

# CONTENTS

## 1. NATURE, DEFINITION AND SCOPE OF ECONOMETRICS

Definition and scope of econometrics

Relationship between economic theory, mathematics and statistics

Economic theory

Mathematical economics

Economic statistics

Model building in econometrics

Models in econometrics

1. Variables:-

- a) Endogenous variables
- b) Exogenous variables
- c) Lagged endogenous variable
- d) Pre-determined variable

2. Equations:-

- a) Behavioural equation
- b) Identities (or) Definitional equations
- c) Technological equations
- d) Institutional equations

3. Data:-

- a) Time series
- b) Cross section data
- c) Pooled data
- d) Panel data
- e) Engineering data

4. Graphical technique.

Goals of Econometrics.

- a) Analysis
- b) Policy making
- c) Forecasting

Limitations of Econometric method

Types or Divisions of econometrics

Notes.

Exercises

## 2. METHODOLOGY OF ECONOMETRIC RESEARCH

Step 1: Statement of theory or hypothesis

Step 2: specification of the econometric model

- (a) Formulation of maintained hypothesis (mathematical model)
- (b) Specification of the econometric model
- (c) Sign and magnitude of parameters.
- (d) Mathematical form of the model.

Step 3: Estimation of the parameters of the model

- (a) Data and Estimation

Step 4: Evaluation of Estimates (or) Statistical Inference.

- (a) Economic (or) a priori criteria
- (b) Statistical criteria (First order tests)
- (c) Econometric criteria (Second order tests)

Step 5 : Forecasting or prediction and evaluation of the forecasting power of the model.

Step 6: Using the model for control or policy purposes

- (a) Policy evaluation

Desirable properties of an econometric model

- a. Simplicity
- b. Theoretical plausibility
- c. Explanatory ability
- d. Accuracy of the parameter estimates
- e. Forecasting ability

Notes

Exercises

## 3. THE SIMPLE LINEAR REGRESSION MODEL

The sample regression function

Simple linear regression

Sources of random disturbances  $-u$

Omission of variables from the functions

Unpredictable (or Random) behaviour of the human beings

Imperfect specification of the mathematical form of the model

Errors of Measurement

Basic assumption of the linear stochastic regression model

Notes

Exercises.

## 4. ORDINARY LEAST SQUARES ESTIMATORS

Derivation of normal equations and least squares estimators.

Derivation of  $b_1$  using deviation method.

Proof for deriving  $b_1$  and  $b_0$  using deviation method

Regression calculations in derivation form.

Empirical illustrations.

Notes.

Exercises.

## **5. STATISTICAL PROPERTIES OF THE LEAST SQUARES ESTIMATORS AND GOODNESS OF FIT**

Gauss-Markov theorem.

The statistical properties of the least square estimators

Linearity

Unbiasedness

Minimum variance properties of OLS Estimators.

The least squares estimators are the best linear unbiased estimators

BLUE.

Empirical estimation of the variance of  $u$

Goodness of fit ( $R^2$  – Coefficient of Determination)

Mathematical derivation of goodness of fit ( $R^2$ )

Relationship between regression and correlation

(i) Interpretation of  $r^2$

Significance of regression

Regression through origin (A function with zero Intercept)

Correlation Analysis

Several possible correlations between variables X and Y scatter diagram.

Deviations taken from arithmetic means of X and Y.

Properties of the correlation co-efficient.

Test of significance

Rank correlation co-efficient.

Measure of goodness of fit : The standard errors of regression estimators

Hypothesis testing about population parameter

Hypothesis testing.

Test criterion and types of errors.

Test statistic

Two tailed and one - tailed tests.

Standard error test of the least squares estimates.

The Z test of the least - squares estimates.

The Z ratio : Rule of thumb

i) The student's t - test of the null hypothesis.

Student's t - ratio - A rule of thumb

Confidence interval from the standard normal distribution.

Confidence interval from the student's t distribution.

Empirical illustrations.

Confidence interval.

Analysis of variance.

The student's t test

Confidence interval.

Notes

Exercises

## 6. MULTIPLE REGRESSION MODEL

Assumptions

Model with two explanatory variables

Statistical properties of the least squares estimates multiple

Linear regression model

Linearity

Unbiasedness

Sampling variance

A measure of goodness of fit - Multiple linear regression model

Adjusted co-efficient of multiple determination

Testing of significance of Individual regression co-efficients

Evaluating the model as a whole

Empirical illustrations.

Computations for K number of independent variables.

Extension of linear regression model to nonlinear relationships

Estimation of non-linear relationship

S - Shapes curves.

