Journal of the Royal Statistical Society*, 1961, p. 5.

⁵ Warren Weaver, "Science and Complexity," *The Scientists Speak*, (Warren Weaver, editor) (New York, New York: Boni and Gaer, 1947), pp. 1-13.

urban phenomena, on the other hand, the number of variables that have to be included increases substantially. In addition, a considerable number of these variables reflect features of organization. Thus these phenomena all "involve dealing simultaneously with a sizeable number of factors which are interrelated into an organic whole. They are all, in the language here proposed, problems of *organized complexity*."⁶ In the area of urban spatial structure, in particular, the consequences of a series of interacting activities which vary in space as well as in time must be identified and measured. The problem thus is compounded. The overwhelming complexities associated with analyzing human behavior make futile all efforts to derive relationships between observable factors. The general result is a complex model of reality which defies empirical verification.

What kind of a scientific attack on this problem of "organized complexity" promises an approach which shows evidence of effectively overcoming some of these problems? It is the fundamental thesis of this paper that a mathematized theory of intra-urban spatial structure will be stochastic rather than deterministic in nature and, above all, will be addressed to answering questions of the following sort: If a set of observations on an urban system are viewed as elements of the set of all possible observations, "what type of model will enable us to predict observations that as a rule will be elements of a specified subset of the set of all possible observations on the system, while it is possible that the observations will not be elements of the subset?"⁷

This thesis emerges from the experiences of other social and natural science disciplines which recently have turned to probabilistic methods for the very same reasons as are suggested above. Psychological learning theory offers a particularly useful example. A principal problem of learning psychologists is to identify, interpret and analyze the relations between stimuli and response as a function of reinforcement. The major contributions of Pavlov, Thorndike, Guthrie and others developed these concepts in a scientific manner. However, the introduction of mathematical analysis into learning theory was beset with formidable difficulties. The indeterminacies in

behavioral processes prevented the discovery of interactive laws analogous to the laws of motion or of gravitation.

"As long as behavioral scientists kept wishing there were such laws of behavior, mathematization of behavioral science remained a pious dream. Things began to look different when mathematical psychologists (1) started to describe behavior patterns as sequences of discrete responses; (2) replaced the classical concept of magnitude by that of probability; and (3) took the statistics of the resulting stochastic process as the dependent variables. . . . The result of this re-formulation was the appearance of the first behavioral mathematical model with a large range of application and a large potential for generalization, namely the stochastic learning model, first proposed (I believe) by W. K. Estes and worked out in detail in the first full-length book on mathematical psychology, treating a single theme in depth, Robert R. Bush and Frederick Mosteller, *Stochastic Models of Learning* . . ."⁸

The introduction of the stochastic-analytic approach by Estes, Bush and Mosteller⁹ initiated a rigorous but mathematically tractable theory construction. Subsequent investigations such as those by Luce, Suppes and Atkinson¹⁰ have produced the beginnings of a systematic theory of learning which has the same sort of "feel" that theories in physics have. With appropriate identification of the theoretical variables, predictions regarding learning behavior may be derived in a mathematically rigorous manner.

⁶ *Ibid.*, p. 6.

⁷ A. T. Reid, "On Stochastic Processes in Biology," *Biometrics*, September 1953, p. 276.

⁸ Anatol Rapoport, review of *Mathematical Methods in Small Group Processes* (Joan Criswell, Herbert Solomon, and Patrick Suppes, editors), *Journal of the American Statistical Association*, September 1963, p. 830.

⁹ W. K. Estes, "Toward a Statistical Theory of Learning," *Psychological Review*, 1950, pp. 94-107; W. K. Estes and Robert R. Bush (editors), *Studies in Mathematical Learning Theory* (Stanford, California: Stanford University Press, 1959); and Robert R. Bush and Frederick Mosteller, *Stochastic Models for Learning* (New York, New York: John Wiley and Sons, 1960).

¹⁰ R. Duncan Luce, *Individual Choice Behavior* (New York, New York: John Wiley and Sons, 1959); and Patrick Suppes and Richard C. Atkinson, *Markov Learning Models for Multiperson Interactions* (Stanford, California: Stanford University Press, 1960).

The emergence of urban spatial structure as a definite and important area of research has developed increasing attempts, in the form of theories, to bring conceptual order out of the complex relationships of human activities with physical space. Analysis of these theories discloses that, to a large extent, their differences stem from the point of view with which the problem is approached and the means by which it is analyzed. Common to all theories, however, has been the strict adherence to determinism. This paper suggests that, due to the overwhelming complexities which underlie human behavior, a probabilistic approach may be the only method by which operational models of considerable generality

can be developed. The use of the probability calculus as a means for assessing the combined effects of a great number of interdependent factors has proved useful in other disciplines and suggests itself as a possible analytical method in urban studies as well.¹¹

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¹¹ For example, see, Andrei Rogers, "A Stochastic Analysis of the Spatial Clustering of Retail Establishments, *Journal of the American Statistical Association*, December 1965, pp. 1094-1103.