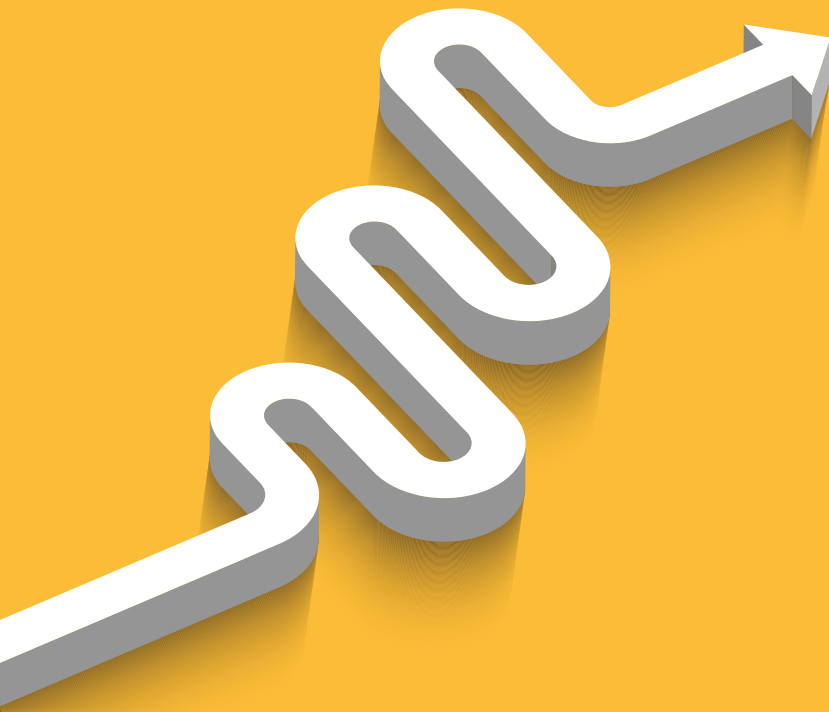


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A Practical Guide to Using Econometrics



SEVENTH EDITION

A. H. Studenmund



β

USING
ECONOMETRICS

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S E V E N T H E D I T I O N
G L O B A L E D I T I O N



A P R A C T I C A L G U I D E
T O

**USING
ECONOMETRICS**

A. H. Studenmund

Occidental College

with the assistance of

Bruce K. Johnson

Centre College



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Dedicated to the memory of

Green Beret

Staff Sergeant

Scott Studenmund

Killed in action in Afghanistan on June 9, 2014

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PREFACE

Econometric education is a lot like learning to fly a plane; you learn more from actually doing it than you learn from reading about it.

A Practical Guide to Using Econometrics represents an innovative approach to the understanding of elementary econometrics. It covers the topic of single-equation linear regression analysis in an easily understandable format that emphasizes real-world examples and exercises. As the title *A Practical Guide* implies, the book is aimed not only at beginning econometrics students but also at regression users looking for a refresher and at experienced practitioners who want a convenient reference.

What's New in the Seventh Edition?

A Practical Guide to Using Econometrics has been praised as “one of the most important new texts of the last 30 years,” so we’ve retained the clarity and practicality of previous editions. However, we’re delighted to have made a number of substantial improvements in the text.

The most exciting upgrades are:

1. **Econometric Labs:** These new and innovative learning tools are optional appendices that give students hands-on opportunities to better understand the econometric principles that they’re reading about in the chapters. The labs originally were designed to be assigned in a classroom setting, but they also have turned out to be extremely valuable for readers who are not in a class or for individual students in classes where the labs aren’t assigned. Hints on how best to use these econometric labs and answers to the lab questions are available in the instructor’s manual on the *A Practical Guide to Using Econometrics* Web site.
2. **The Use of Stata throughout the Text:** In our opinion, Stata has become the econometric software package of choice among economic researchers. As a result, we have estimated all the text examples and exercises with Stata and have included a short appendix to help students get started with Stata. Beyond this, we have added a complete guide to *Using Stata* to our Web site. This guide, written by John Perry of Centre College, explains in detail all the Stata commands needed to replicate the text’s equations and answer the text’s exercises. However, even though we use Stata extensively, *A Practical Guide to Using Econometrics* is not tied to

Stata or any other econometric software, so the text works well with all standard regression packages.

