CHAPTER

12

Introduction to Statistical Methods and Econometrics

"Statistics is the grammar of science."

- Karl Pearson

Learning Objectives

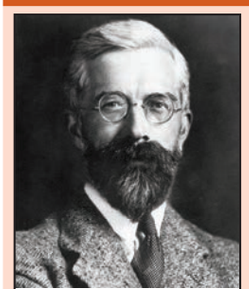
1. To describe some statistical techniques that may be useful to analyze economic issues.
2. To give a brief introduction to the subject of econometrics and its applications

12.1 Etymology and Milestones of Statistics in Global Level

The term statistics originated in the West and was known by various names, such as 'status' in Latin, 'statistik' in German, 'statisque' in French. It is said that Gottfried Achenwall used the word 'statistik' in 1749 to describe the political science of different countries. All these names in short mean to describe the political state.

The first book to have statistics as its title was 'Contributions to vital Statistics' by Francis GP Neison in 1845. It was to prepare a systematic study of birth and death related data.

Father of statistics



Ronald Fisher

The fundamental principles of statistics were developed by the biologist, Ronald fisher who lived in England during the last century. His studies in statistics led to the synthesis of evolution and modern genetics.

The monumental contribution to the subject of statistics can be attributed to R.A. Fisher (1890-1962) who was able to apply statistics to a variety of fields such as Biometry, Genetics, Psychology, Education, Agriculture and others.

Besides he is also known as the pioneer of estimation theory, analysis of variance, and design of experiments. Hence he is known as the father of Statistics.

12.2 Evolution of Statistics in India


Prof. P.C.Mahalanobis

Evidence from history proves that during the reign of Chandra Gupta Maurya, there existed a system of maintaining vital statistics, including registration of births and deaths. Such records can be found in Kautilya's Arthashastra even before 300B.C. The book "Ain-e-Akbari" (1596-97) mentions the statistical and administrative surveys conducted during Akbar's rule. P.C.Mahalanobis is known as the founder of modern statistics and also as father of Statistics in India. Since 2007 29th of June every year is celebrated as Statistics Day to commemorate his birth anniversary.

12.3 Definitions of Statistics

The term 'Statistics' is used in two senses: as singular and plural. In singular form it simply means statistical methods. Statistics when used in singular form helps in the collection, presentation, classification and interpretation of data to make it easily comprehensible. In its plural form it denotes collection of numerical figures and facts. In the narrow sense it has been defined as the science of counting and science of averages.

Definitions of Statistics

Statistics as a science of estimates and probabilities

- Boddington

Statistics may be defined as the collection, organisation, presentation, analysis and interpretation of numerical data

- Croxton & Cowden

12.4 Characteristics and Functions of Statistics

i) **Statistics are an aggregate of facts.** For example, numbers in a calendar pertaining to a year will not be called statistics, but to be included in statistics it should contain a series of figures with relationships for a prolonged period.

ii) **Statistics are numerically enumerated, estimated and expressed.**

iii) **Statistical collection should be systematic with a predetermined purpose:** The purpose of collection of statistics should be determined beforehand in order to get accurate information.

iv) **Should be capable of being used as a technique for drawing comparison:** It should be capable of drawing comparison between two different sets of data by tools such as averages, ratios, rates, coefficients etc.

Functions of Statistics

- Statistics presents facts in a definite form.
- It simplifies mass of figures.
- It facilitates comparison.
- It helps in formulating and testing.
- It helps in prediction.
- It helps in the formulation of suitable policies.

12.5 Nature of Statistics

Different Statisticians and Economists differ in views about the nature of statistics, some call it a science and some say it is an art.

Tipett on the other hand considers Statistics both as a science as well as an art.

12.6 Scope of Statistics

Statistics is applied in every sphere of human activity – social as well as physical – like Biology, Commerce, Education, Planning, Business Management, Information Technology, etc.

Statistics and Economics

Statistical data and techniques are immensely useful in solving many economic problems such as fluctuation in wages, prices, production, distribution of income and wealth and so on.

Statistics and Firms

Statistics is widely used in many firms to find whether the product is conforming to specifications or not.

Statistics and Commerce

Statistics are life blood of successful commerce. Market survey plays an important role to exhibit the present conditions and to forecast the likely changes in future.

Statistics and Education

Statistics is necessary for the formulation of policies to start new course, according to the changing environment. There are many educational institutions owned by public and private engaged in research and development work to test the past knowledge and evolve new knowledge. These are possible only through statistics.

Statistics and Planning:

Statistics is indispensable in planning. In the modern world, which can be termed as the "world of planning", almost all the organisations in the government are seeking the help of planning for efficient working, for the formulation of policy decisions and execution of the same. In order to achieve the above goals, various advanced statistical techniques are used for processing, analyzing and interpreting data. In India, statistics play an important role in planning, both at the central and state government levels, but the quality of data highly unscientific.

Statistics and Medicine

In Medical sciences, statistical tools are widely used. In order to test the efficiency of a new drug or to compare the efficiency of two drugs or two medicines, t - test for the two samples is used. More and more applications of statistics are at present used in clinical investigation.

Statistics and Modern applications

Recent developments in the fields of computer and information technology have enabled statistics to integrate their models and thus make statistics a part of decision making procedures of many organisations. There are many software packages available for solving simulation problems.

12.7 Limitations of statistics

Statistics with all its wide application in every sphere of human activity has its own limitations. Some of them are given below.

1. Statistics is not suitable to the study of qualitative phenomenon: Since statistics is basically a science and deals with a set of numerical data. It is applicable to the study of quantitative measurements. As a matter of fact, qualitative aspects like empowerment, leadership, honesty, poverty, intelligence etc., cannot be expressed numerically and statistical analysis cannot be directly applied on these qualitative phenomena.

2. Statistical laws are not exact: It is well known that mathematical and physical sciences are exact. But statistical laws are not exact and statistical laws are only approximations. Statistical conclusions are not universally true. They are true only on an average.

3. Statistics table may be misused: Statistics must be used only by experts; otherwise, statistical methods are the most dangerous tools on the hands of the inexpert. The use of statistical tools by the inexperienced and untrained persons might lead to wrong conclusions.

4. Statistics is only one of the methods of studying a problem: Statistical method does not provide complete solution of the problems because problems are to be studied taking the background of the countries culture, philosophy, religion etc., into consideration. Thus the statistical study should be supplemented by other evidences.

12.8 Types of Statistics

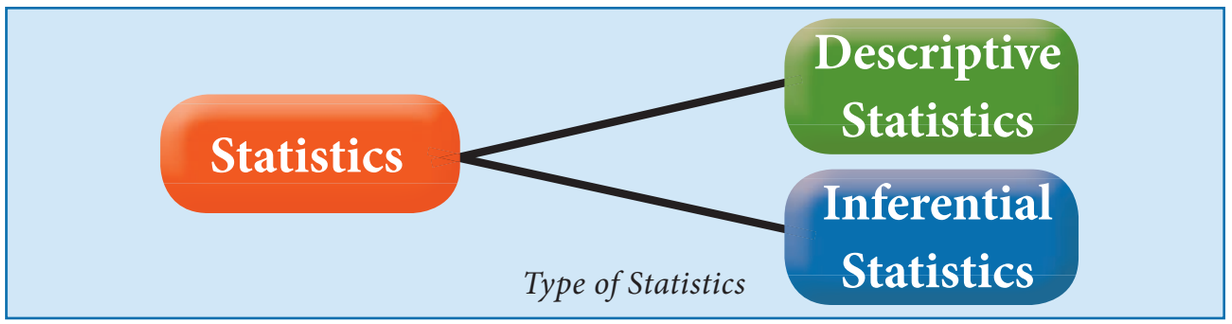
There are two major types of statistics named as Descriptive Statistics and Inferential Statistics.

