

ECONOMETRIC MODELS, TECHNIQUES, AND APPLICATIONS

MICHAEL D. INTRILIGATOR

*Professor of Economics
University of California, Los Angeles*



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NORTH-HOLLAND PUBLISHING COMPANY
AMSTERDAM · OXFORD

PRENTICE-HALL, INC.
ENGLEWOOD CLIFFS, NEW JERSEY 07632

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Prentice-Hall ISBN: 0-13-223255-3

North-Holland ISBN for this series: 0 7204 3600 1

North-Holland ISBN for this volume: 0 7204 3607 9 (cloth-bound)

Library of Congress Cataloging in Publication Data

INTRILIGATOR, MICHAEL D. (1938—)

Econometric models, techniques, and applications.

Bibliography: p.

Includes index.

1.—Econometrics. 2.—Econometrics—Mathematical models. I.—Title.

HB139.I57 330'.01'82 77-14564

ISBN 0-13-223255-3

10 9 8 7 6 5 4

PUBLISHERS:

PRENTICE-HALL, INC., Englewood Cliffs, New Jersey 07632

SOLE DISTRIBUTION:

USA AND CANADA

PRENTICE-HALL, INC., Englewood Cliffs, New Jersey 07632

EUROPE

NORTH-HOLLAND PUBLISHING COMPANY-AMSTERDAM · OXFORD

PRINTED IN THE USA

Introduction to the Series

The aim of the series is to cover topics in economics, mathematical economics and econometrics, at a level suitable for graduate students or final year undergraduates specializing in economics. There is at any time much material that has become well established in journal papers and discussion series which still awaits a clear, self-contained treatment that can easily be mastered by students without considerable preparation or extra reading. Leading specialists will be invited to contribute volumes to fill such gaps. Primary emphasis will be placed on clarity, comprehensive coverage of sensibly defined areas, and insight into fundamentals, but original ideas will not be excluded. Certain volumes will therefore add to existing knowledge, while others will serve as a means of communicating both known and new ideas in a way that will inspire and attract students not already familiar with the subject matter concerned.

THE EDITORS

***To Kenneth
 James
 William
 Robert***

Preface

Econometrics has come of age. It has produced a solid body of theory and, of equal importance, a host of applications both in economics and in other social sciences. In economics it has traditionally been applied to macroeconomics, but over recent years it has been applied to virtually every other field of economics including monetary economics, public finance, international trade, labor economics, and economic development. Political science, sociology, and history also have utilized econometric methods. Applications have been made to such diverse areas as education, law, health, and transportation. As a consequence, there has been a tremendous growth of interest in econometrics on the part of students as well as professional workers in economics and other social sciences.

Purpose

This book introduces and surveys the approach, techniques, and applications of econometrics. Its motivation arose largely from the observation that at least 80% of the material in most of the existing textbooks in econometrics focuses purely on econometric techniques. By contrast, practicing econometricians—or economists or social scientists performing econometric studies—typically spend 20% or less of their time and effort on econometric techniques *per se*; the remainder is spent on other aspects of the study, particularly on the construction of a relevant econometric model and the development of appropriate data before estimation and on the interpretation of results after estimation. The distinctive feature of this book is its balance between the econometric techniques *per se*, the model-building and data-collection areas, and the applications and uses of econometrics. It does not slight the techniques; rather it presents them in a logical, understandable, and usable fashion. It does, however, stress those aspects of econometrics of major importance to students and researchers interested in performing or evaluating econometric studies.

The book should enable the reader to understand and to evaluate existing econometric studies in a variety of areas. To a large extent, econometrics is not a science, defined by a narrow set of theorems, but rather an approach that can be appreciated and understood only by use. Indeed, the reader's comprehension of econometrics in practice will not be complete until he or she has performed an original econometric study, preparation for which is one of this book's basic objectives.

The book can be used as a textbook in first-year graduate or advanced undergraduate courses in econometrics. It can also be utilized as a supplementary text for courses in economic theory, economic statistics, sociometrics, engineering, public administration, policy sciences, or other social sciences. It should

also be of interest to economists, statisticians, engineers, and operations-research analysts.

Prerequisites

The mathematical level has been kept as elementary as possible—an elementary knowledge of basic concepts of calculus, matrix theory, and probability and statistics would suffice. Two appendices review basic concepts—including definitions, examples, and theorems—for matrices (Appendix B) and for probability and statistics (Appendix C). These appendices are not intended as text materials but rather as convenient reviews for readers who have had some previous exposure to the general concepts, usually via previous courses in matrix theory and statistics. They also introduce the notation and some concepts not generally covered in basic courses. Introductory books on these subjects are referenced at the beginning of each appendix.

