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**The Detroit Prototype
of the NBER
Urban Simulation Model**

NATIONAL BUREAU OF ECONOMIC RESEARCH
Urban and Regional Studies 1

The Detroit Prototype of the NBER Urban Simulation Model

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*(Resolution adopted October 25, 1926 and revised February 6, 1933,
February 24, 1941, and April 20, 1968)*

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Foreword

IN THE FALL OF 1968 the National Bureau of Economic Research formed an urban economics research group whose principal activity has been the development of a computer model to simulate the growth processes of urban areas. The model synthesizes and extends our analytical and theoretical understanding of urban growth and development and ultimately could be used to analyze a wide variety of programs and policies designed to improve the quality of urban life, the opportunities available to urban populations, and the "efficiency" of different urban living patterns. The first phase of this ongoing model development and its related program of empirical studies are described in this book.

A principal activity of this first phase was the programming, preliminary calibration, and testing of what we have called the Detroit Prototype of the basic model. From this experience a number of serious deficiencies in the model were exposed. Although it might have been possible to solve these problems and to achieve satisfactory calibration of the Detroit Prototype, the prognosis was not encouraging. Therefore, when more complete data became available for Pittsburgh, at about the mid-point of "phase one," development of the model was shifted to a Pittsburgh data base.

Using these Pittsburgh data, Gregory Ingram and Royce Ginn completed the programming and initial calibration of a new version of the model, which we call Pittsburgh I, in the summer of 1971.¹ The design of Pittsburgh I was essentially identical to that of the Detroit Prototype, with one important exception, which is described in Chapter 9. Therefore, even though this book describes only the Detroit Prototype in detail, it provides a reasonable introductory description of Pittsburgh I as well.

1. Gregory K. Ingram, "A Simulation Model of an Urban Housing Market," Ph.D. dissertation, Harvard University, 1971.

In initial tests, Pittsburgh I has displayed better calibration than the Detroit Prototype. Much, though, still remains to be done. The early test runs of Pittsburgh I, however, have convinced us that we will be able to achieve a satisfactory calibration of the NBER Urban Simulation Model for Pittsburgh, and eventually for other cities as well.

At least two major calibration problems remain unsolved in both the Detroit Prototype and Pittsburgh I. First, we need more satisfactory definitions or delineations of housing submarkets, that is, subcomponents of the total housing market that display decidedly different behavioral traits. Secondly, we need more adequate estimates of the parameters determining housing demand. Of course, satisfactory solution of the second problem depends to a considerable extent on solving the first, so we are pursuing our research on these problems simultaneously. Because meaningful calibration of the model requires solutions to these two problems, we are now actively engaged in research that will lead to changes in the definitions of housing types and some revisions in the structure of Pittsburgh I. These improvements and some further elaboration of the model will form the basis for a third version of the model, Pittsburgh II.

Even with these alterations and extensions, the model described in this book and subsequent versions of the NBER model should be essentially similar. That is, for the foreseeable future, we expect the basic model design described in this report to remain unchanged in its essentials, though being continuously modified (and hopefully improved) in its details. In particular, we have undertaken research that should help us improve those portions of the model *not* dealing directly with housing, e.g., industry location and the performance of urban transportation networks. Nevertheless, our experiences with the Detroit Prototype, Pittsburgh I, and supporting econometric studies have strengthened our convictions about the correctness of the underlying behavioral hypotheses, even in the housing sector. While a great deal still needs to be done, we feel that the representation of the housing market and household behavior embodied in these models is more promising than any other of which we are aware.

Building a complete model of the type represented by the NBER Urban Simulation Model is a complex undertaking requiring a diverse set of skills and the efforts of a large number of individuals. Four major kinds of activities can be identified: (1) the conception and

design of the over-all simulation; (2) the design and programming of individual submodels; (3) the testing of underlying hypotheses and, thereby, the estimation of relationships for the model; and (4) the programming and execution of the final computer model.

All members of the Bureau's urban studies group have participated in the conception and design of the basic model. However, John Kain, as research director of the NBER Urban Studies group, conceived of the underlying behavioral framework and devised several of the techniques used in estimating the parameters of the model. Gregory Ingram was responsible for model design and carried out the initial programming of most of the submodels; the major exceptions are the "movers" and "industry location" submodels, whose design and initial programming were the work of H. James Brown and Royce Ginn.