Descriptive Statistics

The branch of statistics devoted to the summarization and description of data is called Descriptive Statistics

Inferential Statistics

The branch of statistics concerned with using sample data to make an inference about a population of data is called Inferential Statistics.



Type of Statistics

Major differences between Descriptive Statistics and Inferential Statistics

S.No	Descriptive statistics	Inferential statistics
1.	It describes the population under study.	It draws conclusion for the population based on the sample result.
2.	It presents the data in a meaningful way through charts, diagrams, graphs, other than describing in words.	It uses hypotheses, testing and predicting on the basis of the outcome.
3.	It gives the summary of data.	It tries to understand the population beyond the sample.

12.9 Data

Data is the information about facts or numbers collected to be examined and used to help with decisions. Data are the basic raw materials of statistics.

In statistics, data are classified into two broad categories: 1.Quantitative data and Qualitative data.

1. **Quantitative data** are those that can be quantified in definite units of measurement. These refer to characteristics whose successive measurements yield quantifiable observations. Eg. Age, income, number of firms etc

2. **Qualitative data** refer to qualitative characteristics of a subject or an object. A characteristic is qualitative in nature when its observations are defined and noted in terms of the presence or absence of a certain attribute in discrete numbers. These data are further classified as nominal and rank data. Eg. Gender, Community, honesty…

(i) Nominal data are the outcome of classification into two or more categories of items or units comprising a sample or a population according to some quality characteristic. Classification of students according to their sex (as males and females), Workers according to their skill (as skilled, semi-skilled, and unskilled), and of employees according to their level of education (as matriculates, undergraduates, and post-graduates).

(ii) Rank data, on the other hand, are the result of assigning ranks to specify

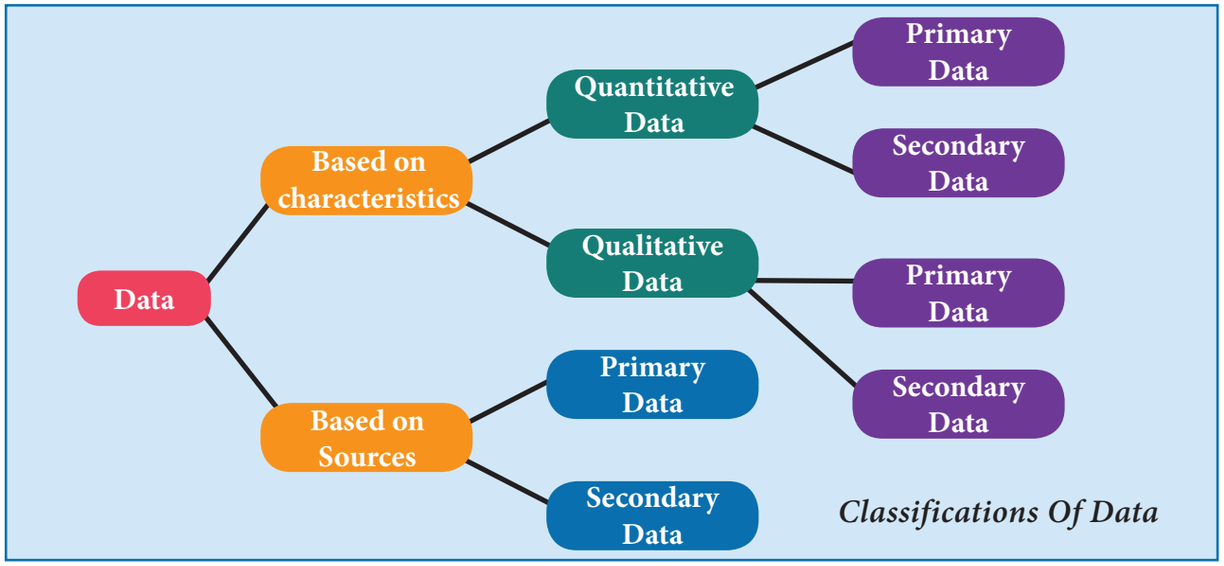
order in terms of the integers 1,2,3, ..., n. Ranks may be assigned according to the level of performance in a test, a contest, a competition, an interview, or a show. The candidates appearing in an interview, for example, may be assigned ranks in integers ranging from I to n, depending on their performance in the interview.

Sources of Collection of data

Based on the data sources, data could be seen as of two types, viz., secondary data and primary data. The two can be defined as under:

(i) Primary data: Those data which do not already exist in any form, and thus have to be collected for the first time from the primary source(s). By their very nature, these data are fresh and first-time collected covering the whole population or a sample drawn from it

(ii) Secondary data: They already exist in some form: published or unpublished in an identifiable secondary source. They are, generally, available from published source(s), though not necessarily in the form actually required. Eg. Data from CSO, NSSO, RBI….



Classifications Of Data

12.10 Arithmetic mean or mean ($\bar{X}$)

Central value is called a measure of central tendency or an average or a measure of locations. There are five averages. Among them mean, median and mode are called simple averages and the other two averages geometric mean and harmonic mean are called special averages.

Meaning of Average

- "A measure of central tendency is a typical value around which other figures congregate."
- "An average stands for the whole group of which it forms a part yet represents the whole."
- "One of the most widely used set of summary figures is known as measures of location."

The mean of a variable is defined as the sum of the observations divided by the number of observations. If the variable x assumes n values x_1, x_2 … x_n then the mean, , is given by summing of all x values divided by the number of x values.

$$\bar{X} = \frac{X_1+X_2+X_3+X_4+\cdots+X_n}{n} = \frac{1}{n}\sum_{i}^{n}{}_{=1}X_i,$$

This formula is for ungrouped or raw data.

Example 1: Calculate the mean for given data 2,4,6,8,10.

Direct Method $\bar{X} = \frac{\sum X}{n}$

Where $\sum X$ = Sum of values

N = No. of items

Solution:

$$\bar{X} = \frac{2+4+6+8+10}{5} = \frac{30}{5} = 6$$

Short- cut method:

The formula for finding mean,

$$\bar{X} = A + \frac{\sum d}{n}$$

Where A= the assumed mean or any value of X

d = deviations of each value from assumed mean.

Example 2: A student's marks in 5 subjects are 75,68,80,92,and 56. Find his average mark.

Solution:

X	d = X - A
75	7
68 → A	**0**
80	12
92	24
56	-12
Total	**31**

$$\bar{X} = A + \frac{\sum d}{n}$$

$$= 68 + \frac{31}{5}$$

$$= 68 + 6.2$$

$$= 74.2$$

12.11 Standard Deviation (σ)

The measures of central tendency serve to locate the center of the distribution, but they do not reveal how the items are spread out on either side of the center. This characteristic of a frequency distribution is commonly referred to as dispersion. The degree of variation is evaluated by various measures of dispersion. There are two kinds of measures of dispersion, namely

1. Absolute measure of dispersion
2. Relative measure of dispersion

Absolute measure of dispersion indicates the amount of variation in a set of values in terms of units of observations.

Relative measures of dispersion are free from the units of measurements of the observations. They are pure numbers. They are used to compare the variation in two or more sets, which are having different units of measurements of observations.

Standard Deviation is one of the methods of Absolute measure of dispersion. Karl Pearson introduced the concept of standard deviation in 1893. Standard deviation is also called Root-Mean Square Deviation. The reason is

that it is the square–root of the mean of the squared deviation from the arithmetic mean. It provides accurate result. Square of standard deviation is called Variance.

Definition:

It is defined as the positive square-root of the arithmetic mean of the square of the deviations of the given observation from their arithmetic mean.

The standard deviation of the population is denoted by the Greek letter **σ (sigma)** The standard deviation of sample is denoted as 's'.

Calculation of Standard deviation-Individual Series:

There are two methods of calculating Standard deviation in an individual series.

a) Deviations taken from Actual mean

b) Deviation taken from Assumed mean

$$\text{Standard Deviation} = \sqrt{\left(\frac{\sum(x-\bar{x})^2}{n}\right)}$$

Where, $\bar{x}$ = mean value of distribution

n = number of observations.

