Mathematics for Econometrics

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Fourth Edition

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Preface

The fourth edition differs significantly from the third edition, in that it has undergone considerable expansion and revision.

The major expansion involves a more complete coverage of basic aspects of mathematics that have continued to play an increasingly significant role in the literature of econometrics. Thus, the chapter on difference equations has been expanded to include enhanced treatment of lag operators (backward shift operators in the statistical literature) that are important not only in the context of the dynamic simultaneous equation GLSEM (general linear structural econometric model), but also time series analysis.

In addition, a chapter on the basic mathematics underlying the analytics of probability theory has been added, as well as a chapter on laws of large numbers and central limit theorems that form the probabilistic basis of classical econometrics. Moreover, there is an informative but not exhaustive discussion of stationary time series analysis, including discussions of the taxonomy of time series, issues of causality and invertibility, with a limited treatment of certain non-linearities such as those found in the popular ARCH (autoregressive conditional heteroskedasticity) model, which together with its many variants has found extensive applications in the literature of financial econometrics. However, there is no discussion of non-stationary time series, which is the subject of the author's *Time Series Unit Roots and Cointegration*, Academic Press, 1998.

Finally, this edition contains two fairly extensive chapters on applications to the GLM (general linear model), GLSEM and time series analysis which treat issues relevant to their underlying theoretical bases, estimation and forecasting.

New York, USA — Phoebus J. Dhrymes

Preface to the Third Edition

The third edition differs from the second edition in several respects. The coverage of matrix algebra has been expanded. For example, the topic of inverting partitioned matrices in this edition deals explicitly with a problem that arises in estimation under (linear) constraints. Often this problem forces us to deal with a block portioned matrix whose (1,1) and (2,2) blocks are singular matrices. The standard method for inverting such matrices fails; unless the problem is resolved, explicit representation of estimators and associated Lagrange multipliers is not available. An important application is in estimating the parameters of the general linear structural econometric model, when the identifying restrictions are imposed by means of Lagrange multipliers. This formulation permits a near effortless test of the validity of such (overidentifying) restrictions.

This edition also contains a treatment of the vector representation of restricted matrices such as symmetric, triangular, diagonal and the like. The representation is in terms of restricted linear subspaces. Another new feature is the treatment of permutation matrices and the vec operator, leading to an explicit representation of the relationship between $A \otimes B$ and $B \otimes A$.

In addition, it contains three new chapters, one on asymptotic expansions and two on applications of the material covered in this volume to the general linear model and the general linear structural econometric model, respectively. The salient features of the estimation problems in these two topics are discussed rigorously and succinctly.

This version should be useful to students and professionals alike as a ready reference to mathematical tools and results of general applicability

in econometrics. The two applications chapters should also prove useful to noneconomist professionals who are interested in gaining some understanding of certain topics in econometrics.

New York, USA Phoebus J. Dhrymes

Preface to the Second Edition

The reception of this booklet has encouraged me to prepare a second edition.

The present version is essentially the original, but adds a number of very useful results in terms of inverses and other features of partitioned matrices, a discussion of the singular value decomposition for rectangular matrices, issues of stability for the general linear structural econometric model, and similar topics.

I would like to take this opportunity to express my thanks to many of my students and others for pointing out misprints and incongruities in the first edition.

New York, USA — Phoebus J. Dhrymes

Preface to the First Edition

This book began as an Appendix to *Introductory Econometrics*. As it progressed, requirements of consistency and completeness of coverage seemed to make it inordinately long to serve merely as an Appendix, and thus it appears as a work in its own right.

Its purpose is not to give rigorous instruction in mathematics. Rather it aims at filling the gaps in the typical student's or professional's mathematical training, to the extent relevant for the study of econometrics.

Thus, it contains a collection of mathematical results employed at various stage of *Introductory Econometrics*. More generally, however, it could serve as a useful adjunct and reference to students of econometrics, no matter what text is being employed.

In the vast majority of cases, proofs are provided and there is a modicum of verbal discussion of certain mathematical results, the objective being to reinforce the student's understanding of the formalities. In certain instances, however, when proofs are too cumbersome, or complex, or when they are too obvious, they are omitted.

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