

This PDF is a selection from an out-of-print volume from the National Bureau of Economic Research

Volume Title: Empirical Models of Urban Land Use: Suggestions on Research Objectives and Organization

Volume Author/Editor: H. James Brown, J. Royce Ginn, Franklin J. James, John F. Kain, and Mahlon R. Straszheim

Volume Publisher: NBER

Volume URL: <http://www.nber.org/books/brow72-1>

Publication Date: 1972

Chapter Title: Front Matter to "Empirical Models of Urban Land Use: Suggestions on Research Objectives and Organization"

Chapter Author: H. James Brown, J. Royce Ginn, Franklin J. James, John F. Kain, and Mahlon R. Straszheim

Chapter URL: <http://www.nber.org/chapters/c3973>

Chapter pages in book: (p. -17 - 0)

*Empirical Models of Urban Land Use:
Suggestions on Research Objectives
and Organization*

NATIONAL BUREAU OF ECONOMIC RESEARCH

Exploratory Report 6

Empirical Models of Urban Land Use: Suggestions on Research Objectives and Organization

H. JAMES BROWN, Harvard University

J. ROYCE GINN, National Bureau of Economic Research

FRANKLIN J. JAMES, Rutgers University

JOHN F. KAIN, Harvard University

MAHLON R. STRASZHEIM, University of Maryland

EXPLORATORY REPORT 6



**NATIONAL BUREAU OF
ECONOMIC RESEARCH**

New York 1972

*Distributed by Columbia University Press
New York and London*

Copyright © 1972 by

National Bureau of Economic Research, Inc.

261 Madison Avenue, New York, N.Y. 10016

All Rights Reserved

Library of Congress Catalog Card Number: 70-188338

ISBN-0-87014-234-8

Printed in the United States of America

National Bureau of Economic Research

OFFICERS

Arthur F. Burns, *Honorary Chairman*
 Theodore O. Yntema, *Chairman*
 Walter W. Heller, *Vice Chairman*
 John R. Meyer, *President*
 Thomas D. Flynn, *Treasurer*
 Douglas H. Eldridge, *Vice President-Executive Secretary*
 Victor R. Fuchs, *Vice President-Research*

F. Thomas Juster, *Vice President-Research*
 Hal B. Lary, *Vice President-Research*
 Robert E. Lipsey, *Vice President-Research*
 Edward K. Smith, *Vice President*
 Donald R. Gilmore, *Assistant Vice President*
 Joan R. Tron, *Director of Publications*
 Evan Stephens, *Controller*
 Charlotte Boschan, *Director of Data Processing*

DIRECTORS AT LARGE

Atherton Bean, *International Multifoods Corporation*
 Joseph A. Beirne, *Communications Workers of America*
 Arthur F. Burns, *Board of Governors of the Federal Reserve System*
 Wallace J. Campbell, *Foundation for Cooperative Housing*
 Erwin D. Canham, *Christian Science Monitor*
 Robert A. Charpie, *The Cabot Corporation*
 Solomon Fabricant, *New York University*
 Frank W. Fetter, *Hanover, New Hampshire*
 Eugene P. Foley, *Dreyfus Corporation*
 Eli Goldston, *Eastern Gas and Fuel Associates*
 Crawford H. Greenewalt, *E. I. du Pont de Nemours & Company*
 David L. Grove, *International Business Machines Corporation*

Walter W. Heller, *University of Minnesota*
 Vivian W. Henderson, *Clark College*
 John R. Meyer, *Yale University*
 J. Irwin Miller, *Cummins Engine Company, Inc.*
 Geoffrey H. Moore, *Bureau of Labor Statistics*
 J. Wilson Newman, *Dun & Bradstreet, Inc.*
 James J. O'Leary, *United States Trust Company of New York*
 Robert V. Roosa, *Brown Brothers, Harriman & Co.*
 Boris Shishkin, *Washington, D.C.*
 Lazare Teper, *International Ladies' Garment Workers' Union*
 Donald B. Woodward, *Riverside, Connecticut*
 Theodore O. Yntema, *Oakland University*