Steps:

1. Find out the actual mean of given data ($\bar{X}$)
2. Find out the deviation of each value from the mean ($x = X - \bar{X}$)
3. Square the deviations and take the total of squared deviations $\sum x^2$
4. Divided the total $\sum x^2$ by the number of observation $\left(\frac{\sum x^2}{n}\right)$
5. The square root of $\left(\frac{\sum x^2}{n}\right)$ is standard deviation.

$$\sigma = \sqrt{\left(\frac{\sum x^2}{n}\right)} \quad \text{or} \quad \sqrt{\left(\frac{\sum(x-\bar{x})^2}{n}\right)}$$

$$\frac{\sum x^2}{n} = \text{Variance} = \frac{\sum(x-\bar{x})^2}{n}$$

When the sample size is less than 30,

$$\text{variance} = \frac{\sum(x-\bar{x})^2}{n-1};$$

When n = number of observations.

Example 1: Calculate the standard deviation from the following data by **Actual Mean Method**: 25, 15, 23, 42, 27, 25, 23, 25, and 20.

Solution: Deviations from actual mean.

Sl. No	Values (X)	$X - \bar{X}$	$(X - \bar{X})^2$
1	25	25-25=0	0
2	15	15-25=10	100
3	23	23-25= -2	4
4	42	42-25=17	289
5	27	27-25=2	4
6	25	25-25=0	0
7	23	23-25=-2	4
8	25	25-25=0	0
9	20	20-25=-5	25
N=9	225	0	426

$$\bar{X} = \frac{225}{9} = 25$$

$$\sigma = \sqrt{\left(\frac{\sum(x-\bar{x})^2}{n}\right)} = \sqrt{\frac{426}{9}} = \sqrt{47.33}$$

σ = 6.88 Answer

Example 2: Calculate the standard deviation for the following data by assumed mean method: 43, 48, 65, 57, 31, 60, 37, 48, 78, 59

Solution: Deviation from assumed mean

Sl. No	(X)	d=X-A (A=57)	d^2
1	43	-14	196
2	48	-9	81
3	65	8	64
4	57	0	0
5	31	-26	676
6	60	3	9
7	37	-20	400
8	48	-9	81
9	78	21	441
10	59	2	4
N=10		$\Sigma d = -44$	$\Sigma d^2=1952$

$$\sigma = \sqrt{\frac{\Sigma d^2}{n} - \left(\frac{\Sigma d}{n}\right)^2} = \sqrt{\frac{1952}{10} - \left(\frac{-44}{10}\right)^2}$$

$$= \sqrt{195.2\text{-}19.36} = \sqrt{175.84} = 13.26,$$

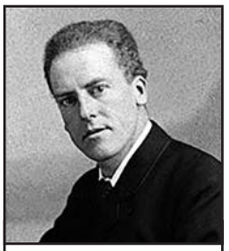
Answer = 13.26

12.12 Correlation (ϒ)

Introduction

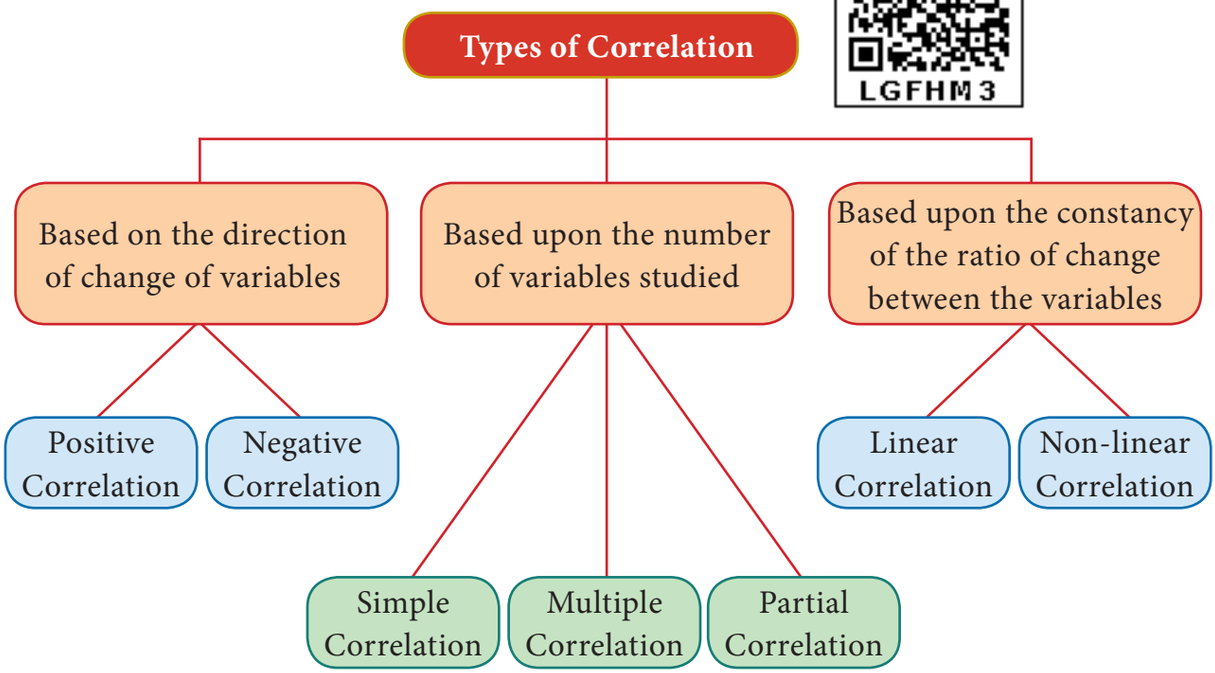
Correlation is a statistical device that helps to analyse the covariation of two or more variables. Sir Francis Galton, is responsible for the calculation of correlation coefficient.

Types of Correlation


Karl Pearson

Correlation is classified in several different ways. Three of the most important ways of classifying correlation are:

LGFHM3



Type I: Based on the direction of change of variables

Correlation is classified into two types as Positive correlation and Negative Correlation based on the direction of change of the variables.

Positive Correlation:

The correlation is said to be positive if the values of two variables move in the same direction.

Ex 1: If income and Expenditure of a Household may be increasing or decreasing simultaneously. If so, there is positive correlation. Ex. Y= a + bx

Negative Correlation:

The Correlation is said to be negative when the values of variables move in the opposite directions. Ex. Y= a – bx

Ex 1: Price and demand for a commodity move in the opposite direction.

Type II: Based upon the number of variables studied.

There are three types based upon the number of variables studied as

a) Simple Correlation
b) Multiple Correlation
c) Partial Correlation

Simple Correlation:

If only two variables are taken for study then it is said to be simple correlation.

Multiple Correlations:

If three or more than three variables are studied simultaneously, then it is termed as multiple correlation.

Ex: Determinants of Quantity demanded

$$Q_d = f(P, Pc, Ps, t, y)$$

Where Q_d stands for Quantity demanded, f stands for function.

P is the price of the goods,

P_c is the price of competitive goods

P_s is the price of substituting goods

t is the taste and preference

y is the income.

Partial Correlation:

If there are more than two variables but only two variables are considered keeping the other variables constant, then the correlation is said to be Partial Correlation

Type III: Based upon the constancy of the ratio of change between the variables

Correlation is divided into two types as linear correlation and Non-Linear correlation based upon the Constancy of the ratio of change between the variables.

Linear Correlation: Correlation is said to be linear when the amount of change in one variable tends to bear a constant ratio to the amount of change in the other.

Ex. Y= a + bx

Non Linear: The correlation would be non-linear if the amount of change in one variable does not bear a constant ratio to the amount of change in the other variables.