A considerable gap normally exists, moreover, between the initial programming of individual submodels and their aggregation into an efficient totality or final simulation model. Royce Ginn, besides making major contributions to the design and programming of each of the submodels, was primarily responsible for integrating the several submodels into an over-all computer simulation model. Whatever efficiency and economy of operation are exhibited by the NBER Urban Simulation Model, or of the submodels as well, are largely attributable to Ginn's experience and skills.

Any large-scale model of the type described here must, of course, have a large body of supporting empirical research. In this particular instance, the supporting research was primarily devoted to testing hypotheses about model structure or estimating parameters for the model. Most of the research done thus far has been concerned with the problems of estimating housing demand and is summarized in this volume. As noted, however, we are pursuing research on other factors that influence urban growth patterns, in particular industry location decisions. It is expected that some of this other research will be published in the near future.²

While the entire NBER Urban Studies group contributed to both

2. Robert A. Leone, *Location of Manufacturing Activity in the New York Metropolitan Area*, New York, National Bureau of Economic Research, forthcoming; and Raymond J. Struyk and Franklin James, "Intrametropolitan Industry Location: The Pattern and Processes of Change in Four Metropolitan Areas," New York, National Bureau of Economic Research, 1972 (processed).

the NBER Urban Simulation Model and this volume, the drafting of most of the chapters in this book and preparation of the final manuscript were largely the work of Gregory Ingram and John Kain. Royce Ginn drafted the appendix on programming but, as noted, his contributions extend more widely to the design, programming, and calibration of the model—without which there would have been no Detroit Prototype and no book.

H. James Brown made important contributions to the design and programming of the mover submodel and to the description of that submodel contained in Chapter 6. He and John Kain performed the research on the housing choices of San Francisco households described in Appendix B and prepared the first draft of that material. Stephen Dresch assumed primary responsibility for estimating the critical demand allocation equations and prepared a preliminary draft of the material presented in Chapter 8.

In addition to these persons, several other individuals and organizations have made significant contributions to the NBER urban modeling project. Data used to calibrate the model and test many of its underlying hypotheses were made available by the Bay Area Transportation Study Commission, the Detroit Transportation and Land Use Study, the Southeast Michigan Council of Governments, the Southeastern Wisconsin Regional Planning Commission, and the Southwestern Pennsylvania Regional Planning Commission. Individuals associated with these organizations who were very helpful include William Goldner, Wesley Welles, Irving Rubin, Alexander Kennedy, S. Thyagarayan, Sheldon Sullivan, and Wade Fox.

