Chapter One

Introduction

1.1 Definition and scope of econometrics

The economic theories we learn in various economics courses suggest many relationships among economic variables. For instance, in microeconomics we learn demand and supply models in which the quantities demanded and supplied of a good depend on its price. In macroeconomics, we study 'investment function' to explain the amount of aggregate investment in the economy as the rate of interest changes; and 'consumption function' that relates aggregate consumption to the level of aggregate disposable income.

Each of such specifications involves a relationship among economic variables. As economists, we may be interested in questions such as: If one variable changes in a certain magnitude, by how much will another variable change? Also, given that we know the value of one variable; can we forecast or predict the corresponding value of another? The purpose of studying the relationships among economic variables and attempting to answer questions of the type raised here is to help us understood the real economic world we live in.

However, economic theories that postulate the relationships between economic variables have to be checked against data obtained from the real world. If empirical data verify the relationship proposed by economic theory, we accept the theory as valid. If the theory is incompatible with the observed behavior, we either reject the theory or in the light of the empirical evidence of the data, modify the theory. To provide a better understanding of economic relationships and a better guidance for economic policy making we also need to know the quantitative relationships between the different economic variables.

We obtain these quantitative measurements taken from the real world. *The field of knowledge which helps us to carry out such an evaluation of economic theories in empirical terms is econometrics.*

Dear students! Having said the background statement in our attempt for defining '*ECONOMETRICS*', we may now formally define what econometrics is.

WHAT IS ECONOMETRICS?

Literally interpreted, econometrics means "economic measurement", but the scope of econometrics is much broader as described by leading econometricians. Various econometricians used different ways of wordings to define econometrics. But if we distill the fundamental features/concepts of all the definitions, we may obtain the following definition.

"*Econometrics is the science which integrates economic theory, economic statistics, and mathematical economics to investigate the empirical support of the general schematic law established by economic theory. It is a special type of economic analysis and research in which the general economic theories, formulated in mathematical terms, is combined with empirical measurements of economic phenomena. Starting from the relationships of economic theory, we express them in mathematical terms so that they can be measured. We then use specific methods, called econometric methods in order to obtain numerical estimates of the coefficients of the economic relationships.*"

Measurement is an important aspect of econometrics. However, the scope of econometrics is much broader than measurement. As

D.Intriligator rightly stated the *"metric"* part of the word econometrics signifies *'measurement'*, and hence econometrics is basically concerned with measuring of economic relationships.

In short, econometrics may be considered as the integration of economics, mathematics, and statistics for the purpose of providing numerical values for the parameters of economic relationships and verifying economic theories.

1.2 Econometrics vs. mathematical economics

Mathematical economics states economic theory in terms of mathematical symbols. There is no essential difference between mathematical economics and economic theory. Both state the same relationships, but while economic theory use verbal exposition, mathematical symbols. Both express economic relationships in an exact or deterministic form. Neither mathematical economics nor economic theory allows for random elements which might affect the relationship and make it stochastic. Furthermore, they do not provide numerical values for the coefficients of economic relationships.

Econometrics differs from mathematical economics in that, although econometrics presupposes, the economic relationships to be expressed in mathematical forms, it does not assume exact or deterministic relationship. Econometrics assumes random relationships among economic variables. Econometric methods are designed to take into account random disturbances which relate deviations from exact behavioral patterns suggested by economic theory and mathematical economics. Furthermore, econometric methods provide numerical values of the coefficients of economic relationships.

1.3 Econometrics vs. statistics

Econometrics differs from both mathematical statistics and economic statistics. An economic statistician gathers empirical data, records them, tabulates them or charts them, and attempts to describe the pattern in their development over time and perhaps detect some relationship between various economic magnitudes. Economic statistics is mainly a descriptive aspect of economics. It does not provide explanations of the development of the various variables and it does not provide measurements the coefficients of economic relationships.

Mathematical (or inferential) statistics deals with the method of measurement which are developed on the basis of controlled experiments. But statistical methods of measurement are not appropriate for a number of economic relationships because for most economic relationships controlled or carefully planned experiments cannot be designed due to the fact that the nature of relationships among economic variables are stochastic or random. Yet the fundamental ideas of inferential statistics are applicable in econometrics, but they must be adapted to the problem economic life. Econometric methods are adjusted so that they may become appropriate for the measurement of economic relationships which are stochastic. The adjustment consists primarily in specifying the stochastic (random) elements that are supposed to operate in the real world and enter into the determination of the observed data.

1.4 Economic models vs. econometric models

i) Economic models:

Any economic theory is an observation from the real world. For one reason, the immense complexity of the real world economy makes it

impossible for us to understand all interrelationships at once. Another reason is that all the interrelationships are not equally important as such for the understanding of the economic phenomenon under study. The sensible procedure is therefore, to pick up the important factors and relationships relevant to our problem and to focus our attention on these alone. Such a deliberately simplified analytical framework is called on economic model. It is an organized set of relationships that describes the functioning of an economic entity under a set of simplifying assumptions. All economic reasoning is ultimately based on models. Economic models consist of the following three basic structural elements.

1. A set of variables
2. A list of fundamental relationships and
3. A number of strategic coefficients

ii) Econometric models:

The most important characteristic of economic relationships is that they contain a random element which is ignored by mathematical economic models which postulate exact relationships between economic variables.

Example: Economic theory postulates that the demand for a commodity depends on its price, on the prices of other related commodities, on consumers' income and on tastes. This is an exact relationship which can be written mathematically as:

$$Q=b_0+b_1P+b_2P_0+b_3Y+b_4t$$

The above demand equation is exact. However, many more factors may affect demand. In econometrics the influence of these 'other' factors is taken into account by the introduction into the economic

relationships of random variable. In our example, the demand function studied with the tools of econometrics would be of the stochastic form:

$$Q=b_0+b_1P+b_2P_0+b_3Y+b_4t+u$$

Where u stands for the random factors which affect the quantity demanded.

