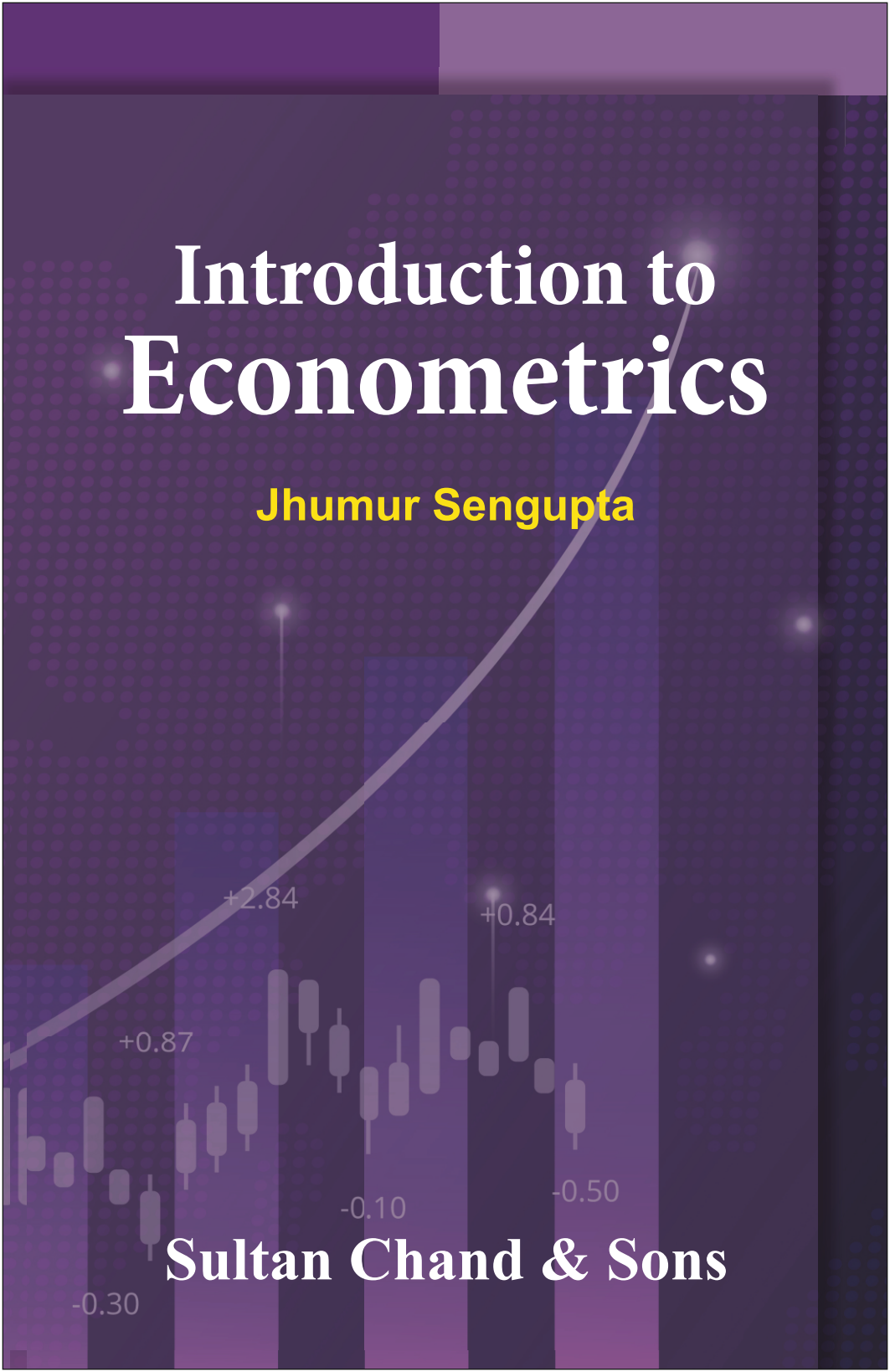
Introduction to Econometrics

Jhumur Sengupta



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Introduction to Econometrics

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Preface

This book is designed for Undergraduate students studying Economics Honours and follows the updated syllabus outlined in the National Education Policy (NEP) 2020 and the Choice Based Credit System (CBCS) syllabus. Econometrics under the CBCS syllabus is divided into two parts– Introductory Econometrics as a core course and Applied Econometrics as a discipline-specific elective. This book covers the syllabus of Introductory Econometrics.

