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Regional Development Modeling: Theory and Practice

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MURAT ALBEGOV
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PREFACE

This volume contains a collection of papers presented at a conference on "Theoretical and Practical Aspects of Regional Development Modeling", held at the International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria on March 19–21, 1980. The conference was organized by the Regional Development Task at IIASA as part of its work on comparing and synthesizing recent research on applied regional development modeling. Its aim was to bring together theoretical and practical results of applied regional development modeling in both market and planned economies, in an attempt to summarize the state of the subject at the beginning of the 1980s.

Some 50 papers were presented at the conference; of these, 26 were selected for this volume. Although the papers were brought together at the conference, this book should not be seen primarily as a conference proceedings; rather, the contributions have been selected to strike a balance between the theory and the applications of regional systems analysis.

The book has been divided into seven parts. The first is basically an introduction, while the second and third contain overviews of current modeling practice in market and planned economies. In the next two parts the focus shifts to the theoretical problems encountered in structural and multiobjective analysis of regional systems. The final two sections contain examples of regional development models currently ready for use or in operation and analyze the success of these models in clarifying regional planning and policy problems.

Last but not least we must thank the authors contributing both to the conference and to this book for their valuable material and comments, and the staff of the Regional Development Task at IIASA for their skillful and efficient assistance, without which this volume would not have been possible.

The Editors

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Chapter 1

REGIONAL DEVELOPMENT MODELING – THEORY AND PRACTICE

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1.1. Basic philosophy of regional development modeling

The purpose of this book is to present the current theory and practice of regional development modeling in industrialized nations with different resource endowments, economic structures, and political systems. This will be done by giving examples of approaches and applications in various countries, rather than providing a comprehensive overview. The book is primarily intended to give a broad coverage of approaches and is not specifically oriented toward the theoretical aspects. A very important aim is to provide a basis for comparing the regional problems tackled and the quantitative methods employed in market and planned economies.

An attempt will be made to demonstrate how modeling can be and is being used as a tool for solving regional problems in the framework of regional development planning. Regional development planning is defined here as the process of dealing with the long-term overall structural economic problems of regions within a nation. Thus, both the growth strategies for developing regions and the problems of economically well-developed regions facing rapid structural change will be highlighted. The emphasis is on resource distribution between regions rather than on intraregional allocation problems. Although general, these statements imply that regional development modeling is seen as taking a constructive role in regional and national economic development.

It should already be apparent that regional development planning has different connotations in different countries and also at different regional levels. This may be due in part to national variations in the pattern of regional development (balanced regional growth in some countries, interregional imbalances in others). It may also be a

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reflection of the role of planning and particularly the role of regional development planning in the different countries.

In countries that have pure market economies, i.e., in which planning is viewed primarily as a tool for correcting market imperfections, regional development planning plays a minor role. Regional development is not usually regarded as external to the market and therefore little attention is given to policies with a regional dimension. Such is the case, for instance, in the USA, where regional planning is quite a recent phenomenon; this may also be seen from Chapters 6 and 26 of this volume.

In mixed economies of the western-European type, regional development planning has traditionally been aimed at removing interregional discrepancies in income and employment opportunities. The regional planning framework has been welfare-oriented rather than efficiency-oriented. Even in the analysis of the long-term consequences for Sweden of phasing out nuclear power, the regional effects are evaluated mainly by employment indicators (see Chapter 25).

In planned economies the regional dimension has always been used as a means of increasing overall economic efficiency. Whereas support in the form of increased investment may be given to chronically depressed regions in mixed-type market economies, in planned economies investment is directed primarily to regions with the potential for expansion. Examples of this are provided in Chapters 22 and 24, which relate to the development of territorial production complexes and other industrial expansion projects in Siberia.

Of course, in market economies the efficiency-oriented regional distribution of investment capital is governed by the regional differentials in capital returns. This will, in principle, give rise to an economically efficient regional distribution of labor (although this is questioned, for example, in the so-called center–periphery theory). From this perspective, it is natural that optimal territorial planning should also be used in planned economies to achieve such interregional efficiency. In both types of system, therefore, interregional flows of labor and capital necessary and sufficient to promote growth would tend to emerge. The welfare-oriented role of regional development planning characteristic of mixed economies serves to keep these processes of structural change within socially acceptable limits. Chapter 27 gives a provocative view of the success of Dutch regional policies in this respect over the last decade.