Ex. $Y = a + bx^2$

Methods of Studying Correlation:

The various methods of ascertaining whether two variables are correlated or not are:

1. Scatter diagram Method
2. Graphic Method
3. Karl Pearson's Co - efficient of correlation and
4. Method of Least Squares.

Of these, the first two are based on the knowledge of diagram and graphs, whereas the others are mathematical methods.

1. Scatter Diagram Method:

Scatter diagram is a graph of observed plotted points where each point represents the values of X and Y as a coordinate. It portrays the relationship between these two variables graphically.

Advantages of Scatter Diagram method

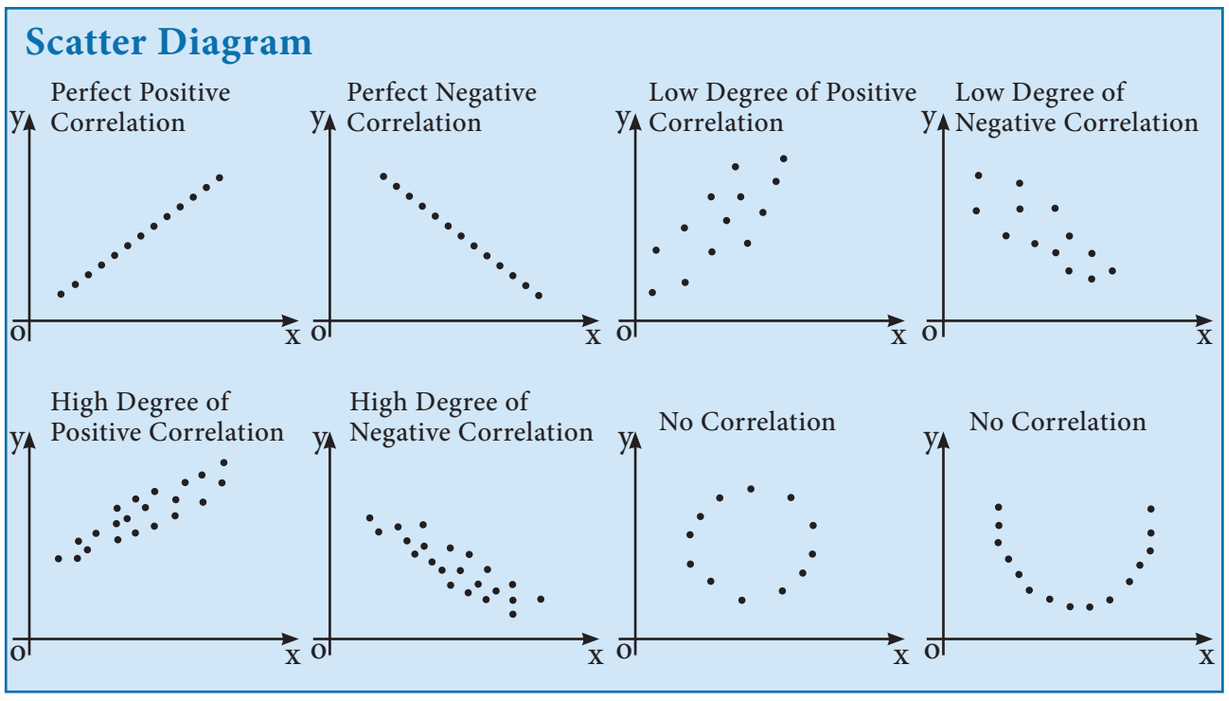
(1) It is very simple and non- mathematical method

(2) it is not influenced by the size of extreme item.

(3) It is the first step in resting the relationship between two variables.

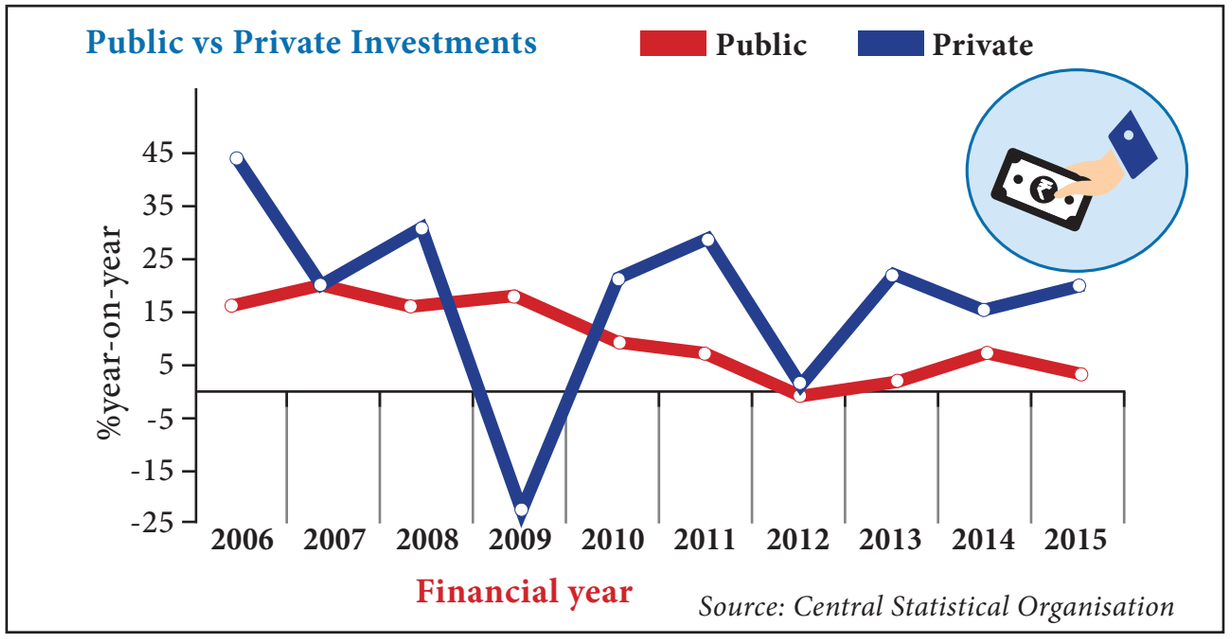
Disadvantages of Scatter diagram method

It cannot establish the exact degree of correlation between the variables, but provides direction of correlation and depicts it is high or low.



2. Graphic method

In this method, the individual values of two variables are plotted on the graph sheet and draw the curves of both the variables say x and y. If both X and Y are moving in the same direction either upward or downward, then the correlation is said to be positive. If the curves of X and Y move in the opposite direction; then the correlation is said to be negative.



Source: Central Statistical Organisation

3. Karl Pearson's Coefficient of Correlation

Karl Pearson's Method is popularly known as Pearson's coefficient of correlation denoted by the symbol 'r'. The coefficient of correlation 'r' measures the degree of linear relationship between two variables say X and Y. The Formula for computing Karl Pearson's Coefficient of correlation is:

1) $$r = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{N\Sigma X^2 - (\Sigma X)^2}\sqrt{N\Sigma Y^2 - (\Sigma Y)^2}}$$

'r' is calculated by **Direct Method** without taking deviation of terms either from actual mean or assumed mean.

2) r is calculated by taking the **Deviation from actual mean.**

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}$$ where $x = (x-\bar{x})$, $y = (y-\bar{y})$

3) 'r' is calculated by taking assumed mean

$$r = \frac{N\Sigma dxdy - (\Sigma dx)(\Sigma dy)}{\sqrt{N\Sigma dx^2 - (\Sigma dx)^2}\sqrt{N\Sigma dy^2 - (\Sigma dy)^2}}$$

Where dx refers to deviations of x series from assumed mean A (X-A), dy refers to deviations of y series from an assumed mean θ (Y-B)

$\Sigma dxdy$ = Sum of product of the deviations x and y series from their assumed means.