3. **Expanded Econometric Content:** We have added coverage of a number of econometric tests and procedures, for example the Breusch-Pagan test and the Prais–Winsten approach to Generalized Least Squares. In addition, we have expanded the coverage of even more topics, for example the F -test, confidence intervals, the Lagrange Multiplier test, and the Dickey–Fuller test. Finally, we have simplified the notation and improved the clarity of the explanations in Chapters 12–16, particularly in topics like dynamic equations, dummy dependent variables, instrumental variables, and panel data.
4. **Answers to Many More Exercises:** In response to requests from instructors and students, we have more than tripled the number of exercises that are answered in the text’s appendix. These answers will allow students to learn on their own, because students will be able to attempt an exercise and then check their answers against those in the back of the book without having to involve their professors. In order to continue to provide good exercises for professors to include in problem sets and exams, we have expanded the number of exercises contained in the text’s Web site.
5. **Dramatically Improved PowerPoint Slides:** We recognize the importance of PowerPoint slides to instructors with large classes, so we have dramatically improved the quality of the text’s PowerPoints. The slides replicate each chapter’s main equations and examples, and also provide chapter summaries and lists of the key concepts in each chapter. The PowerPoint slides can be downloaded from the text’s Web site, and they’re designed to be easily edited and individualized.
6. **An Expanded and Improved Web Site:** We believe that this edition’s Web site is the best we’ve produced. As you’d expect, the Web site includes all the text’s data sets, in easily downloadable Stata, EViews, Excel, and ASCII formats, but we have gone far beyond that. We have added *Using Stata*, a complete guide to the Stata commands needed to estimate the book’s equations; we have dramatically improved the PowerPoint slides; and we have added answers to the new econometric labs and instructions on how best to use these labs in a classroom setting. In addition, the Web site also includes an instructor’s manual, additional exercises, extra interactive regression learning exercises, and additional data sets. But why take our word for it? Take a look for yourself at <http://www.pearsonglobaleditions.com/Studenmund>

Features

1. Our approach to the learning of econometrics is simple, intuitive, and easy to understand. We do not use matrix algebra, and we relegate proofs and calculus to the footnotes or exercises.
2. We include numerous examples and example-based exercises. We feel that the best way to get a solid grasp of applied econometrics is through an example-oriented approach.
3. Although most of this book is at a simpler level than other econometrics texts, Chapters 6 and 7 on specification choice are among the most complete in the field. We think that an understanding of specification issues is vital for regression users.
4. We use a unique kind of learning tool called an *interactive regression learning exercise* to help students simulate econometric analysis by giving them feedback on various kinds of decisions without relying on computer time or much instructor supervision.
5. We're delighted to introduce a new innovative learning tool called an *econometric lab*. These econometric labs, developed by Bruce Johnson of Centre College and tested successfully at two other institutions, are optional appendices aimed at giving students hands-on experience with the econometric procedures they're reading about. Students who complete these econometric labs will be much better prepared to undertake econometric research on their own.

The formal prerequisites for using this book are few. Readers are assumed to have been exposed to some microeconomic and macroeconomic theory, basic mathematical functions, and elementary statistics (even if they have forgotten most if it). Students with little statistical background are encouraged to begin their study of econometrics by reading Chapter 17, "Statistical Principles," on the text's Web site.

Because the prerequisites are few and the statistics material is self-contained, *A Practical Guide to Using Econometrics* can be used not only in undergraduate courses but also in MBA-level courses in quantitative methods. We also have been told that the book is a helpful supplement for graduate-level econometrics courses.

The Stata and EViews Options

Stata and EViews are two of the best econometric software programs available.

We urge professors to make these options available to their students even if Stata or EViews aren't used in class. The advantages to students of owning their own regression software are many. They can run regressions when they're off-campus, they will add a marketable skill to their résumé if they learn Stata or EViews, and they'll own a software package that will allow them to run regressions after the class is over if they choose the EViews option.

Acknowledgments

This edition of *A Practical Guide to Using Econometrics* has been blessed by superb contributions from Ron Michener of the University of Virginia and Bruce Johnson of Centre College. Ron was the lead reviewer, and in that role he commented on every section and virtually every equation in the book, creating a 132-page *magnum opus* of textbook reviewing that may never be surpassed in length or quality.