DIRECTORS BY UNIVERSITY APPOINTMENT

Moses Abramovitz, *Stanford*
 Charles H. Berry, *Princeton*
 Francis M. Boddy, *Minnesota*
 Tom E. Davis, *Cornell*
 Otto Eckstein, *Harvard*
 Walter D. Fisher, *Northwestern*
 R. A. Gordon, *California*
 Robert J. Lampman, *Wisconsin*

Kelvin J. Lancaster, *Columbia*
 Maurice W. Lee, *North Carolina*
 Lloyd G. Reynolds, *Yale*
 Robert M. Solow, *Massachusetts Institute of Technology*
 Henri Theil, *Chicago*
 Thomas A. Wilson, *Toronto*
 Willis J. Winn, *Pennsylvania*

DIRECTORS BY APPOINTMENT OF OTHER ORGANIZATIONS

Emilio G. Collado, *Committee for Economic Development*
 Thomas D. Flynn, *American Institute of Certified Public Accountants*
 Nathaniel Goldfinger, *American Federation of Labor and Congress of Industrial Organizations*
 Harold G. Halcrow, *American Agricultural Economics Association*
 Douglas G. Hartle, *Canadian Economics Association*

Walter E. Hoadley, *American Finance Association*
 Douglass C. North, *Economic History Association*
 Charles B. Reeder, *National Association of Business Economists*
 Murray Shields, *American Management Association*
 Willard L. Thorp, *American Economic Association*
 W. Allen Wallis, *American Statistical Association*

DIRECTORS EMERITI

Percival F. Brundage
 Gottfried Haberler

Albert J. Hettinger, Jr.

George B. Roberts
 Joseph H. Willits

SENIOR RESEARCH STAFF*

Gary S. Becker
 Charlotte Boschan
 Phillip Cagan
 James S. Earley
 Solomon Fabricant
 Milton Friedman
 Victor R. Fuchs
 Raymond W. Goldsmith
 Jack M. Guttentag
 Daniel M. Holland
 F. Thomas Juster
 C. Harry Kahn
 John F. Kain
 John W. Kendrick

Irving B. Kravis
 Hal B. Lary
 Robert E. Lipsey
 John R. Meyer
 Jacob Mincer
 Ilse Mintz
 Geoffrey H. Moore*
 M. Ishaq Nadiri
 Nancy Ruggles
 Richard Ruggles
 Anna J. Schwartz
 Robert P. Shay
 George J. Stigler
 Victor Zarnowitz

* On leave.

RELATION OF THE DIRECTORS TO THE WORK AND PUBLICATIONS
OF THE NATIONAL BUREAU OF ECONOMIC RESEARCH

1. The object of the National Bureau of Economic Research is to ascertain and to present to the public important economic facts and their interpretation in a scientific and impartial manner. The Board of Directors is charged with the responsibility of ensuring that the work of the National Bureau is carried on in strict conformity with this object.

2. The President of the National Bureau shall submit to the Board of Directors, or to its Executive Committee, for their formal adoption all specific proposals for research to be instituted.

3. No research report shall be published until the President shall have submitted to each member of the Board the manuscript proposed for publication, and such information as will, in his opinion and in the opinion of the author, serve to determine the suitability of the report for publication in accordance with the principles of the National Bureau. Each manuscript shall contain a summary drawing attention to the nature and treatment of the problem studied, the character of the data and their utilization in the report, and the main conclusions reached.