Σdx^2 = Sum of the squares of the deviations of x series from an assumed mean

Σdy^2 = Sum of the squares of the deviations of y series from an assumed mean

Σdx = sum of the deviation of x series from an assumed mean of x

Σdy = sum of the deviation of y series from an assumed mean of y

Procedure for Computing the Correlation Coefficient: (For Direct and Deviation from actual mean method).

- **Step-1** Calculate the mean of two series 'X' 'Y'
- **Step-2** Calculate the deviations 'X' and Y in two series from their respective mean.

❖ **Step-3** Square each deviations of 'X' and 'Y' then obtain the sum of the Squared deviation, That is and

❖ **Step-4** Multiply each deviation under X with each deviation under Y and obtain the product of 'xy'. Then obtain the sum of the product of X,Y. Then obtain the sum of the product of x,y is Σxy.

❖ **Step-5** Substitute the value in the formula.

Formula of Karl Pearson's Coefficient of Correlation - Ungrouped Data.

Direct Method	Indirect Method
Using the Variables as it is	Actual Mean deviation method

1 $$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \, \Sigma y^2}}$$

$$r = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{N\Sigma X^2 - (\Sigma X)^2}\sqrt{N\Sigma Y^2 - (\Sigma Y)^2}}$$

where $x = (x-\bar{x})$, $y = (y-\bar{y})$

2. Assumed Mean Deviation Method

$$r = \frac{N\Sigma dxdy - (\Sigma dx)(\Sigma dy)}{\sqrt{N\Sigma dx^2 - (\Sigma dx)^2}\sqrt{N\Sigma dy^2 - (\Sigma dy)^2}}$$

2. Indirect Method

$dx = (x-\bar{x})$ and $dy = (y-\bar{y})$

r is free from origin

r is free from unit of measurement $-1 \le r \le +1$

Direct Method:

Example 1: Calculate Karl Pearson's Coefficient of correlation from the following data and interpret its value:

Price :X	10	12	14	15	19
Supply:Y	40	41	48	60	50

Solution: Let us take Price as X and supply as Y

Computation of Pearson's Correlation Coefficient				
Price: X	Supply: Y	XY	X^2	Y^2
10	40	400	100	1600
12	41	492	144	1681
14	48	672	196	2304
15	60	900	225	3600
19	50	950	361	2500
$\Sigma x = 70$	$\Sigma y = 239$	$\Sigma xy = 3414$	$\Sigma x^2 = 1026$	$\Sigma y^2 = 11685$

$$r = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{N\Sigma X^2 - (\Sigma X)^2}\sqrt{N\Sigma Y^2 - (\Sigma Y)^2}} \qquad r = \frac{(5 \times 3414) - (70 \times 239)}{\sqrt{(5 \times 1026) - (70)^2}\sqrt{5x11685 - (239)^2}}$$

$$r = \frac{17,070 - 16,730}{\sqrt{230 \times 1304}} \qquad r = \frac{340}{547.65} = +0.621$$

Price of the product and supply for the product is positively correlated. When price of the product increases then the supply for the product also increases.

Actual Mean Method:

Ex-1: Estimate the coefficient of correlation with actualmean method for the following data.

Age of Cars in years	3	6	8	9	10	6
Cost of Annual Maintains (in 000 ₹)	1	7	4	6	8	4

Solution:

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \ \sum y^2}} \quad \text{where } x = x - \bar{x},\ y = y - \bar{y}$$

S.No	x	$x-\bar{x}$ x - 7=x	$(x-\bar{x})^2 = x^2$	Y	$y-\bar{y}$ Y −5=y	$(y-\bar{y})^2 = y^2$	xy
1	3	-4	16	1	-4	16	16
2	6	-1	1	7	2	4	-2
3	8	+1	1	4	-1	1	-1
4	9	2	4	6	1	1	2
5	10	3	9	8	3	9	9
6	6	-1	1	4	-1	1	+1
	$\bar{x}\ \frac{42}{6} = 7$	0	32	$\bar{y}\ \frac{42}{6} = 7$	0	32	25

$$\sum x^2 = 32 \qquad \sum y^2 = 32 \qquad \sum xy = 25$$

Applying in Formula

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \ \sum y^2}} = \frac{25}{\sqrt{32 \times 32}} = \frac{25}{32} = 0.781$$

r = 0.781, The Car is getting old in years the cost of maintenance is also increasing. The age of Car and its maintenance are positively correlated.

Assumed Mean Deviation Method

Ex 1: Find the Karl Pearson coefficient of Correlation between X and Y from the following data:

X:	10	12	13	16	17	20	25
Y:	19	22	26	27	29	33	37

Solution:

Formula for Assumed Mean Deviation method.

$$r = \frac{N\sum dxdy - (\sum dx)(\sum dy)}{\sqrt{N\sum dx^2 - (\sum dx)^2}\sqrt{N\sum dy^2 - (\sum dy)^2}}$$

S.No	X	Y	(X-A)=dx	(Y-A)=dy	dx2	dy2	Dxdy
1	10	19	-6	-8	36	64	48
2	12	22	-4	-5	16	25	20
3	13	26	-3	-1	9	1	3
4	16	27	0	0	0	0	0
5	17	29	1	2	1	4	2
6	20	33	4	6	16	36	24
7	25	37	9	10	81	100	90
N=7	ΣX=113	ΣY=193	Σ(X-A)=1	Σ(Y-A)=4	Σdx^2=159	Σdy^2=230	Σdxdy=187

$$\bar{x} = \frac{\Sigma X}{N} = \frac{113}{7} = 16\frac{1}{7}$$

$$\bar{y} = \frac{\Sigma Y}{N} = \frac{193}{7} = 27\frac{4}{7}$$

Take the assumed values A = 16 & B = 27 therefore dx = X – A $\Rightarrow$ X – 16 and

dy = Y- A $\Rightarrow$ Y – 27

$$\therefore r = \frac{N\sum dxdy - (\sum dx)(\sum dy)}{\sqrt{N\sum dx^2 - (\sum dx)^2}\sqrt{N\sum dy^2 - (\sum dy)^2}}$$

$$= \frac{7\times187 - 1\times4}{\sqrt{7\times159 - (1)^2}\sqrt{7\times230 - (4)^2}}$$

$$= \frac{1309 - 4}{\sqrt{1112}\sqrt{1610 - 16}}$$

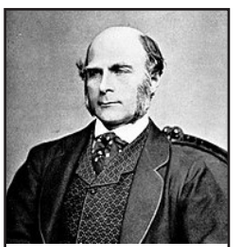
$$= \frac{1305}{\sqrt{1112}\sqrt{1594}} = \frac{1305}{(33.34)(39.92)}$$

$$= \frac{1305}{1330.9} = 0.9865 \qquad r = 0.986$$

There exists a positive high correlation between X and Y

12.13 Regression

Evolution of Regression


Francis Galton

The term 'Regression' was first coined and used in 1877 by Francis Galton while studying the relationship between the height of fathers and sons. The average height of children born of parents of a given height tended to move or "regress" toward the average height in the population as a whole. Galton's law of universal regression was confirmed by his friend Karl Pearson, who collected more than a thousand records of heights of members of family groups. The literal meaning of the word "regression" is **"Stepping back towards the average".**

Regression is the study of the relationship between the variables. If Y is the dependent variable and X is independent variable, the linear relationship between the variable is called the regression equation of Y on X, The

regression equation is used to estimate the value of Y corresponding to the known value of X. The line describing this tendency to regress or going back was called by Galton a "**Regression Line**".

