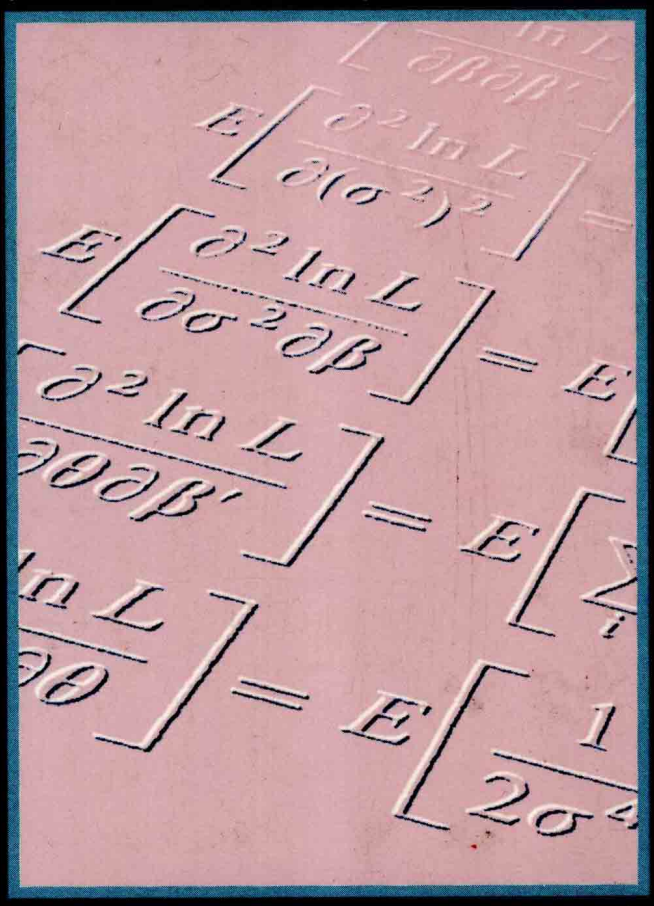
Econometric Analysis

Second Edition



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PREFACE

This book is intended for a one-year graduate course in econometrics. The prerequisites for that course would include calculus, basic mathematical statistics, and an introduction to econometrics at the level of, say, Gujarati's *Basic Econometrics* (McGraw-Hill, 1988) or Maddala's *Introduction to Econometrics* (Macmillan, 1992). I have included in Chapters 2 through 4 self-contained summaries of the matrix algebra and statistical theory used later in the book. The remainder of the book is intended to provide an up-to-date summary of econometric methods. This includes the traditional treatment of the multiple linear regression model as well as some recent developments in estimation and hypothesis testing. The latter include GMM estimation, Lagrange multiplier and conditional moment tests, testing for unit roots in macroeconomic data, the analysis of panel data, and limited dependent variables.

Readers may wonder what has motivated a second edition so soon (three years) after the first. One consideration was some second thoughts about some of the presentations. But with this edition I hope to offer students an accessible treatment of some important topics which, surprisingly, still remain absent from even the most recently published texts. These include estimation by the method of moments (GMM), conditional moment testing, and models of duration. The latter was deliberately and, I now believe, mistakenly omitted from my first edition. The former has simply become too widespread to neglect. Also, my earlier disclaimer notwithstanding, I hope that Chapter 19 has satisfactorily updated the treatment of at least some topics in time-series analysis.

I have attempted to keep the mathematical level consistent throughout. This has meant liberal use of matrix algebra but has required relatively little advanced distribution theory. Still, purists may prefer more in the way of detailed mathematical proofs. I give formal proofs only when they are particularly revealing about some underlying principle that will reappear in other contexts or provide students with a useful tool for their work. White's proof of the limiting distribution of the Wald statistic in Chapter 10 is an example. In contrast, a proof of the central limit theorem, while obviously of great utility on its own, is a one-shot deal. For those who are teaching at a relatively high level and who desire more of the theorem/proof format, I would suggest Peter Schmidt's *Econometrics* (Marcel Dekker, 1976) as a very handy adjunct.

One feature that distinguishes this work from its predecessors is its greater attention to nonlinear models, including full chapters on nonlinear regression and nonlinear optimization. Computer software now in wide use has made estimation of nonlinear models as simple as estimation of linear ones, and the recent literature reflects that progression. The purpose of these chapters is to bring the textbook treatment up to the level of common practice. I have also included two long chapters on limited dependent-variable models. These models are becoming ever more common in the applied literature. I have written

these chapters because there is no other source that presents these topics at a level elementary enough to initiate the newcomer but complete enough to enable a diligent student to use the information to undertake a serious piece of empirical analysis.