1.5 Methodology of econometrics

Econometric research is concerned with the measurement of the parameters of economic relationships and with the predication of the values of economic variables. The relationships of economic theory which can be measured with econometric techniques are relationships in which some variables are postulated as causes of the variation of other variables. Starting with the postulated theoretical relationships among economic variables, econometric research or inquiry generally proceeds along the following lines/stages.

1. Specification the model
2. Estimation of the model
3. Evaluation of the estimates
4. Evaluation of the forecasting power of the estimated model

1. Specification of the model

In this step the econometrician has to express the relationships between economic variables in mathematical form. This step involves the determination of three important tasks:

i) The dependent and independent (explanatory) variables which will be included in the model.

ii) The *a priori* theoretical expectations about the size and sign of the parameters of the function.

iii) The mathematical form of the model (number of equations, specific form of the equations, etc.)

Note: The specification of the econometric model will be based on economic theory and on any available information related to the phenomena under investigation. Thus, specification of the econometric model presupposes knowledge of economic theory and familiarity with the particular phenomenon being studied.

Specification of the model is the most important and the most difficult stage of any econometric research. It is often the weakest point of most econometric applications. In this stage there exists enormous degree of likelihood of committing errors or incorrectly specifying the model. Some of the common reasons for incorrect specification of the econometric models are:

1. The imperfections, looseness of statements in economic theories.
2. The limitation of our knowledge of the factors which are operative in any particular case.
3. The formidable obstacles presented by data requirements in the estimation of large models.

The most common errors of specification are:

a. Omissions of some important variables from the function.
b. The omissions of some equations (for example, in simultaneous equations model).
c. The mistaken mathematical form of the functions.

2. Estimation of the model

This is purely a technical stage which requires knowledge of the various econometric methods, their assumptions and the economic implications for the estimates of the parameters. This stage includes the following activities.

a. Gathering of the data on the variables included in the model.
b. Examination of the identification conditions of the function (especially for simultaneous equations models).
c. Examination of the aggregations problems involved in the variables of the function.
d. Examination of the degree of correlation between the explanatory variables (i.e. examination of the problem of multicollinearity).
e. Choice of appropriate economic techniques for estimation, i.e. to decide a specific econometric method to be applied in estimation; such as, OLS, MLM, Logit, and Probit.

3. Evaluation of the estimates

This stage consists of deciding whether the estimates of the parameters are *theoretically meaningful and statistically satisfactory*. This stage enables the econometrician to evaluate the results of calculations and determine the reliability of the results. For this purpose we use various criteria which may be classified into three groups:

i. *Economic a priori criteria*: These criteria are determined by economic theory and refer to the size and sign of the parameters of economic relationships.

ii. *Statistical criteria (first-order tests)*: These are determined by statistical theory and aim at the evaluation of the statistical reliability of the estimates of the parameters of the model. Correlation coefficient test, standard error test, t-test, F-test, and R^2-test are some of the most commonly used statistical tests.

iii. *Econometric criteria (second-order tests)*: These are set by the theory of econometrics and aim at the investigation of whether the assumptions of the econometric method employed are satisfied or not in any particular case. The econometric criteria serve as a second order test (as test of the statistical tests) i.e. they determine the reliability of the statistical criteria; they help us establish whether the estimates have the desirable properties of unbiasedness, consistency etc. Econometric criteria aim at the detection of the violation or validity of the assumptions of the various econometric techniques.

4) Evaluation of the forecasting power of the model:

Forecasting is one of the aims of econometric research. However, before using an estimated model for forecasting by some way or another the predictive power of the model. It is possible that the model may be economically meaningful and statistically and econometrically correct for the sample period for which the model has been estimated; yet it may not be suitable for forecasting due

to various factors (reasons). Therefore, this stage involves the investigation of the stability of the estimates and their sensitivity to changes in the size of the sample. Consequently, we must establish whether the estimated function performs adequately outside the sample of data. i.e. we must test an extra sample performance the model.

1.6 Desirable properties of an econometric model

An econometric model is a model whose parameters have been estimated with some appropriate econometric technique. The 'goodness' of an econometric model is judged customarily according to the following desirable properties.

1. *Theoretical plausibility*. The model should be compatible with the postulates of economic theory. It must describe adequately the economic phenomena to which it relates.
2. *Explanatory ability*. The model should be able to explain the observations of he actual world. It must be consistent with the observed behaviour of the economic variables whose relationship it determines.
3. *Accuracy of the estimates of the parameters*. The estimates of the coefficients should be accurate in the sense that they should approximate as best as possible the true parameters of he structural model. The estimates should if possible possess the desirable properties of unbiasedness, consistency and efficiency.
4. *Forecasting ability*. The model should produce satisfactory predictions of future values of he dependent (endogenous) variables.

5. *Simplicity*. The model should represent the economic relationships with maximum simplicity. The fewer the equations and the simpler their mathematical form, the better the model is considered, ceteris paribus (that is to say provided that the other desirable properties are not affected by the simplifications of the model).

1.7 **Goals of Econometrics**

Three main goals of Econometrics are identified:

i) *Analysis* i.e. testing economic theory

ii) *Policy making* i.e. Obtaining numerical estimates of the coefficients of economic relationships for policy simulations.

iii) *Forecasting* i.e. using the numerical estimates of the coefficients in order to forecast the future values of economic magnitudes.

Review questions

- How would you define econometrics?
- How does it differ from mathematical economics and statistics?
- Describe the main steps involved in any econometrics research.
- Differentiate between economic and econometric model.
- What are the goals of econometrics?