Preface

In the twelve years since the third edition of this book was published, the computing power at the fingertips of econometricians has dramatically increased. Econometric theorists have also been substantially increasing the number of suggested estimation, testing, and diagnostic procedures, most of which were quickly made available in econometric software packages. Faced with this cornucopia, the applied econometrician, whose task is the analysis of real-life data, often suffers from "intellectual indigestion" and finds it difficult to make informed and sensible judgments about which procedures to implement.

In writing this new edition we have had two major objectives. The first is to provide a comprehensive and accessible account of available econometric methods. The second is to illustrate these methods with applications to some real data sets, which are given on the data diskette that accompanies the book; thus, the reader can replicate the applications in the text, experiment with some of the problems suggested at the chapter ends, and carry out further analyses of her own choosing. These objectives have dictated an almost total rewriting of the book and the addition of substantial treatments of new topics that have not appeared in previous editions.

As with earlier editions, it is assumed that the reader has an understanding of the basic concepts of statistical inference. However, Appendix B, on statistics, gives a review of the major topics, and the detailed treatment of inference procedures in the earlier chapters should help with statistical recall. Again, matrix algebra is used extensively in the text. Appendix A, on matrix algebra, provides a comprehensive treatment, where the development matches as far as possible the order in which the various matrix concepts are used in the main text. Thus, a reader new to matrix algebra can switch between the text and Appendix A as the topics require.

Recent econometric developments surveyed in this edition may be grouped into six major areas:

- Asymptotics
- Time series
- Model evaluation
- Generalized method of moments
- Computationally intensive methods
- Microeconometrics
- Asymptotics

Realistic model specifications often do not permit the development of exact, finite-sample results. It is, however, frequently possible to derive results that hold asymptotically. The maximum likelihood principle is used extensively in recent work, and the classical likelihood ratio, Wald, and Lagrange multiplier tests are frequently applied. An introduction to asymptotic results and to the maximum likelihood principle is given in Chapterthe context of the two-variable model, where the regressor is the lagged value of the dependent variable. The student is thus introduced to these basic concepts at an early stage. Chapter 5 gives an extended treatment of maximum likelihood and the trinity of classical tests. Chapter 6, on heteroscedasticity and autocorrelation, describes many applications of these tests.

Time Series

Analysis of univariate time series continues to be an important topic, but the major new development in this field is the investigation of nonstationary series and the impact of nonstationarity on estimation procedures. Thus, one needs to test for stationarity, and a large literature has developed around unit root tests. When a regression is run containing two or more nonstationary series, there is the possibility that some linear combination of these series has stationary residuals, in which case the series are said to be cointegrated. Tests for the possible existence of cointegration are thus important, and estimation procedures for a given data set depend on the number of cointegrating relations found. The contrast between stationary and nonstationary series is introduced in Chapter the context of the two-variable model, where the regressor is the lagged value of the dependent variable. This is developed fully in Chapter 7, which is devoted to the analysis of univariate time series. This chapter closes with an empirical application to monthly data on U.S. housing starts. Chapter 8 contains an extensive discussion of cointegration tests and estimation procedures. These are illustrated in an empirical study of gasoline demand.

Model Evaluation

There has been intense debate on model evaluation and diagnostic procedures. The debate continues and there is, as yet, little consensus. However, it does seem that more applied researchers are conducting various evaluation tests. A basic principle of this approach is to divide sample data into two subsets: one to be used for estimating some specified model and the other to be used for evaluating the results of the estimation. Chapter 4 illustrates the application of many of these tests to a least-squares, linear regression model. Chapter 8 contains a detailed account of the use of diagnostic tests in the development of a model of the demand for gasoline.

Generalized Method of Moments (GMM)

Led initially by developments in macroeconomics, in particular "Euler equation approaches," GMM has become an increasingly important topic and has been given its own separate chapter (Chapter 10). As work in this area has developed, it has become apparent that GMM also provides a pedagogically useful way to look at old questions. In particular, the role of the "orthogonality condition" is highlighted as an organizing framework for looking at some old problems (OLS, 2SLS, Hausman tests, and even classical experimental design.)

Computationally Intensive Methods

One consequence of the "computer revolution" is the increased use of methods that, not too many years earlier, were computationally prohibitive. In Chapter 11, we review several of these methods: Monte Carlo methods, the bootstrap, permutation tests, and nonparametric estimation methods. As several of these techniques have merited separate treatises, it is impossible to cover the topics comprehensively. Instead the chapter aims at a more modest goal: to introduce the student to several of these developments and to provide an understanding of some basic principles and their potential range of application. Toward that end, several simple examples are presented in the text in some detail in the hope that the student can begin to use some of these techniques even in more realistic and complex situations.

Microeconometrics

Perhaps nowhere else has the increased sophistication of statistical software made a greater mark on econometric practice than in microeconometric applications. Chapter 12, on panel data, introduces the student to the simplest models-the fixed effect and random effect models-that are routinely applied to the ever-increasing number of panel data sets available. We also attempt to provide the student with practical advice about the advantages and disadvantages of these techniques. In Chapter 13 we review limited dependent variable models. Our review is selective: The literature is so vast, and the techniques available to researchers in statistical programs so numerous, that the temptation to provide a "cookbook" rendition of these topics is very strong. We have resisted the temptation as far as possible. This has meant the omission of some important topics-to name just two, hazard models and models with multiple choices (except the ordered probit). On the other hand, we go through the probit and logit models in some detail using an empirical illustration with the data diskette. As some software packages routinely calculate "Huber" standard errors for the probit and logit, it was felt some discussion of heteroscedasticity in these models and quasi-maximum likelihood was necessary. A discussion of heteroscedasticity in the Tobit led us to include two recent techniques for the censored regression model: "symmetrically trimmed least squares" and "least absolute deviations." The chapter concludes with a brief discussion of the ubiquitous "Heckman correction" and related issues.

Acknowledgments

Many helpful suggestions came from colleagues at the University of California, Irvine, especially Jae-Woo Lee, David Lilien, and Janey Morrison. A special debt is owed to Hiroyuki Kawakatsu, who read the complete manuscript, posed many penetrating and insightful questions, checked all empirical examples, and wrote the Solutions Manual. David Lilien kindly provided the software (MicroTSP and EViews) that has been used extensively in the preparation of the empirical illustrations in the book. Thanks also go to DRI/McGraw-Hill for permission to reproduce from the data set, DRI Basic Economics, many of the series on the data diskette. We are also very indebted to Ian Domowitz, Kiseok Lee, and Timothy Vogelsang, who read the entire manuscript and contributed many valuable suggestions.

DiNardo, in particular, would like to thank Julie Berry Cullen, Kristin Butcher, Kenneth Chay, Angus Deaton, Whitney Newey, Jack Porter, his MIT students, and the Econometrics Lunch at MIT for helpful instruction. In addition his warmest thanks go to Cheng Hsiao, Dean Hyslop, Jörn-Steffen Pischke, Gary Solon, Robert Valletta, and Jean Wohlever for extensive comments on earlier drafts of Chapters 10-13, which improved the exposition immensely. He also thanks Dave Card and the Industrial Relations Section at Princeton University, Michael Grossman and the National Bureau of Economic Research in New York, and the Department of Economics at MIT for their hospitality during the completion of the book.