4. For each manuscript so submitted, a special committee of the Board shall be appointed by majority agreement of the President and Vice Presidents (or by the Executive Committee in case of inability to decide on the part of the President and Vice Presidents), consisting of three directors selected as nearly as may be one from each general division of the Board. The names of the special manuscript committee shall be stated to each Director when the manuscript is submitted to him. It shall be the duty of each member of the special manuscript committee to read the manuscript. If each member of the manuscript committee signifies his approval within thirty days of the transmittal of the manuscript, the report may be published. If at the end of that period any member of the manuscript committee withholds his approval, the President shall then notify each member of the Board, requesting approval or disapproval of publication, and thirty days additional shall be granted for this purpose. The manuscript shall then not be published unless at least a majority of the entire Board who shall have voted on the proposal within the time fixed for the receipt of votes shall have approved.

5. No manuscript may be published, though approved by each member of the special manuscript committee, until forty-five days have elapsed from the transmittal of the report in manuscript form. The interval is allowed for the receipt of any memorandum of dissent or reservation, together with a brief statement of his reasons, that any member may wish to express; and such memorandum of dissent or reservation shall be published with the manuscript if he so desires. Publication does not, however, imply that each member of the Board has read the manuscript, or that either members of the Board in general or the special committee have passed on its validity in every detail.

6. Publications of the National Bureau issued for informational purposes concerning the work of the Bureau and its staff, or issued to inform the public of activities of Bureau staff, and volumes issued as a result of various conferences involving the National Bureau shall contain a specific disclaimer noting that such publication has not passed through the normal review procedures required in this resolution. The Executive Committee of the Board is charged with review of all such publications from time to time to ensure that they do not take on the character of formal research reports of the National Bureau, requiring formal Board approval.

7. Unless otherwise determined by the Board or exempted by the terms of paragraph 6, a copy of this resolution shall be printed in each National Bureau publication.

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

Contents

	<i>Page</i>
FOREWORD	xi
ACKNOWLEDGMENTS	xv
INTRODUCTION	3
1. LAND-USE-TRANSPORTATION PLANNING STUDIES	6
Introduction	6
The "Standard" Method	7
Trip Generation	9
Zonal Interchange	10
Modal Choice	13
Network Assignment	15
2. SURVEY OF LAND-USE MODELING: AN OVERVIEW	17
Introduction	17
The Models	19
Tables of Land-Use Models	21
3. PUGET SOUND REGIONAL TRANSPORTATION STUDY	30
Introduction	30
Methodology	32
Aggregate Projections of Employment and Population	32
Employment Allocation Models	32
Population Allocation Models	35
Overview	37
4. SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION STUDY	38
Introduction	38
Methodology	40
Residential Land Use	40
Industrial Land Use	43
Service Sector	43
Special and Agricultural Sectors	43
Overview	43

5. ATLANTA REGION METROPOLITAN PLANNING STUDY	<i>Page</i> 45
Introduction	45
Methodology	47
Population and Employment Projections	47
Allocation of Industrial Employment	47
Allocation of Population	48
Determination of Mean Family Income	48
Housing and Residential Density	49
Allocation of the Labor Force	49
Retail Land Use	50
Overview	51
 6. DETROIT REGIONAL TRANSPORTATION AND LAND-USE STUDY	 53
Introduction	53
Methodology	55
Population and Employment Control Totals	55
Employment Model	55
Household-Income Model	56
Life-Cycle Model	56
Population Model	58
Land-Use Model	58
Overview	58
 7. BAY AREA SIMULATION STUDY	 60
Introduction	60
Methodology	61
Retail Trade	62
Industrial Land-Use Model: Manufacturing, Trucking and Warehousing, Wholesale Trade	62
Finance, Insurance and Real Estate, Education and Government Services	64
Residential Housing Location	65
Overview	67
 8. BAY AREA TRANSPORTATION STUDY	 68
Introduction	68
Methodology	68
Industry Location	68
Population-serving Employment and Households (PLUM)	71
Overview	76

