

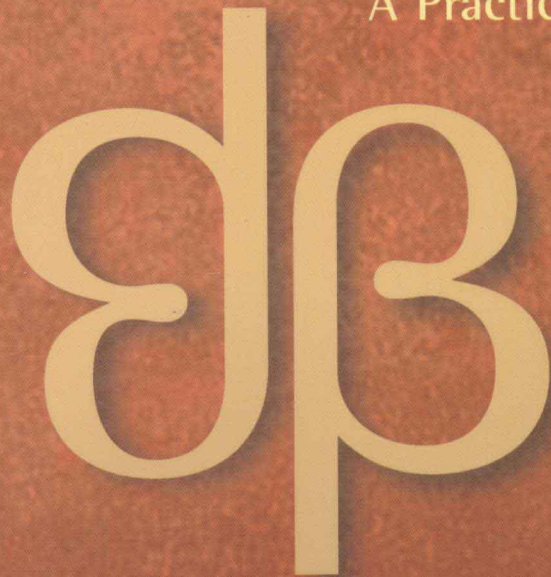


Pearson International Edition

FIFTH EDITION

USING  
ECONOMETRICS

A Practical Guide



A.H. STUDENMUND



# USING ECONOMETRICS

A PRACTICAL GUIDE

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FIFTH EDITION

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**A. H. Studenmund**  
Occidental College



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ISBN: 0-321-31155-8

1 2 3 4 5 6 7 8 9 10—CRW—09 08 07 06 05

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*Dedicated to*  
*Jaynie Miller Studenmund*

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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.*

*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 subtitle, *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.

The material covered by this book is traditional, but there are five specific features that we feel distinguish *Using Econometrics*:

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 offer the student version of EViews, the premier econometric software package for Windows computers, as an option with each copy of the text at an extremely low additional cost. We're excited about adding EViews to our package, because students appreciate the program's accuracy and easy-to-use Windows interface. Although we use EViews to produce the regression results in the book, *Using Econometrics* is not tied to EViews in any way, so the text fits well with all standard regression programs.

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 of it). Students with little statistical background are encouraged to begin their study of econometrics by reading Chapter 16, Statistical Principles.

Because the prerequisites are few and the statistics material is self-contained, *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.

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## **What's New in the Fifth Edition?**

*Using Econometrics* has been praised as “one of the most important new texts of the last 30 years,” and we appear to rank #1 in adoptions among elementary econometrics textbooks. Because of this success, we’ve revised the book in a way that retains the clarity and practicality of previous editions. Econometrics doesn’t stand still, however, so we’ve made a number of substantial improvements in the fifth edition.

The most exciting improvements are:

1. The entire text has been rewritten to take into account the ideas and suggestions of Peter Kennedy of Simon Fraser University. Peter is the author of *A Guide to Econometrics*, long considered the “bible” of professional econometricians. Peter’s comprehensive analysis of the fourth edition of *Using Econometrics* includes a review of every section, every equation, and every footnote for possible improvements in accuracy, readability, and organization.
2. EViews 3.1 has been upgraded to EViews 4.1. This means that the student version of EViews that can be included with each copy of this text (at an additional cost far lower than the wholesale price of the program) is now much more powerful. The econometric procedures have been updated and refined, and the software can handle many more variables and observations than ever before.
3. We’ve added a completely new section to Chapter 11 entitled “Practical Advice for Applied Econometricians.” This section was inspired by and heavily draws upon Chapter 21, “Applied Econometrics,” in Peter Kennedy’s *A Guide to Econometrics*. It includes a revised version of

Peter's "Ten Commandments of Econometrics," advice on what to check if you get an unexpected sign for a coefficient, and a summary of practical econometric hints from the first ten chapters of *Using Econometrics*.

4. The text's Web site, [www.aw-bc.com/studenmund](http://www.aw-bc.com/studenmund), has been modernized and made easier to use. In particular, the Web site contains all of the text's updated datasets, ready for downloading in EViews, ASCII, and Excel formats. The Web site also includes advice on using EViews and additional interactive exercises.
5. The text's exercises, examples, and data sets have been improved, expanded, and updated.
6. We've expanded the Instructor's Manual, which includes answers to odd-numbered exercises, lecture notes, sample examinations, and an additional interactive exercise.

---

## The EViews Option

We're excited to be able to offer our readers the chance to purchase the student version of EViews at an extremely low price. EViews is the number one Windows-based econometric software package in the world; it's accurate, easy to use, and provides support for a wide range of advanced options.

We urge professors and students alike to take advantage of this low-cost EViews option even if a different regression package is used for class exercises. The advantages to students of owning their own regression software are many: they can run regressions when they are off campus, and, most importantly, they'll have a regression package to use for research after the class is over, and even after they've graduated.

---

## Acknowledgments

Peter Kennedy's contributions to the fifth edition were extraordinary. He reviewed the entire book, commented on virtually every page, wrote suggested improvements for tricky passages, and coauthored Section 11.5 on "Practical Advice for Applied Econometricians." Throughout the process, Peter was patient, enthusiastic, tireless, clear, and direct. Best of all, he was a consistent advocate of the principle that the book should include fewer equations, more examples, and simpler footnotes.