Organization

The book consists of seven major parts. *Part I* introduces the nature of econometrics and the econometric approach. It discusses some of the important objectives of econometrics in order to motivate the student—by specifically indicating what the study of econometrics may provide. *Part II* treats models and data, particularly econometric models and economic data. It provides examples of relevant models, including two prototype models that not only illustrate various aspects of models and model building but also represent a bridge to the later discussion of applications of econometrics. The discussion of data should facilitate an understanding of the nature and sources of data. *Part III* concerns the estimation of single-equation models, including discussions of multiple linear regression and problems in and extensions of the basic linear regression model. *Part IV* covers applications of the techniques developed in Part III, including applications to the household (demand functions), to the firm (production and cost functions), and to other areas. *Part V* concerns the estimation of simultaneous-equations systems, including a discussion of the identification problem, limited-information techniques, and full-information techniques. *Part VI* discusses applications of these techniques to macroeconomic models and to other areas. Finally, *Part VII* provides a discussion of three major uses of econometrics: structural analysis, forecasting, and policy evaluation.

Appendix A outlines an econometric project, which students and other readers of this book are encouraged to perform. *Appendix B* summarizes important definitions and theorems concerning matrices, while *Appendix C* summarizes the probability and statistics used in the book, including relevant statistical tables.

Distinctive Features

The distinctive features of this book are primarily the materials covered in Parts II, IV, VI, and VII.

Part II discusses those aspects of econometrics that are logically prior to estimation, namely the specification of the model and the development of data for

its estimation. Remarkably enough, these aspects are generally not treated in existing econometrics textbooks.

Parts IV and VI provide case studies of the applications of econometrics to a wide variety of areas. They include traditional areas, such as the estimation of demand functions and production functions, as illustrative of single-equation estimation, and macroeconomic models, as illustrative of simultaneous-equations estimation. They also include, however, some newer areas of application of both single-equation and simultaneous-equations methods, such as monetary economics, labor economics, industrial organization, and health economics. The purpose is not to be exhaustive, but rather to select several studies illustrating the application of econometric techniques to each area and to provide references to other such studies (see, in particular, the Bibliography for Chapter 9). After having seen econometric methods applied to several areas, the reader—and especially the student—should be able to carry out an econometric project, including the specification of the model, development of data, estimation, and use, as outlined in Appendix A.

Part VII discusses the various uses to which an estimated econometric model can be put. An estimated econometric model is a very valuable product, not to be admired for its own sake, but rather to be put to use for structural analysis, forecasting, and policy evaluation. This elementary but important observation appears to have been overlooked in most existing econometrics textbooks.

The Nature of the Problems

Another distinctive feature of this book is the inclusion of problems in most chapters. These problems challenge the reader to enlarge upon the basic knowledge contained in the chapter by proving further results or developing extensions. The intent is to provide the student of econometrics with a challenge somewhat comparable to the laboratory problem facing a student in the natural sciences. The student must take the initiative and, based upon the material in the chapter, prove or discover some additional results or extension of the basic material. The problems also provide a test as to whether the material contained in the chapter has been fully comprehended.

Acknowledgments

This book is based largely on courses I have given over the last ten years at the University of California, Los Angeles; the University of Southern California; and the California Institute of Technology. My principal acknowledgment is to the students who have given me the benefit of their comments and suggestions. I have also been extremely fortunate in receiving helpful comments and suggestions from William Barger, David Belsley, Christopher Bliss, Murray Brown, Jeffrey Conner, Camilo Dagum, Otto Eckstein, Arthur Goldberger, Stephen Goldfeld, Jay Helms, Bruce Herrick, Leif Johansen, Dale Jorgenson, Linda Kleiger, Robert McNown, Jeffrey Perloff, Inga Rynell-Heller, Herman Stekler, Jack Tawil, and Victor Zarnowitz.