The objective of writing the book is to introduce to the students the basic theory of Econometrics including linear regression, estimation, and data problems. The prerequisites for the course include statistics, calculus, and basic mathematical procedures. Chapter 1 deals with the basic ideas of econometrics, and its application in various fields. Chapter 2 explains the techniques of doing estimation of simple linear regression analysis and three variable multiple linear regression models. Chapter 3 discusses the properties of the regression estimators and dummy variable regression. Chapter 4 deals with hypothesis testing in regression analysis and analysis of variance. Chapter 5 explains the three data problems-multicollinearity, heteroscedasticity, and autocorrelation, and proposes remedial measures for the various types of data problems. Chapter 6 is about the issue of the specification of models. It deals with the problems related to the mis-specifications of regression models and statistical tests to detect the incorrect model specification.

The book is written in a simple manner. Complicated exposition of techniques sometimes makes the study of econometrics tortuous

for students. Therefore, calculations and derivations used in this book have been kept as simple as possible. *Basic Econometrics* by Damodar N. Gujarati, *Introduction to Econometrics* by G.S. Maddala, and *Econometric Analysis* by William H. Greene have been consulted to write this book.

In studying Econometrics, students should keep in mind that knowledge of tools and techniques used in econometrics is necessary as it has extensive applications in empirical research. Today, industries and financial firms need data analysts and econometricians for running their businesses. Besides its wide range of applications in academic research, knowledge of econometrics increases job opportunities to a great extent.

I express my gratitude to my parents, teachers, friends, and colleagues who have encouraged me to write this book.

Dr. Jhumur Sengupta

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Theoretical & Applied Econometrics 1

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Syllabus

UNIVERSITY OF DELHI

Delhi School of Economics

B.A. (Hons.) Economics

Semester IV - 2022

I. Nature and scope of Econometrics

II. Simple Linear Regression Model: Two Variable Case

(*i*) Estimation of model by method of ordinary least squares

(*ii*) Properties of estimators

(*iii*) Goodness of fit

(*iv*) Testing of Hypotheses

(*v*) Scaling and units of measurement

(*vi*) Confidence intervals

(*vii*) Gauss Markov Theorem

(*viii*) Forecasting

III. Multiple Linear Regression Model

(*i*) Estimation of parameters

(*ii*) Properties of OLS estimators

(*iii*) Goodness of fit - R^2 and Adjusted R^2

(*iv*) Partial regression coefficients

(*v*) Testing Hypotheses: Individual and Joint

(*vi*) Functional Forms of Regression Models

(*vii*) Qualitative (dummy) independent variables

IV. Violations of Classical Assumptions: Consequences, Detection and Remedies

(*i*) Multicollinearity

(*ii*) Heteroscedasticity

(*iii*) Serial Correlation

V. Specification Analysis

(*i*) Omission of a relevant variable

(*ii*) Inclusion of irrelevant variable

(*iii*) Tests of specification

UNIVERSITY OF DELHI

Bachelor of Arts (Hons.) Economics
(Effective from A.Y. 2019-20)
Semester IV (Core Course)
Introductory Econometrics (HC43)

Course Objective

This course introduces students to the econometric methods used to conduct empirical analysis in Economics. The course is designed to provide the students with the basic quantitative techniques needed to undertake applied research projects. It also provides the base for more advanced optional courses in econometrics.

Course Learning Outcomes

Students will learn to estimate linear models using ordinary least squares and make inferences about population parameters. They will also understand the biases created through mis-specified models, such as those that occur when variables are omitted.

Unit 1

Nature and scope of econometrics

Unit 2

Simple linear regression model: Two variable case

Ordinary least squares estimation of a linear model; properties of estimators; goodness of fit; testing of hypotheses; scaling and

units of measurement; confidence intervals; the Gauss-Markov theorem; forecasting and prediction

Unit 3

Multiple linear regression model

Extension of the single explanatory variable case to a multivariate setting; introducing non-linearities through functions of explanatory variables

Unit 4

Violations of classical assumptions

Consequences, detection and remedies Multicollinearity; heteroscedasticity; serial correlation

Unit 5

Specification Analysis

Omission of a relevant variable; inclusion of irrelevant variable; specification tests