Nonlinear Models and Transformations

Simple quadratic relationship

Two - variable quadratic relationship

Fitting of power curve  $Y = b_0 X^{b_1}$

The multiplicative model  $Y = b_0 X_1^{b_1} X_2^{b_2}$

Fitting of exponential curves.

Fitting of reciprocal model.

Engel curves

Pareto's curve

Production function

Cobb-Douglas production function.

Empirical illustrations.

Selection of the type of curve to be fitted.

Growth curves.

Exercises.

Econometric computation : The OLS Regression calculations

Gauss -Dolittle method

## 7. MATRIX ALGEBRA

Definition of a matrix.

Vectors

Transpositions

Sub Matrix

Types of Matrices

Square matrix

Diagonal matrix

Scalar matrix

- Identity (or) unit matrix
- Symmetric matrix
- Triangular matrix
- Null (or) zero matrix
- Null vector
- Equal matrices
- Traces
- Orthogonal matrix
- Singular and non-singular matrices
- Idempotent matrix
- Conformable
- Matrix addition and multiplication
- Equality of matrices
- Addition of matrix
- Subtraction of matrices
- Scalar multiplication
- Matrix multiplication
- Properties of addition of matrices
- Properties of multiplication of matrices
- Transpose
- Partitioned matrices
- Determinants and inverses
- The value of a first order determinant
- The value of a second order determinant of a  $2 \times 2$  matrix
- Higher order determinants
- Co-factor
- Minor
- Finding the inverse of a square matrix.
- Properties of determinants
- Solutions of simultaneous equations
- Existence of solution
- System of linear equations
- Matrix representation
- Cramer's rule or determinant method
- Matrix differentiation
- Notes
- References

## **8. MATRIX APPROACH TO LINEAR REGRESSION ANALYSIS**

- Matrix vectors and linear regression model
- Normal equations for the two variable case
- Normal equations for three variable case
- The statistical properties of the model
  - Linearity
  - Unbiasedness
  - Sampling variances

BLUE properties of OLS Estimators  
Consistency

The derivations of an unbiased estimator of  $\sigma_u^2$

Co-efficient of determination ( $R^2$ )

Summary of the results

Matrix algebra and analysis of variance

ANOVA

Empirical illustrations

Significance tests and confidence intervals

Three variable case

Working with deviation form

Test of significance

Summary of results

## 9. REGRESSION ANALYSIS AND ANALYSIS OF VARIANCE (ANOVA)

The basic principle of ANOVA

Assumptions in Analysis of Variance

Uses of ANOVA

Technique of Analysis of Variance

ANOVA-Unequal samples.

Regression & Analysis of variance

Model with two explanatory variables.

Model with k – explanatory variables.

Testing the improvement of fit obtained from additional explanatory variables.

Relationship between the F-test & T-test.

CHOW test: comparing two regressions

CHOW test and Multiple Linear regression

Exercise

## 10. FORECASTING

Types of forecasting

Point forecast

Interval forecast

Conditional forecast

Unconditional forecast

Ex-post forecast

Ex-ante forecast

Point prediction

Interval prediction

Actual observation

Test of significance between actual and predicted value

Forecast error variance and matrix algebra in multiple regression model

Forecast error variance (simple regression)

Measures of the accuracy of forecast  
Theil's U-Statistic  
Exercise

## **11. DUMMY VARIABLE AND REGRESSION MODEL**

Dummy variable trap  
ANCOVA models  
Dummy variables and measuring the shift of the function over time  
Difference in intercept  
Difference in slope  
Difference in slope and intercept  
Change in the intercept  
Changes in slope  
Changes in both intercept and slope.  
Piecewise linear regression  
Qualitative variables with several category  
Detrending and deseasonalisation  
The Chow test and dummy variable technique  
Separate versus pooled regression approach  
Additive/multiplicative dummy variable approach  
Regression on dummy dependent variables  
Exercises

## **12. MULTICOLLINEARITY**

Multicollinearity  
Consequences of perfect multicollinearity  
Consequences of imperfect multicollinearity  
Detection of multicollinearity  
Auxiliary regressions  
Variance inflation factor  
Relationship between  $R^2_h$  and VIF  
Solution to the problem of multicollinearity  
Exercises

## **13. HETEROSCEDASTICITY**

Testing for heteroscedasticity  
1. Homoscedastic error term with respect to  $X_i$ .  
2. Heteroscedastic error term with respect to  $X_i$   
Spread of actual data and predicted regression line.  
Causes for heteroscedasticity.  
Consequences of heteroscedasticity.  
Tests for detecting heteroscedasticity.  
1. Spearman's rank correlation test.  
2. Park test  
3. Glejser test

4. Goldfeld - Quandt test
5. White test
6. Breusch - Pagan test

Remedies for heteroscedasticity  
Exercises.