Although this book is not intended to be a critical review of regional planning systems, we believe that it is possible to assess the different approaches to regional development modeling and the models characteristic of different countries using the background outlined above.

Regional development planning undeniably requires a multidimensional approach. Regardless of the geographical level or the economic or political structure of the region under study, the aim is to analyze and influence different components of economic and social processes simultaneously. The complexity of regional development planning stems from the fact that both spatial and temporal interdependencies are present and must be included. Comprehensiveness calls for an explicit analysis of uncertainties and long-term options, since many regional processes are inert and contain temporal indivisibilities. Chapter 11 points to the need to develop new criteria for evaluating

such problems and to set new standards for freedom of action and robustness. This type of approach is often more appropriate than attempting to minimize some cost function or maximize some efficiency function.

The above discussion suggests that it is useful to assess the role of systems-analytic approaches in regional development planning. In what directions have the theories and models of regional development planning evolved in market and planned economies? Are current planning problems being tackled with the same type of models used in the last two decades, using methods which were formulated for very different circumstances? Are problems similar to those that occurred in earlier decades now being analyzed with different tools? Are the current quantitative modeling techniques quite general or more specialized, i.e., is the same type of methodology used in countries with different economic and political structures?

In this introductory chapter, these questions will be examined briefly by means of an historical summary and a comparison of some of the approaches mentioned in other chapters. As part of this background, the attempts at the International Institute for Applied Systems Analysis (IIASA) to provide a framework for applied regional development modeling will be described. This will be further illustrated by a summary of the IIASA case studies, which were performed in a variety of economic, social, and institutional settings. This chapter concludes with a summary of the regional issues that this work suggests should be examined using systems analysis in the future.

1.2. Regional development analysis in the last two decades

There are a number of different ways in which the evolution of new theories and models for regional development planning over the last two decades may be examined. Here the framework given in Table 1.1 will be used, though this categorization is in no way unique.

Some important developments in interregional or multiregional explanatory modeling will first be outlined. Following the original work of Leontief (1951) on national input–output modeling, Isard (1951) formulated the general interregional input–output model. This piece of work encouraged the development of techniques to overcome the computational difficulties inherent in these input–output methods; see, for example, Moses (1955) and Leontief and Strout (1963). However, although this model was formulated in the 1950s it has still not been widely applied.

A more direct reformulation of the Leontief model as a regional input–output model has had greater success. It has been applied in various countries at all geographical levels, often complemented by independent econometric estimates of import, export, and consumption functions.

Spatial general equilibrium models are scarce, owing to the lack of theories and the dearth of statistical information to support or reject them. Lefeber (1958) formulated a model of this type, though the brief treatment of the transportation sector has led to problems in implementation. Location theoretical analysis performed by Koopmans

Table 1.1. Classification of regional development modeling research.

Spatial scope	Type of model	
	Explanatory and predictive	Planning and policy
Interregional or multiregional	Input/output Spatial general equilibrium Central place Migration	Multiregional planning Economic growth Transport and/or investment cost-minimization
Regional	Input/output Basic/nonbasic Growth pole	Mathematical programming Spatial competition
Intraregional	Urban land equilibrium Transportation Spatial interaction Lowry-inspired	Transportation/land-use optimization Cost–benefit Accessibility

and Beckmann (1957), as well as classical studies by Hotelling (1929), suggest different reasons for the fact that market equilibria may not, even in theory, be sustained in a multiregional system. Koopmans and Beckmann (1957) single out the indivisibility of certain factors as one possible explanation, while Hotelling (1929) stresses the small number of actors. Although both of these results have been questioned in more recent research, applied general equilibrium models of interregional development are still uncommon. However, many recent econometric regional models rely implicitly on equilibrium concepts; see Chapter 6.

There has been a marked development in the use of equilibrium models for the study of intraregional land-use patterns during the last decade. These models, often termed "new urban economics models", stem from the work of Alonso (1964) and Muth (1969) on the functioning of the urban residential market. They have reached the application stage in many urban areas, especially in combination with urban transportation models, which are also quite often of the equilibrium type; see, for example, Florian (1976) and Ben Akiva and Lerman (1977).