Difference between Correlation and Regression

S.No	Correlation	Regression
1	Correlation is the relationship between two or more variables, which vary with the other in the same or the opposite direction	Regression means going back and it is a mathematical measure showing the average relationship between two variables
2	Both the variables X and Y are random variables	Both the variables may be random variables
3	It finds out the degree of relationship between two variables and not the cause and effect relationship.	It indicates the cause and effect relationship between the variables and establishes functional relationship.
4	It is used for testing and verifying the relation between two variables and gives limited information	Besides verification it is used for the prediction of one value, in relation to the other given value.
5	The coefficient of correlation is a relative measure. The range of relationship lies between –1 and +1	Regression coefficient is also relative measure. If we know the value of the independent variable, we can find the value of the dependent variable
6	There may be spurious correlation between two variables.	In regression there is no such spurious regression
7	It has limited application, because it is confined only to linear relationship between the variables	It has wider application, as it studies linear and nonlinear relationship between the variables
8	It is not very useful for further mathematical treatment.	It is widely used for further mathematical treatment

Two Regression lines

$$X \text{ on } Y \Rightarrow X = a + by$$

$$Y \text{ on } X \Rightarrow Y = a + bx$$

Regression line is the line which gives the best estimate of one variable from the value of any other given variable. The line gives the average relationship between the two variables in mathematical form. The line of regression is the line which gives the best estimate to the value of one variable for any specific value of the other variable.

To fit Regression equations X on Y and Y on X the following examples are given

Ex 1: Fit two regression equation

X on Y and Y on X for the following data.

$\bar{X}$=12, $\bar{Y}$=10, σy= 0.2, σx =0.1 and r = 0.85

Solution

The equation of the regression line of X on Y is

$$(X-\bar{X}) = r \times \frac{\sigma x}{\sigma y} \times (Y-\bar{Y})$$

Given $\bar{X} = 12$, $\bar{Y} = 10$

$r = 0.85$, $\sigma x = 0.1$ and $\sigma y = 0.2$

Then substituting the values in formula

$$(X-12) = 0.85 \times (0.1/0.2) \times (Y-10)$$
$$(X-12) = 0.85 \times (0.5) \times (Y-10)$$
$$X = 0.425 \times (Y-10) + 12$$
$$X = 0.425Y - 4.25 + 12$$
$$X = 0.425Y + 7.75$$

X on Y

Answer X = 0.425Y + 7.75

The equation of the regression line of Y on X is

$$(Y-\bar{Y}) = r \times \frac{\sigma y}{\sigma x} \times (X-\bar{X})$$

Given $\bar{X} = 12$, $\bar{Y} = 10$

$r = 0.85$, $\sigma x = 0.1$ and $\sigma y = 0.2$

Then substituting the values in formula

$$(Y-10) = 0.85 \times (0.2/0.1) \times (X-12)$$
$$(Y-10) = 0.85 \times (2) \times (X-12)$$
$$Y = 1.7 \times (X-12) + 10$$
$$Y = 1.7X - 20.4 + 10$$
$$Y = 1.7X - 10.4$$

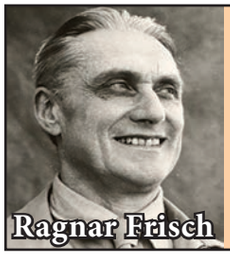
Y on X

Answer Y = 1.7X–10.4

12.14 Introduction To Econometrics

Origin Of Econometrics

Economists tried to support their ideas with facts and figures in ancient times. Irving Fisher is the first person, developed mathematical equation in the quantity theory of money with help of data. Ragnar Frisch, a Norwegian economist and statistician named the integration of three subjects such that mathematics, statistical methods and economics as Econometrics" in 1926.



Ragnar Anton Kittil Frisch Noble Memorial Prize in 1969

The term econometrics is formed from two words of Greek origin, 'oukovouia' meaning economy and 'uetpov' meaning measure. Econometrics emerged as an independent discipline studying economic phenomena.

Econometrics may be considered as the integration of economics, Statistics and Mathematics.

Econometrics is an amalgamation of three subjects which can be easily understood by following Venn diagram and picture representation.

Economics + Mathematics= Mathematical Economics

Mathematical Economics+ Statistical Data & Its Technique = Econometrics

{Economics + Statistics + Mathematics}+Empirical Data = Econometrics

Definitions

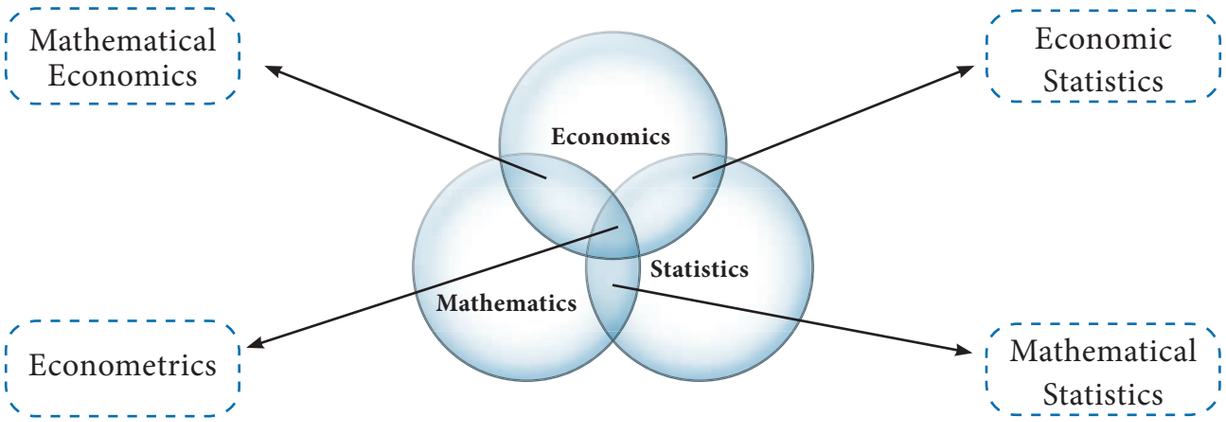
In the words of **Arthur S. Goldberger,** "Econometrics may be defined as the social science in which the tools of economic theory, mathematics and statistical inference are applied to the analysis of economic phenomena".

Gerhard Tinbergen points out that "Econometrics, as a result of certain outlook on the role of economics, consists of application of mathematical statistics to economic data to lend empirical support to the models constructed by mathematical economics and to obtain numerical results".

H Theil"Econometrics is concerned with the empirical determination of economic laws"

In the words of **Ragnar Frisch** "The mutual penetration of quantitative econometric theory and statistical observation is the essence of econometrics".

Econometrics means economic measurement. Econometrics deals with the measurement of economic relationships.



Objectives Of Econometrics

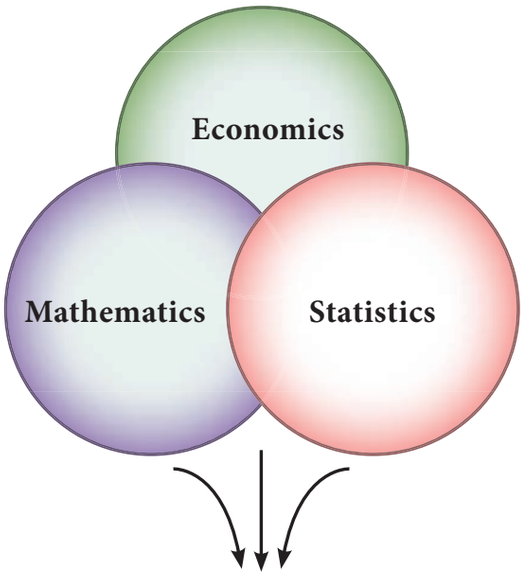
The general objective of Econometrics is to give empirical content to economic theory. The specific objectives are as follows:

1. It helps to explain the behaviour of a forthcoming period that is forecasting economic phenomena.

2. It helps to prove the old and established relationships among the variables or between the variables

3. It helps to establish new theories and new relationships.

4. It helps to test the hypotheses and estimation of the parameter.



Amalgamation of above Three Subjects is Econometrics

Methodology Of Econometrics

Broadly speaking, traditional or classical econometric methodology consists of the following steps.