UNIVERSITY OF CALCUTTA

B.A. / B.Sc Economics (Honours)

Semester IV

1. **Nature and Scope of Econometrics**
   - 1.1 Distinction between Economic Model and Econometric model
   - 1.2 Concept of stochastic relation, Role of random disturbance in econometric model
   - 1.3 Types of data
   - 1.4 Application of Econometrics in different branches of social science
2. **Classical Linear Regression Model (Simple linear regression and multiple linear regression): Part 1**
   - 2.1 The classical assumptions (basic interpretation)
   - 2.2 Concepts of population regression function and sample regression function
   - 2.3 Estimation of model by method of ordinary least squares (Derivation in simple linear model (SLRM) and multiple linear model (MLRM) with two regressors only)

2.4 Simple correlation, partial correlation and multiple correlation (Definition, and interpretation in the context of SLRM and MLRM)

2.5 Limitations of SLRM and additional complications in MLRM

2.6 Economic interpretations of the estimated model

3. Classical Linear Regression Model (Simple linear regression and multiple linear regression): Part 2

3.1 Properties of the Least Squares Estimators (BLUE) in SLRM- Gauss-Markov theorem

3.2 Qualitative (dummy) independent variables – intercept dummy and slope dummy (only interpretation of the model)

3.3 Forecasting - Ex-post forecast and Ex-ante forecast, forecast error (only for two variable model)

4. Statistical inference in linear regression model

4.1 Use of standard normal, chi-square, *t*, and *F* statistics in linear regression model

4.2 Testing hypothesis

Single test (*t*-test and chi-square test)

Joint test (*F* test)

4.3 Goodness of fit (in terms of R^2, adjusted R^2 and *F* statistic), Analysis of Variance (ANOVA)

4.4 Statistical significance and economic importance

5. Violations of Classical Assumptions

5.1 Multicollinearity - Consequences, Detection (Variance Inflationary Factor (VIF)) and Remedies

5.2 Heteroscedasticity - Consequences, Detection (Lagrange Multiplier test) and Remedies

5.3 Autocorrelation - Consequences, Detection (Durbin-Watson test) and Remedies

6. Specification Analysis
6.1 Omission of a relevant variable
6.2 Inclusion of irrelevant variable
6.3 Tests of specification errors
6.4 Testing for linearity and normality assumptions

About the Book

The book is intended for the Core Course on "Introductory Econometrics" for Economics Honours students at the Undergraduate level according to the National Education Policy (NEP), 2020 and Choice Based Credit System syllabus. All the UGC-recognized Universities are the potential users of the book. In addition, the book covers a part of the UGC NET Syllabus. Students and researchers who want to learn basic Econometric theory will find the book very useful. The book addresses the basic theories of Econometrics in a clear and lucid manner.

Salient Features

- The book covers topics including regression models, parameter estimation techniques, properties of the estimators, statistical testing and model specification problems in detail.
- Elementary concepts of statistics have been provided in Chapter 1 of the book. For ease of understanding, chapters on advanced topics are covered in the later part of the book.
- Statistical and mathematical derivations are used in the book in a thorough manner for the students and researchers who do not have any exposure to the course Econometrics.
- Each chapter contains several examples and exercise problems illustrating the applications of econometric theories.
- Some of the examples and exercise problems have been taken from the UGC NET Examination, Examinations at several Universities and Competitive Examinations.
- Every effort has been made to explain the basic theories in a simple way for easy understanding of the subject.
- A discussion on Computer Packages STATA and R is given in the Appendix Section.

About the Author

Dr. Jhumur Sengupta is an Assistant Professor of Economics at Dinabandhu Andrews College, Calcutta, India. She has more than Eighteen years of teaching experience in the fields of Econometrics and Quantitative Economics. Her previous affiliations include Assistant Professor at the International School of Business, Calcutta; Jaypee Business School, Noida; South City College, Calcutta; and Kirorimal College under Delhi University. She got her Master's Degree and M.Phil Degree in Economics from Jawaharlal Nehru University, New Delhi. She completed her Ph.D. at the University of Calcutta. Her research area includes Mathematical Economics, Econometrics, Empirical Economics, and Political Economy. She has published several research papers based on empirical research in various peer-reviewed Journals of National and International repute. She has a passion for undertaking research in areas of Empirical and Quantitative Economics.

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