At regional and intraregional levels there has also been increased interest in comprehensive land-use and transportation models of the nonequilibrium or partial equilibrium type. The first large-scale models of urban and regional processes fall into this category. Some of them, such as the basic/nonbasic model developed by Lowry (1964), were exceedingly successful and have led to the development of a new class of models, now termed "spatial interaction models". Wilson (1970) is the most prominent exponent of this modeling approach. Other models, for example, some very large-scale transportation models developed in the USA, were not successful, and did not reach the application stage. Complex large-scale models, such as that developed by Forrester (1969), were subjected to heavy criticism, for example, by Lee (1973). The main criticisms were related to the "over-optimistic" view of the usefulness of computer techniques in regional planning (Putman, 1973). Nevertheless, spatial inter-

action models have provided planners with computer-based tools for quantitative modeling that did not exist in the early 1960s, although the lack of theory at the core of these models may still be questioned.

There has been very slow development in the modeling of intraregional production patterns. The allocation of urban land is generally considered to be a question of dividing land between residential and transport use, presupposing the fact that production always outbids other activities in central locations.

Economic geographers and location theorists have built on the work of Christaller (1966) and Lösch (1954) in trying to validate and apply "central-place" concepts in regional development planning. Rather than working with zonal subdivisions, these approaches presuppose that regional development occurs in a network of interlinked villages, towns, and cities, which form a hierarchy. Chapter 15 outlines a dynamic version of this theory. The concept is to some extent related to the idea of growth poles, which was developed in relation to the French territorial planning system by Perroux (1955), although growth poles generally refer to a nonspatial system. However, central-place concepts, although theoretically pleasing, have not played a very important role in the development of quantitative models. In spite of this, the conceptual importance of central-place and growth-pole models should not be underestimated. These ideas have been used to formulate policies as well as to provide a framework for policy evaluation in several European countries.

There is no clear distinction between "explanatory" regional modeling and "planning" regional modeling. This is particularly true of the mathematical descriptions of different approaches. In many cases the same conditions may be derived from both programming and simulation models.

The primal–dual relationships of linear programming provide a framework within which the results of an optimization approach can be interpreted as a market equilibrium. Alternatively, the primal problem expressed in terms of quantity allocation could be used to optimize resource allocation in a planned economy; see also Chapter 9.

If, then, this similarity in model structure reflected a similarity in actual economic processes, planned and market economies would be truly dual, both converging to the same stationary state. However, in general the same mathematical theories have not been used in different economic systems. Programming models are assumed by western economic planners to be applicable only (or primarily) to planned economies, while eastern economic planners discard the shadow-price system as unrealistic.

Multiregional planning models have been developed by Tinbergen (1967) and also by Soviet workers; see, for example, Aganbegyan et al. (1972). The Tinbergen system was based on a hierarchical framework with sectoral, interregional, and local levels. It was assumed that regional development planning should also take place on these three levels and that planning models appropriate for each level should be used consecutively.

Although the Tinbergen models were set in a comprehensive framework, they were still based heavily on the minimization of cost by linear models. They were followed by a number of other planning models with transport and/or investment cost-minimization as the basic goal. The models developed by Mennes et al. (1969) and Carrillo-Arronte (1970) were both of this type.

In the USSR rapid development of regional modeling began in the early 1960s in an attempt to aid the development of existing and recently established industrial regions. In the first stage, intersectoral relations for the country as a whole and for separate regions were modeled, and national–regional models were developed for the main sectors.

From the beginning, the main emphasis was on national intersectoral analysis (Ephimov and Berry, 1965) but some work was also devoted to investigating regional problems (Kossov, 1973). At the same time experience in modeling sectoral growth and location led to the generalization of existing methods for solving these problems by optimization techniques.