1) Statement of the theory or hypothesis
2) Specification of the mathematical model of the theory
3) Specification of the econometric model of the theory
4) Obtaining the data
5) Estimation of the parameters of the econometric model
6) Hypothesis testing
7) Forecasting or prediction
8) Using the model for control or policy purposes.

Flow Chart of Anatomy / Methodology of Econometrics

Anatomy of Econometric Modeling

Economic theory

Mathematical model of the theory

Economic model of the theory

Data

Estimation of econometric model

Hypothesis Testing

Forecasting or prediction

Using the model for control or policy purpose

Difference between the Econometric model with Mathematical models and statistical models

1. Models in Mathematical Economics are developed based on Economic Theories, while, Econometric Models are developed based on Economic Theories to test the validity of Economic Theories in reality through the actual data.
2. Regression Analysis in Statistics does not concentrate more on error term while Econometric Models concentrate more on error terms

Statistics Regression:

$$Yi = \beta_0 + \beta_1 X_i$$

Econometrics Regression:

$$Yi = \beta_0 + \beta_1 X_i + U_i$$

(with more than 2 variables) or

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + U_i$$

Systematic Part: $\beta_0 + \beta_1 Xi$ or explained part and Random Part: U_i unexplained part in a regression. U_i represents the role of omitted variables in specifying a regression relationship of Y on X. Hence, the U_i cannot and should not be ignored.

Assumptions of the Linear Regression Model

The Linear regression model is based on certain assumptions

1. Some of them refer to the distribution of the random variable .
2. Some of them refer to the relationship between U_i and the explanatory variables (x_1, x_2, x_3 given in the above example).
3. Some of them refer to the relationship between U_i the explanatory variables themselves.

Assumptions about the distribution of the values of are called stochastic assumptions of ordinary least squares (OLS). Assumptions relating to the relationship between U_i and explanatory variables and relating to the relationship among the explanatory variables are called other assumptions.

Assumptions

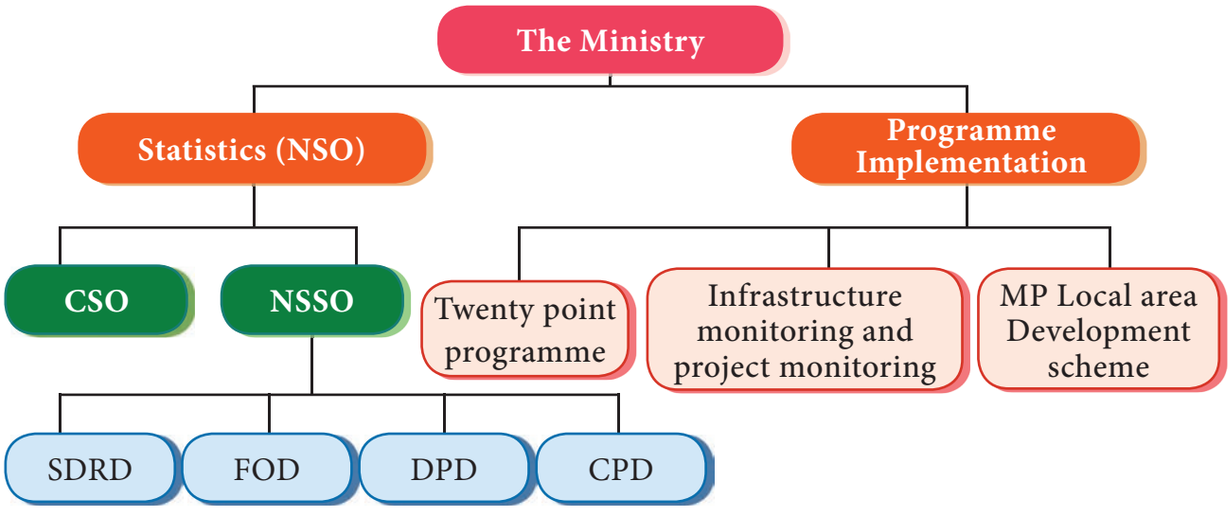
1. "U" is a random real variable. That is "U" may assume positive, negative or zero values. Hence the mean of the "U" will be zero.
2. The variance of "U" is constant for all values of "U"
3. The "U" has a normal distribution.
4. The Covariances of any U_i with any other U_j are equal to zero
5. "U" is independent of explanatory variable (s)
6. Explanatory variables are measured without error.
7. The explanatory variables are not perfectly linearly correlated.
8. The variables are correctly aggregated.
9. The relationship is correctly identified and specified.
10. Parameters are linear.

12.15 Official Statistics

Official Statistics are statistics published by government agencies or other public bodies such as international organizations. They provide quantitative or qualitative information on all major areas of citizens' lives. Official Statistics make information on economic and social development accessible to the public, allowing the impact of government policies to be assessed, thus improving accountability.

The Ministry of Statistics and Programme Implementation (MOSPI) came into existence as an Independent Ministry in 1999 after the merging of the Department of Statistics and the Department of Programme Implementation.

The Ministry has two wings, Statistics and Programme Implementation.



The Statistics Wing called the National Statistical Office (NSO) consists of the Central Statistical Office (CSO), the Computer Centre and the National Sample Survey Office (NSSO).

Central Statistical Office (CSO)

The Central Statistical Office is one of the two wings of the National Statistical Organisation (NSO). It is responsible for co-ordination of statistical activities in the country and for evolving and maintaining statistical standards. Its activities include compilation of National Accounts; conduct of Annual Survey of Industries and Economic Censuses, compilation of Index of Industrial Production as well as Consumer Price Indices. It also deals with various social statistics, training, international cooperation, Industrial Classification, etc.

The CSO is headed by a Director-General who is assisted by 5 Additional Director-Generals looking after the National Accounts Division, Social Statistics Division, Economic Statistics Division, Training Division and the Coordination and Publication Division.

CSO is located in the Sardar Patel Bhawan, Parliament Street, New Delhi. The Industrial Statistics Wing of CSO is located in Kolkata. The Computer Centre also under the CSO is located in R K Puram, New Delhi.

National Sample Survey Organisation (NSSO)

The National Sample Survey Organisation, now known as National Sample Survey Office, is an organization under the Ministry of Statistic of the Government of India.It is the largest organisation in India, conducting regular socio-economic surveys. It was established in 1950. NSSO has four divisions:

1. Survey Design and Research Division (SDRD)
2. Field Operations Division (FOD)
3. Data Processing Division (DPD)
4. Co-ordination and Publication Division (CPD)

The Programme Implementation Wing has three Divisions, namely,

(i) Twenty Point Programme

(ii) Infrastructure Monitoring and Project Monitoring

(iii) Member of Parliament Local Area Development Scheme.

Besides these three wings, there is National Statistical Commission created through a Resolution of Government of India (MOSPI) and one autonomous Institute, viz., Indian Statistical Institute declared as an institute of National importance by an Act of Parliament.

Summary

First Part deals with meaning of statistics, nature, type and scope. Brief information about the data, data source and its kinds are given in the second part. The third part of this chapter explains correlation 'r' which measures the strength and direction of the linear association between two quantitative variables x and y. The fourth section depicts regression. The last part of this chapter introduces Econometrics. Next the organizational structure of Indian statistical system is given in a gist.

MODEL QUESTIONS

YD2CBY

Part – A

Multiple choice questions

1. The word 'statistics' is used as _____.

   (a) Singular.
   (b) Plural
   (c) Singular and Plural.
   (d) None of above.

2. Who stated that statistics as a science of estimates and probabilities.

   (a) Horace Secrist.
   (b) R.A Fisher.
   (c) Ya-Lun-Chou
   (d) Boddington

3. Sources of secondary data are _____.

   (a) Published sources.
   (b) Unpublished sources.
   (c) neither published nor unpublished sources.
   (d) Both (A) and (B)

4. The data collected by questionnaires are_____.

   (a) Primary data.
   (b) Secondary data.
   (c) Published data.
   (d) Grouped data.