This book's spiritual parents are Henry Cassidy and Carolyn Summers. It was Henry Cassidy who saw the need for a follow-on to Rao and Miller's legendary *Applied Econometrics* and who coauthored the first edition of *Using Econometrics* as an expansion of his own work of the same name. And it was Carolyn Summers who, for the four previous editions, was the text's superb editorial consultant, proofreader, and indexer. It's impossible to even list all that Henry and Carolyn did to make this book a success, and we will always be in their debt.

Gary Smith of Pomona College once again wrote the excellent chapter on statistics. His book, *Introduction to Statistical Reasoning* (McGraw-Hill, 1998, ISBN: 0-07-059276-4) would be a perfect text for a course that acts as a prerequisite for an elementary econometrics course.

Doug Steigerwald of the University of California at Santa Barbara played a major role in the revision of Chapter 12. Doug's proposed redraft of the chapter included a number of new ideas for (and new approaches to) the material, and his suggestions improved the chapter significantly. I also want to thank Nobel Prize winner Rob Engle of New York University for his help on a previous version of the same chapter.

In addition, this edition benefited from the evaluations of an extremely talented group of professional reviewers:

Neil O. Alper, Northeastern University  
Susan Averett, Lafayette College  
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Eric Suess, California State University, Hayward  
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Invaluable in the editorial and production process were Ashley Booth, Adrienne D'Ambrosio, Gina Hagen Kolenda, Barbara Lipson, Lois Lombardo, Nancy Guenther, Holly McLean-Aldis, and Katy Watson. Others who provided timely and useful assistance to this edition were David Lilien of EViews, Nancy Grubb, Manfred Keil (Claremont McKenna College), Teresa Kvisler, Silver Oak, Barbara Passerelle, Frank Wykoff (Pomona College), and my family, Jaynie, Scott, and Connell Studenmund.

In addition, we appreciate the permission of William F. Lott and Subhash C. Roy, and their publisher, Harcourt Brace and Company, for permission to reproduce a number of data-intensive exercises that originally were published in their excellent text, *Applied Econometrics: Problems with Data Sets* (1992).

Finally, but perhaps most importantly, I'd like to thank my superb Occidental College colleagues and students for their feedback and encouragement. These included Lyndsey Allison, Jonathan Brogaard, Mario Cruz, Irene Fine, Matt Mihm, Robby Moore, Tracy Orcholski, Sita Slavov, Audrey Spencer, and, especially, Chris Smutny.

*A. H. Studenmund*

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part I

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# The Basic Regression Model

# An Overview of Regression Analysis

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- 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

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## 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 don't want to see in the making—sausage and econometric research."<sup>1</sup>*

*"Econometrics may be defined as the quantitative analysis of actual economic phenomena."<sup>2</sup>*

*"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

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1. Attributed to Edward E. Leamer.

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 what 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.

### 1.1.1 Uses of Econometrics

Econometrics has three major uses:

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

The simplest use of econometrics is **description**. We can use econometrics to quantify economic activity 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 commodity often can be thought of as a relationship between the quantity demanded ( $Q$ ) and the commodity's price ( $P$ ), the price of a substitute good ( $P_s$ ), 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 good. Econometrics actually allows us to estimate that relationship based

upon past consumption, income, and prices. In other words, a general and purely theoretical functional relationship like:

$$Q = f(P, P_s, Y_d) \quad (1.1)$$

can become explicit:

$$Q = 27.6 - 0.61P + 0.09P_s + 0.24Y_d \quad (1.2)$$

This technique gives a much more specific and descriptive picture of the function.<sup>3</sup> Let's compare Equations 1.1 and 1.2. Instead of expecting consumption merely to "increase" if there is an increase in disposable income, Equation 1.2 allows us to expect an increase of a specific amount (0.24 units for each unit of increased disposable income). The number 0.24 is called an estimated regression coefficient, and it is the ability to estimate these coefficients that makes econometrics valuable.

The second and perhaps most common use of econometrics is **hypothesis testing**, the evaluation of alternative theories with quantitative evidence. Much of economics involves building theoretical models and testing them against evidence, and hypothesis testing is vital to that scientific approach. For example, you could test the hypothesis that the product in Equation 1.1 is what economists call a normal good (one for which the quantity demanded increases when disposable income increases). You could do this by applying various statistical tests to the estimated coefficient (0.24) of disposable income ( $Y_d$ ) in Equation 1.2. At first glance, the evidence would seem to support this hypothesis because the coefficient's sign is positive, but the "statistical significance" of that estimate would have to be investigated before such a conclusion could be justified. Even though the estimated coefficient is positive, as expected, it may not be sufficiently different from zero to convince us that the true coefficient is indeed positive instead of zero.

The third and most difficult use of econometrics is to **forecast** or predict what is likely to happen next quarter, next year, or further into the future, based on what has happened in the past. For example, economists use econometric models to make forecasts of variables like sales, profits, Gross Domestic Product (GDP), and the inflation rate. The accuracy of such forecasts depends in large measure on the degree to which the past is a good guide to the future. Business leaders and politicians tend to be especially interested in this use of econometrics because they need to make decisions about the

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3. The results in Equation 1.2 are from a model of the demand for chicken that we will examine in more detail in Section 6.1.