These independent analyses of national, regional, and sectoral problems laid the foundations for a system of national–regional intersectoral models. This work was started in Novosibirsk and Moscow; see Aganbegyan et al. (1972) and Danilov-Danilyan and Zavelsky (1975). Rather elaborate systems were developed to coordinate important features of the national and regional plans (such as final consumption, volume of production, and interregional distribution of capital and labor). These schemes proved to be very difficult to implement on the computer; one example was the general Isard (1951) model. For this reason only one version of the Granberg model was completed. Research work in this field carried out in Moscow is described in Baranov (1969).

The simplified set of interregional–intersectoral models developed by Albegov (1970) was more successful. In this system the interregional distribution of labor is given exogenously and transport is described rather roughly, but at least the model allows the problems to be analyzed practically.

In the early 1970s, interest shifted from sectoral to multisectoral analysis and to the analysis of territorial production complexes (TPCs). In another trend, interest moved away from regional economic analysis using input–output techniques to the development of regional model systems.

In the first of these developments, Albegov and Solodilov (1970) analyzed a multisectoral system, taking into account the nonlinear dependence of resource costs and the effects of agglomeration. Multisectoral analyses on a local level were carried out with the help of multistage models of TPCs. These analyses included not only production, but also population, settlement and service, and environmental systems. This has resulted in well-balanced development of the main sectors of regional economies and auxiliary subsystems; see Bandman (1980).

In later developments of this approach in both East and West, the hierarchical structure has been relaxed and intersectoral relationships have been introduced at the interregional stage (see Paelinck and Nijkamp, 1976, and Granberg, 1978). Current research in market, mixed, and planned economies involves the introduction of multiple objectives into these multiregional models.

There are relatively few linear models of this type at the regional level. When used, they often take the form of cost–benefit models; the cost measures are extended to include all urban gains and losses that can be given monetary values and specified linearly (see Ben Shahar et al., 1969). The housing market models based on the linear programming model of Herbert and Stevens (1960) are good examples of this approach.

Another theoretical advance in regional planning modeling was made by Rahman (1963), in a model which was designed to examine whether there was a conflict between national economic growth and regional equality. The main result was that a technologically less efficient region could compensate for inefficiency by a higher savings ratio, so that for long-run national growth it would be profitable to invest in lagging regions as well as advanced areas. This approach has been extended by several Japanese researchers, for instance Outsuki (1971), to show that the Rahman results are true even in a more general regional economic setting. This class of growth models has recently been analyzed by Fujita (1978), with various production functions.

Although these growth models have not been used in regional development practice, their importance for regional policy-making should not be underestimated. They differ from other models in their explicit treatment of time and show that this may lead to results that are quite different from those of static models.

Models of spatial competition are similar to regional growth models in their treatment of the dynamic aspects of regional development processes. They provide a possible explanation for the formation and development of service centers and are therefore useful in planning and policy-making. Recent analyses by Gannon (1977) and Webber (1977) use techniques that are different from those employed in Hotelling's (1929) original work.

In these more modern approaches the only element that has been changed is the spatial demand elasticity. The fact that there is a distance factor in spatial demand patterns is usually reflected by introducing accessibility indicators into regional models. Such indicators were introduced on an ad hoc basis in classical economic geography but have been adopted over the past decade by research workers such as Hägerstrand (1970). More recent research has pursued axiomatic theories of accessibility measures; see Weibull (1976) and Smith (1978). This research indicates the need to devote more attention to the formulation of goal and interdependency indicators in regional planning models. Normative land-use transportation models using such indicators have been developed in some mixed-economy settings; see, for example, Sharpe et al. (1975) and Lundqvist (1977). Work on the development of econometric intraregional models has also just been initiated in the USSR; a dynamic model of economic growth in the Ukrainian Republic has already been constructed. A survey of multiregional economic models carried out by the Regional Development Task at the International Institute for Applied Systems Analysis (IIASA) during 1980 and 1981 indicates that there has been a considerable increase in the number of econometric multiregional and regional models developed in the USA and western Europe. This new trend first became apparent in the late 1970s.

A number of recent developments in regional modeling have now been considered briefly. The main conclusion is that there have been no major changes in the theoretical bases for this type of modeling. Therefore, with the notable exceptions mentioned above, it must be admitted that current problems are being tackled with the help of old theories. There are no significant differences between the models used in practice in the various countries, whether in East or West.

On the other hand, it must be acknowledged that substantial changes have occurred