It is now generally accepted that training in econometrics must include some exposure to the mechanics of computation. This, it seems to me, should be self-evident. Computers and computer software have come a long way from the days when one trudged across campus in the snow to hand a deck of cards to the operator of a hostile mainframe (only to find out the next day that the entire job had aborted because of a comma punched in the wrong column). The greatest advance has been the appearance of microcomputers, which have changed both teaching and research. One now has on a desktop as much computer power as was once contained in a room-sized mainframe. What this means for teaching is that students can be given realistic data sets and challenging empirical analyses as routinely as theoretical exercises. To this end, I have included in this book a large number of data sets, many of which have been used in studies already in the literature. In addition, the appendix to Chapter 20 contains a yearly data set on a number of macroeconomic variables. (Quarterly data are available from the same sources.) These could be used, for example, to update Klein's model I or, for the more ambitious, to estimate a new model.

There are many computer programs that students can use in an econometrics course. Their most important features are ease of use and flexibility; the same program can easily be used for many different types of analyses. A partial list of the general econometrics programs now in use is as follows:

ET*	Econometric Software, Bellport, New York (general econometrics, tobit, probit, matrix algebra)
GAUSS*	Aptech Systems, Kent, Washington (matrix programming language, maximum likelihood)
LIMDEP	Econometric Software, Bellport, New York (limited and qualitative dependent variables and general econometrics)
MicroTSP*	Quantitative Micro Software, Irvine, California (forecasting and time-series models, nonlinear regression)
RATS	VAR Econometrics, Minneapolis, Minnesota (regression analysis of time series)
SAS	SAS Institute, Cary, North Carolina (general econometrics and modeling)
SHAZAM	Professor Ken White, University of British Columbia (general econometrics, multiple-equations models, tobit, probit)
SORITEC	Sorities Group, Springfield, Virginia (large-scale multiple-equation modeling)
SPSS	SPSS, Inc., Chicago, Illinois (general statistical analysis for social scientists)
SST	Dubin Rivers Research, Pasadena, California (regression, maximum likelihood, limited dependent variables)
TSP	TSP International, Palo Alto, California (general econometrics, linear and nonlinear multiple-equation models, time-series analysis)

Most of these programs are available in both mainframe and microcomputer versions. Those marked with an asterisk were written especially for personal computers. All are general-purpose programs. Their primary differences (apart from price) are their range of techniques (suggested in the listing), the amount of programming required of the user, and the level of difficulty of command entry. For the last of these, programs vary from those with commands that are very low level, such as Gauss, which is a programming language,

to those that use powerful single commands to invoke large processors that automate many complex computations, such as TSP's LSQ procedures. Since the tastes and needs of users will vary, prospective users should contact the authors for information about the programs. Journals such as *The American Statistician* and the *Journal of Applied Econometrics* also publish reviews of particular programs. Finally, a clearing house for information about software is the Centre for Computing in Economics at the University of Bristol in the United Kingdom.

It is a pleasure to express my appreciation to those who have influenced this work (some inadvertently). I would add my name to the long list of practitioners, teachers, and authors who have thanked Arthur Goldberger for his contribution to their education. Dennis Aigner and Laurits Christensen were also influential in shaping my views on econometrics. The number of students and colleagues whose input has helped produce what you find here is far too large to allow me to thank them individually. I do owe a debt to Aline Quester, whose persistent questioning and encouragement strongly influenced Chapters 21 and 22, to David Hensher and Donald Waldman, who allowed me to cite their unpublished work in these chapters, and to Martin Evans and Paul Wachtel, whose suggestions helped to shape Chapter 19.

This book has benefited at several stages from the careful reading of many reviewers, including Badi H. Baltagi, University of Houston; Leonard A. Carlson, Emory University; Chris Cornwell, University of Georgia; Michael Ellis, Wesleyan University; K. Rao Kadiyala, Purdue University; William Lott, University of Connecticut; Edward J. Mathis, Villanova University; Thad Mirer, State University of New York at Albany; Peter J. Schmidt, Michigan State University; Terry G. Seaks, University of North Carolina at Greensboro; Donald Snyder, California State University, Los Angeles; Houston H. Stokes, University of Illinois at Chicago; Mark Watson, Harvard University; and Kenneth D. West, Princeton University. The empirical work has been improved by a thorough review by Ken White of the University of British Columbia. This edition will also reflect many of the suggestions of those too numerous to thank individually who wrote, called, and e-mailed (a new verb?) to comment on the first edition. I would also like to thank Jack Repcheck, who initiated my first edition; Ron Harris and Jill Lectka, of Macmillan; and Diane Belleville, of NYU, for their contribution to the completion of this book. I owe special thanks to Terry Seaks, whose painstaking review went far beyond the call of duty. I owe my greatest debt to my wife, Lynne, and to my daughters, Lesley, Allison, Elizabeth, and Juliana.

W. H. G.

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