Just as importantly, Ron introduced us to Bruce Johnson. Bruce wrote the first drafts of the econometric labs and three other sections, made insightful comments on the entire revision, helped increase the role of Stata in the book, and proofread the manuscript. Because of Bruce's professional expertise, clear writing style, and infectious enthusiasm for econometrics, we're happy to announce that he will be a coauthor of the 8th and subsequent editions of *A Practical Guide to Using Econometrics*.

This book's spiritual parents were Henry Cassidy and Carolyn Summers. Henry co-authored the first edition of *A Practical Guide to Using Econometrics* as an expansion of his own work of the same name, and Carolyn was the text's editorial consultant, proofreader, and indexer for four straight editions. Other important professional contributors to previous editions were the late Peter Kennedy, Nobel Prize winner Rob Engle of New York University, Gary Smith of Pomona College, Doug Steigerwald of the University of California at Santa Barbara, and Susan Averett of Lafayette College.

In addition, this edition benefitted from the evaluations of a talented group of professional reviewers:

Lesley Chiou, Occidental College
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A. H. Studenmund

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Chapter 1

An Overview of Regression Analysis

1.1 What Is Econometrics?

1.2 What Is Regression Analysis?

1.3 The Estimated Regression Equation

1.4 A Simple Example of Regression Analysis

1.5 Using Regression to Explain Housing Prices

1.6 Summary and Exercises

1.7 Appendix: Using Stata

1.1 What Is Econometrics?

"Econometrics is too mathematical; it's the reason my best friend isn't majoring in economics."

"There are two things you are better off not watching in the making: sausages and econometric estimates."¹

"Econometrics may be defined as the quantitative analysis of actual economic phenomena."²

"It's my experience that 'economy-tricks' is usually nothing more than a justification of what the author believed before the research was begun."

Obviously, econometrics means different things to different people. To beginning students, it may seem as if econometrics is an overly complex obstacle to an otherwise useful education. To skeptical observers, econometric

1. Ed Leamer, "Let's take the Con out of Econometrics," *American Economic Review*, Vol. 73, No. 1, p. 37.

2. Paul A. Samuelson, T. C. Koopmans, and J. R. Stone, "Report of the Evaluative Committee for *Econometrica*," *Econometrica*, 1954, p. 141.

results should be trusted only when the steps that produced those results are completely known. To professionals in the field, econometrics is a fascinating set of techniques that allows the measurement and analysis of economic phenomena and the prediction of future economic trends.

You're probably thinking that such diverse points of view sound like the statements of blind people trying to describe an elephant based on which part they happen to be touching, and you're partially right. Econometrics has both a formal definition and a larger context. Although you can easily memorize the formal definition, you'll get the complete picture only by understanding the many uses of and alternative approaches to econometrics.

That said, we need a formal definition. **Econometrics**—literally, “economic measurement”—is the quantitative measurement and analysis of actual economic and business phenomena. It attempts to quantify economic reality and bridge the gap between the abstract world of economic theory and the real world of human activity. To many students, these worlds may seem far apart. On the one hand, economists theorize equilibrium prices based on carefully conceived marginal costs and marginal revenues; on the other, many firms seem to operate as though they have never heard of such concepts. Econometrics allows us to examine data and to quantify the actions of firms, consumers, and governments. Such measurements have a number of different uses, and an examination of these uses is the first step to understanding econometrics.

Uses of Econometrics

Econometrics has three major uses:

1. describing economic reality
2. testing hypotheses about economic theory and policy
3. forecasting future economic activity

The simplest use of econometrics is description. We can use econometrics to quantify economic activity and measure marginal effects because econometrics allows us to estimate numbers and put them in equations that previously contained only abstract symbols. For example, consumer demand for a particular product often can be thought of as a relationship between the quantity demanded (Q) and the product's price (P), the price of a substitute (P_s), and disposable income (Y_d). For most goods, the relationship between consumption and disposable income is expected to be positive, because an increase in disposable income will be associated with an increase in the consumption of the product. Econometrics actually allows us to estimate that