M. D. INTRILIGATOR

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PART I

Introduction

The Econometric Approach

1.1 What is econometrics?

To start with a definition, *econometrics* is the branch of economics concerned with the empirical estimation of economic relationships. The “metric” part of the word signifies *measurement*; and econometrics is basically concerned with measuring economic relationships. Econometrics utilizes economic theory, as embodied in an *econometric model*; facts, as summarized by *relevant data*; and statistical theory, as refined into *econometric techniques*, in order to measure and to test empirically certain relationships among economic variables, thereby giving empirical content to economic reasoning. While this definition is oriented to economics, the econometric approach is not confined exclusively to economics; it can be applied to other disciplines, especially other social sciences, such as history, political science, sociology, and psychology. It can also be applied to areas of public policy, including health, education, transportation, housing, and environmental protection.

When the term “econometrics” was first used, in the 1930s, it conveyed both the development of pure theory from a mathematical viewpoint and the empirical estimation of economic relationships. Now it signifies primarily the latter; the mathematical development of economic theory is now called *mathematical economics*.¹

A distinction might also be drawn between econometrics and economic statistics. *Economic statistics* is concerned with descriptive statistics, including developing and refining economic data such as the national income accounts and index numbers, while econometrics utilizes these data to estimate quantitative economic relationships and to test hypotheses about them.²

1.2 The nature of the econometric approach

Figure 1.1 summarizes the econometric approach.³ There are two basic ingredients in any econometric study—theory and facts. Indeed, a major accom-

¹ For expositions of mathematical economics see Intriligator (1971a) and Takayama (1974). The theory developed in mathematical economics is often a guide to the specification of an econometric model, as will be seen in Chapters 7 and 8, which include the applications of econometrics to the estimation of demand functions and production functions, respectively.

² See Chapter 3 for a discussion of data used in econometric studies.

³ For a related diagram see Stone (1965) and Intriligator (1971b).

plishment of econometrics is simply that of combining these two ingredients. By contrast, a considerable amount of work in economics emphasizes one of them to the exclusion of the other. The “theory-only” school is concerned solely with purely deductive implications of certain postulate systems involving economic phenomena. Examples from mathematical economics include the neoclassical theories of demand, production, and general equilibrium. The “facts-only” school, by contrast, is concerned solely with developing and improving data on the economy. Examples from economic statistics include the collection of data at the macro level, such as the national income accounts, or at the micro level, such as individual lifetime work and income histories. Either of these extreme positions would be difficult to defend. As to the theory-only school, pure theory, by itself, has little empirical content. Furthermore, rival theories can often be developed, and the proper way to choose between them is on the basis of evidence in the form of facts, with facts guiding the development of theory. As to the facts-only school, the facts do not “speak for themselves,” and to use them effectively they typically must be interpreted in terms of an underlying structure, embodied in a theory. Econometrics utilizes both theory and facts, combining them, using statistical techniques, to estimate economic relationships.

Theory is one of the basic ingredients in any econometric study, but it must be developed in a usable form. The most usable form for the purposes of econometrics, as shown in Figure 1.1, is typically that of a *model*, in particular an *econometric model*. The model summarizes the theory relevant to the system

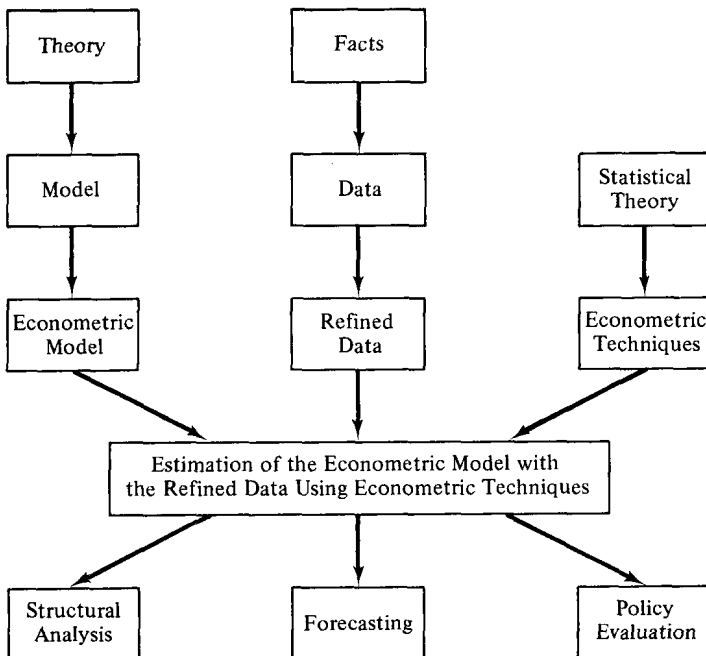


Figure 1.1 The Econometric Approach