9. LAND-USE MODELING: CURRENT PROBLEMS AND FUTURE DIRECTIONS	<i>Page</i>
Technical and Methodological Problems	78
Cross-Sectional Bias	79
Interdependencies and Their Sequential Representation	81
Industrial Location	82
Housing Stock Adjustments and Changes in the Character of Residential Areas	82
Housing Segregation: The Race Issue	83
Modeling Focus	84
Testing the Models	84
Problems in Organization, Planning, and the State of the Art of Modeling	85
Organizational Problems Affecting Modeling	85
Documentation	87
Basic Research	90
Total Cost and the Allocation of Study Budgets	91
SELECTED SOURCES	96
INDEX	99

Tables

	<i>Page</i>
1. Techniques and Procedures	22
2. Puget Sound Regional Transportation Study	24
3. Southeastern Wisconsin Regional Planning Commission	24
4. Atlanta Region Metropolitan Planning Study	26
5. Detroit Regional Transportation and Land-Use Study	26
6. Bay Area Simulation Study	28
7. Bay Area Transportation Study	28
8. Transportation Study Budget	94

Figures

	<i>Page</i>
1. The Land-Use-Transportation Forecasting Model	8
2. Basic Structural Linkages of the Land-Use Models	20
3. Synthesized Flow Diagram for the Puget Sound Land-Use Model	31
4. Southeastern Wisconsin Land-Use-Transportation Study Planning System	39
5. Synthesized Flow Diagram for the Southeastern Wisconsin Residential Model	41
6. Synthesized Flow Diagram for the Atlanta Area Land-Use Model	46
7. Synthesized Flow Diagram for the Southeastern Michigan Growth Model	54
8. Synthesized Flow Diagram for the Bay Area Transportation Land-Use Model	69

Foreword

DURING THE PAST fifteen years or so the United States has experienced a burgeoning interest in metropolitan land-use-transportation studies. Virtually every major metropolitan area in the United States has undertaken such a study. Several areas have undertaken more than one.

The very first of these models were fairly primitive: forecasts of the demand for transportation facilities often were made by simply "factoring up" (i.e., increasing) observed demands for existing facilities. Slowly, the realization set in that patterns of metropolitan land use depended upon the design and extent of the transportation system; this led to studies of increasing complexity and cost. Today these efforts commonly cost several millions of dollars, and the national investment in them is consequently great. Many talented people and sophisticated techniques have been employed. It is an understatement to say that the techniques are evolving. Thus, in the six studies examined in this survey, a diversity and increasing sophistication of techniques is quite evident.

In this environment of rapid change, a survey of current developments seems warranted. As the authors of this survey point out, there has been an unfortunate lack of candid and complete communication among the persons involved. In part this is the result of the institutional structure within which these modeling efforts are carried out. An equally important explanation, however, has been the comparative newness of these studies and the great number of innovations they embody. Communication under conditions of extremely rapid and independent development is almost never satisfactory. Given the great investments in these models themselves, not to mention the much greater investments affected by their outputs, this lack of adequate criticism and understanding potentially could be enormously expensive.

Empirical tests of the adequacy of the models as simulations of the

real world have also been insufficient—in fact, largely impossible. For practical reasons, discussion and criticism of the models, therefore, have had to be *a priori*.

Criticism of land-use-transportation models is too varied and abundant to be effectively summarized in the space of these comments. The authors concentrate primarily on an obvious weakness of current land-use modeling efforts: lack of convincing behavioral content. As the authors suggest, current models have been created in a policy planning environment which places enormous emphasis on producing forecasts. Adequate basic research on the processes underlying and creating the patterns being forecast has not been encouraged to any large extent. Understandably, in this environment basic research has remained by and large inadequate. The resulting models are mechanistic; their logic and theoretical bases are often impenetrable.