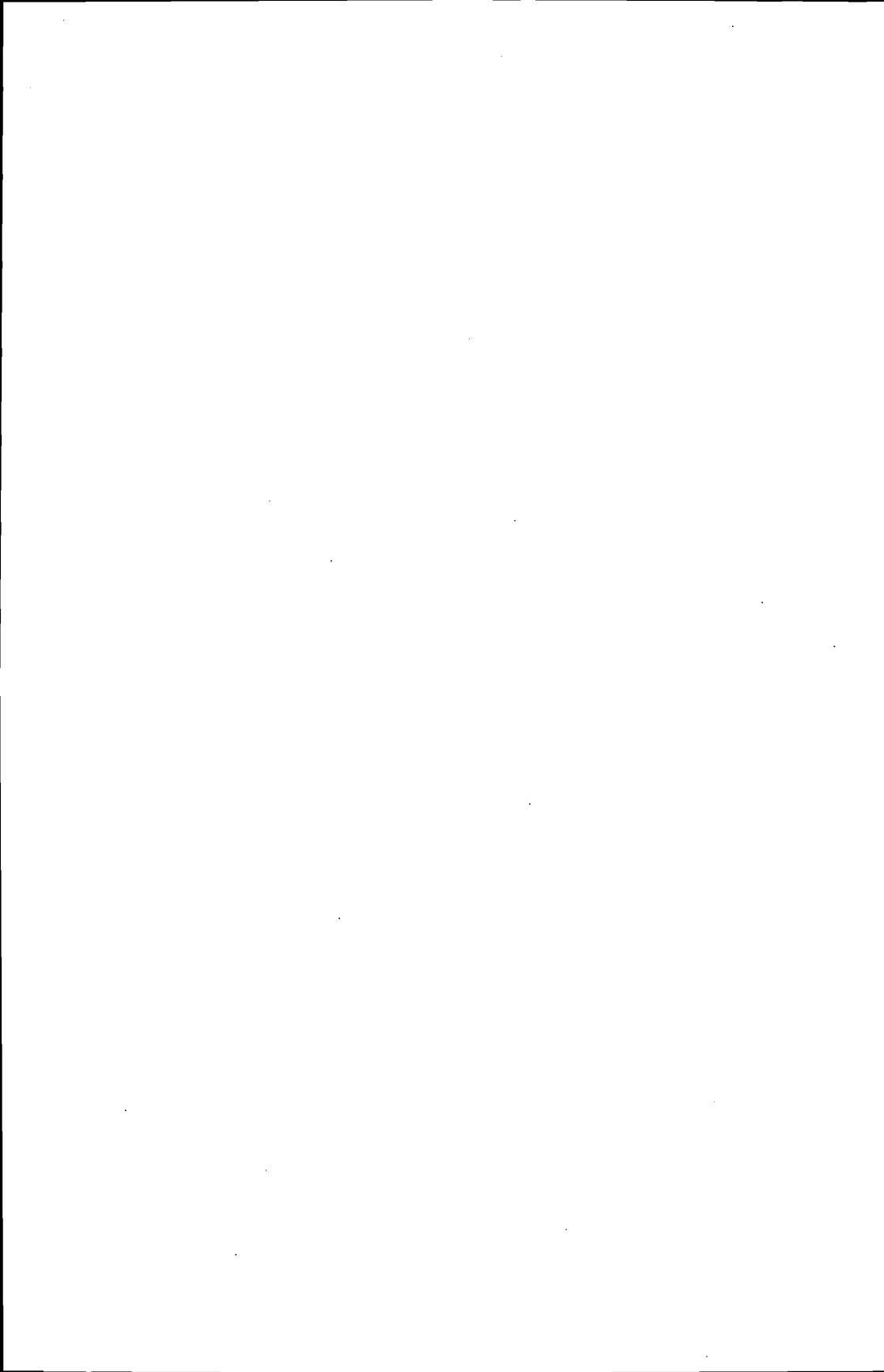
The original financial support for model development was provided by U.S. Department of Housing and Urban Development Grant NY-MTD 15, administered by the Office of Urban Transportation Development and Liaison, Division of Systems Research and Development. Additional support was provided by unrestricted funds of the National Bureau and the Graduate Fellowship Program of the National Science Foundation.

Similarly, the entire effort, including model development and creation of an urban studies program at the Bureau, has benefited from the suggestions and advice of the National Bureau's Advisory Committee for Urban Economic Studies. The Advisory Committee comprises Wallace J. Campbell, William G. Colman, Anthony Downs,

Nathan Glazer, Charles M. Haar, Frederick O'R. Hayes, Vivian W. Henderson, Saul B. Klamman, Sherman J. Maisel, Peter F. McNish, Boris Shishkin, Norman Strunk, Leo J. Troy, Phylis Wallace, James Q. Wilson, and Kenneth M. Wright. The authors are also especially indebted to the staff reading committee, David Kendrick and Mahlon R. Straszheim; and to the Board reading committee, Wallace J. Campbell, R. A. Gordon, and Almarin Phillips. Helpful suggestions were also received from Emilio Collado and William G. Colman.

In addition, Robert Goldberg and Elizabeth Pinkston deserve special recognition for their competent programming and research assistance. The final draft of the manuscript was skillfully typed by Barbara Clark. The charts and maps were drawn by H. Irving Forman, and the manuscript was edited by Ester Moskowitz. Finally, Joseph J. Persky, John M. Quigley, Irving Silver, Laura Steig, Ana Bell, and Margie Dewer all made valuable contributions to the design of the model or the preparation of this manuscript.

JOHN R. MEYER



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