#### **14. AUTOCORRELATION**

Pure serial correlation

Impure serial correlation

Serial correlation caused by an omitted variable

Serial correlation caused by incorrect functional form.

Visual inspection

Negative autocorrelation

Positive autocorrelation

Consequences of Autocorrelation (or) Serial correlation

Sources of Autocorrelation.

1. Omitted Explanatory variables.
2. Misspecification of the mathematical form of the model
3. Interpolation in the statistical observations.
4. Misspecification of the true random error.

Testing for autocorrelation.

1. A Non-parametric Test
2. Durbin - Watson test

Solutions for autocorrelation

A priori Information on  $\rho$

When  $\rho$  is not known – Two step feasible GLS procedure.

1. The Cochrane - Orcutt Iterative procedure.
2. Prais - Winsten procedure.

Methods of estimating  $\rho$

1. Estimated from the Residuals
2. Based on Durbin Watson - d - statistic.
3. Theil and Nagar Method.
4. Theil's method
5. Sargan's method
6. Durbin's two step method
7. Hildreth - Lu scanning procedure
8. Johnson's method

Statistical properties of equations with lagged dependent variables

Testing for serial correlation in models with lagged Dependent variables.

Breusch - Godfrey Test.

Exercises.

#### **15. DISTRIBUTED LAG AND DYNAMIC MODELS**

Finite lag distributions

Infinite lag distributions.



Koyck transformation

1. Geometric or KOYCK lag model
2. The adaptive expectation model
3. The partial adjustment model
4. Compound geometric lag model

Testing for autocorrelation in a model with a lagged dependent variable.

LM test

Estimation of models with lagged dependent variables

1. Model with no auto correlated disturbances.
2. Model with auto correlated disturbances.

Polynomial distributed lags.

Selection of the length of the finite lag.

Exercises.

## 16. SPECIFICATION ERROR

1. Omission of a relevant explanatory variable (s)
2. Inclusion of irrelevant variable (s)

Akaike's information criterion and Schwarz criterion

Functional form mis-specification

Ramsey's RESET test

Exercises

## 17. ERRORS IN VARIABLES

Assumptions about the measurement errorConsequences.

- A. Zero expectations.
- B. Constant variance
- C. Covariances.

1. Inverse least square
2. Wald's two group method
3. Bartlett's three group method
4. Weighted regression method
5. Durbin ranking method
6. Instrumental variable method.

Exercises.

## 18. SIMULTANEOUS - EQUATION MODELS

Endogenous and exogenous variables

Endogenous variables

Lagged endogenous variable

Exogenous variables

Predetermined variables.

Simultaneity

The structural form of the econometric model

Reduced - form equations.

Structural and reduced form equations

Exercises.

## 19. IDENTIFICATION AND SIMULTANEOUS EQUATION METHODS

Illustrations of the identification problem in econometrics.  
The order condition for identifiability  
The Rank condition for identifiability  
Simultaneous versus recursive equation system.  
Recursive models.  
The reduced form method (or) Indirect least squares (ILS)  
Methods of simultaneous equation models  
Dependent variable: Quantity supplied.  
Instrumental variable method.  
Estimation by Two-Stage Least Squares.  
2 SLS – Exactly identified.  
2 SLS – over identified.  
Testing for simultaneity and endogeneity  
    1. Simultaneity  
    2. Endogeneity  
Three stage least squares (3 SLS) : An efficient estimator  
Special case : Seemingly unrelated Equations.  
Estimation of SURE models by OLS  
Exercise

## 20. AN INTRODUCTION TO PANEL DATA MODELS

Types of Panel Data Analytic Models  
Estimation of the (One Way) Fixed Effects Model.  
Testing for Fixed Effects  
Estimation of Panel Data Regression Model : Random Effects  
Estimation:  
Testing FE vs. RE  
Breusch and Pagan LM-Test for the significance of random effects  
Dynamic Panel Data Model  
Heteroscedasticity.  
Random Coefficients Model

## MULTIPLE CHOICE QUESTIONS

## SELECT BIBLIOGRAPHY

## APPENDIX

**Table – A.1** – Standard normal (Z) table

**Table – A.2** – Student's t table

**Table – A.3** – Chi – Square table

**Table – A.4** – F distribution tables.

**Table – A.5 (Part I)** – The Durbin - Watson statistic 0.05 critical values for dL and dU.

**Table – A.5 (Part II)** – The Durbin - Watson statistic 0.05 critical values for dL and dU.

## INDEX

This document was created with Win2PDF available at <http://www.win2pdf.com>.  
The unregistered version of Win2PDF is for evaluation or non-commercial use only.  
This page will not be added after purchasing Win2PDF.