As with the earlier exploratory reports issued by the National Bureau,¹ this report should be regarded as simply suggestive and not as a final program of research. The survey reported in this volume is both the rationalization and the first product of an effort at the National Bureau to undertake some of the basic research necessary to the development of satisfactory metropolitan land-use-transportation models. Several interrelated studies are now under way at the Bureau in the area of urban economics, research that we hope will eventually result in a much more complete understanding of the metropolitan area as an economic unit. An example of these studies is a large-scale econometric analysis of household residential choice. In this the effects of many factors are being studied—workplace location, income, demographic variables (including racial characteristics), and the design of transportation systems—on the choice by households of residence type, neighborhood type, and location. On the basis of the econometric estimations of these relationships, we hope to construct a computer simulation model of this process. Others at the Bureau are studying the determinants of intrametropolitan manufacturing location choices, using time-series data which allow cohort analysis. Still others are investigating the effects of different fiscal arrangements on the behavior of local governments. Effort is also being directed at achieving a better understanding of urban labor markets and their operation, including a study of the participation of minority groups in these labor markets. In all, these

¹ *Research in Securities Markets* (1946); *Research in the Capital and Securities Markets* (1954); *Suggestions for Research in the Economics of Pensions* (1957); *The Comparative Study of Economic Growth and Structure: Suggestions on Research Objectives and Organization* (1959); *Research in the Capital Markets* (1964).

studies range from investigations of patterns of migration to and among urban areas to studies of specifically intraurban phenomena.

This preliminary report or survey has been done by the staff specifically involved in the land-use modeling. It has benefited from the insights and cooperation of many researchers active in the field. Its audience should be, I think, not only men technically involved in this type of modeling but all those interested in current research into the determinants of the form of metropolitan change and growth. We hope that it can be of significant value to both researchers technically involved and sophisticated in this field and to interested lay observers.

JOHN R. MEYER

Acknowledgments

THIS MONOGRAPH WAS a product of the initial stages of a research project done at the National Bureau with the support of the U.S. Department of Housing and Urban Development. The aim of the project was the development of experimental models of the spatial relationships of urban land-use activities. Compiling this survey and critique seemed to us, and to the Department of Housing and Urban Development, a natural adjunct to our modeling activities.

It is impossible to separately identify the contributions of individual authors. Each of us was involved in the development of every part of the monograph. However, some suggestion of the general demarcation of responsibilities may be useful, both for the record and for the reader. Mahlon Straszheim made major contributions to Chapter 1, in which a general introduction to the structure of transportation planning models is given. James Brown and Franklin James concentrated their efforts on Chapters 2 through 8, where summaries of the structures of the six models surveyed are presented. John Kain contributed greatly to Chapter 9, which offers criticisms and suggestions for improvement in the techniques of land-use modeling. Royce Ginn made important contributions to all areas of the monograph.

Of course, the authors owe a great deal to a great many people. Special thanks are due to Raymond J. Struyk, Stephen P. Dresch, Gregory K. Ingram, and Irving R. Silver of the NBER staff reading committee, whose criticisms and suggestions were invaluable to the authors; and to the members of the Board of Directors' reading committee for this study: Wallace J. Campbell, J. Irwin Miller, and Boris Shishkin. In addition, William Goldner and Joseph Nathanson of the Bay Area Transportation Study, T. R. Lakshmanan and D. D. Lamb of the Consad Research Corporation, and I. J. Rubin and S. Thyagarajan of the Detroit Regional Transportation and Land-Use Study (TALUS) de-

serve thanks for the patience and tolerance they showed while introducing us to their modeling efforts. In addition, we owe special thanks to Gnomi Schrift Gouldin and Hedy D. Jellinek for their editing of the manuscript, to H. Irving Forman for the charts, and to Mrs. Mary Parker for excellent typing. Her skill and dependability made our work much easier.

This report is part of a larger investigation supported by HUD Grant Number NY-MTD-15, administered by the Office of Urban Transportation Development and Liaison, Division of Systems Research and Development. We wish to thank the sponsors for their generous support. They are not, of course, to be held responsible for any of the statements made or views expressed.