5. A measure of the strength of the linear relationship that exists between two variables is called:

   (a) Slope
   (b) Intercept
   (c) Correlation coefficient
   (d) Regression equation

6. If both variables X and Y increase or decrease simultaneously, then the coefficient of correlation will be:

   (a) Positive
   (b) Negative
   (c) Zero
   (d) One

7. If the points on the scatter diagram indicate that as one variable increases the other variable tends to decrease the value of r will be:

(a) Perfect positive
(b) Perfect negative
(c) Negative
(d) Zero

8. The value of the coefficient of correlation r lies between:

(a) 0 and 1
(b) -1 and 0
(c) -1 and +1
(d) -0.5 and +0.5

9. The term regression was used by:

(a) Newton
(b) Pearson
(c) Spearman
(d) Galton

10. The purpose of simple linear regression analysis is to:

(a) Predict one variable from another variable
(b) Replace points on a scatter diagram by a straight-line
(c) Measure the degree to which two variables are linearly associated
(d) Obtain the expected value of the independent random variable for a given value of the dependent variable

11. A process by which we estimate the value of dependent variable on the basis of one or more independent variables is called:

(a) Correlation
(b) Regression
(c) Residual
(d) Slope

12. If Y = 2 - 0.2X, then the value of Y intercept is equal to

(a) -0.2
(b) 2
(c) 0.2X
(d) All of the above

13. In the regression equation $Y = \beta_0+\beta_1X$, the Y is called:

(a) Independent variable
(b) Dependent variable
(c) Continuous variable
(d) none of the above

14. In the regression equation $Y = \beta_0+\beta_1X$, the X is called:

(a) Independent variable
(b) Dependent variable
(c) Continuous variable
(d) none of the above

15. Econometrics is the integration of

(a)Economics and Statistics
(b) Economics and Mathematics
(c)Economics, Mathematics and Statistics
(d) None of the above

16 .Econometric is the word coined by

(a) Francis Galton
(b) RagnarFrish
(c) Karl Person
(d) Spearsman

17. The raw materials of Econometrics are:

    (a) Data
    (b) Goods
    (c) Statistics
    (d) Mathematics

18. The term Uiin regression equation is

    (a) Residuals
    (b) Standard error
    (c) Stochastic error term
    (d) none

19. The term Uiis introduced for the representation of

    (a) Omitted Variable
    (b) Standard error
    (c) Bias
    (d) Discrete Variable

20. Econometrics is the amalgamation of

    (a) 3 subjects
    (b) 4 subjects
    (c) 2 subjects
    (d) 5 subjects

Answers

1	2	3	4	5	6	7	8	9	10
c	d	d	a	c	a	c	c	d	a
11	12	13	14	15	16	17	18	19	20
b	b	b	a	c	b	a	c	a	a

Part-B

Answer the following in one or two sentences

21. What is Statistics?
22. What are the kinds of Statistics?
23. What do you mean by Inferential Statistics?
24. What are the kinds of data?
25. Define Correlation.
26. Define Regression.
27. What is Econometrics?

Part-C

Answer the following questions in one paragraph:

28. What are the functions of Statistics?
29. Find the Standard Deviation of the following data:
    14, 22, 9, 15, 20, 17, 12, 11 (Answer: = 4.18)
30. State and explain the different kinds of Correlation.
31. Mention the uses of Regression Analysis.
32. Specify the objectives of econometrics.

33. Differentiate the economic model with econometric model.

34. Discuss the important statistical organizations (offices) in India.

Part-D

Answer the following questions

35. Elucidatethe nature and scope of Statistics.

36. Calculate the Karl Pearson Correlation Co-efficient for the following data

Demand of Product X :	23	27	28	29	30	31	33	35	36	39
Sale of Product Y:	18	22	23	24	25	26	28	29	30	32

Answer: r=0.9955)

37.Find the regression equation Y on X and X on Y for the following data:

Y:	45	48	50	55	65	70	75	72	80	85
X:	25	30	35	30	40	50	45	55	60	65

(Answer: Y = 0.787X + 7.26, and X =0.87Y + 26.65)

38. Describe the application of Econometrics in Economics.

ACTIVITY

1. Check, Count and make a data set of the number of pages of your subject books of Economics, Commerce, History, Tamil and English

References

1. Agarwal.D.R (2003)"Statistics for Economists" Vrinda Publications (P) Ltd New Delhi,
2. Christopher Dougherty (2007), Introduction to Econometrics, Oxford University Press, 3rd edition, Indian Edition.
3. Greene W.H., (2003) Econometric analysis , 5ed., Prentice Hall,
4. Gujarati.N and Sangeetha (2012) Basic Econometrics, McGraw Hill, Indian Reprint
5. Gupta.S.P, Gupta.M.P (1998) "Business Statistic" Sultan Chand & Sons. 16th revised) enlarge edition.
6. Gupta.S.P(2012), "Statistical method" Sultan Chand, New Delhi.
7. Jan Kmenta (2008), Elements of Econometrics, Indian Reprint, Khosla Publishing House, 2nd edition.
8. Kapur.J.N&Saxena,H.C (2001) "Mathematical statistics" Sultan chand and Company Ltd., New Delhi.
9. Koutsoyiannis.A, Theory of Econometrics , Indian Reprint, Replika Press Pvt. LtdKundli
10. Maddala G.S. 1992 , Introduction to econometrics , 2ed., Macmillan
11. Mehta.B.C&KrantiKapoor(2005), Fundamental of Econometrics, Second Revised Edition, Himalaya Publishing House.
12. Phillips,C(2002)"Statistics – I Economics, management, Finance and the social science" Published by University of London Press, University of London.
13. Vittal P.R (1986), "Business mathematics and statistics," Marghan Publications Madras.

TERMINOLOGY

Accelerator	முடுக்கி
Balance of trade	அயல்நாட்டு வாணிப நிலை
Balance of payments	அயல்நாட்டு செலுத்து நிலை
Budget	வரவு செலவு திட்டம்
Budgetary deficit	நிதிநிலை பற்றாக்குறை
Commercial Banks	வணிக வங்கிகள்
Central Bank	மத்திய வங்கி
Credit creation	கடன் உருவாக்கம்
Cash Reserve Ratio	ரொக்க இருப்பு வீதம்
Capitalism	முதலாளித்துவம்
Capital formation	மூலதனத் உருவாக்கம்
Capital	மூலதனம்
Consumption function	நுகர்வுச் சார்பு
Comparative cost advantage	ஒப்பீட்டு செலவு நன்மை
Customs union	சுங்க வரி ஒன்றியம்
Common market	பொதுச் சந்தை
Capital accumulation	மூலதனத் திரட்சி
Casino capitalism	சூதாட்ட முதலாளித்துவம்
Crony capitalism	சலுகைசார் முதலாளித்துவம்
Credit control	கடன் கட்டுப்பாடு
Credit Rationing	கடன் பங்கீடு
Correlation co-efficient	உடன் தொடர்பு கெழு
Development	மேம்பாடு
Disposable income	செலவிடக் கூடிய வருமானம்
Deflation	பணவாட்டம்
Disinflation	மித பணவீக்கம்
Demonetization	பண மதிப்பிழப்பு
Devaluation	நாணய மதிப்பு குறைப்பு
Developing countries	வளரும் நாடுகள்
Developed countries	வளர்ந்த நாடுகள்
Demand deposit	தேவை வைப்பு
Economics	பொருளியல்
Exchange rate	மாற்று விதம்
Exchange control	மாற்று வீத கட்டுபாடு

Economic union	பொருளாதார கூட்டு
Eco system	சுற்று சூழல்
Econometrics	பொருளாதார அளவியல்
Face value	முக தோற்ற மதிப்பு
Foreign country	அயல் நாடு
Fiscal policy	பொது நிதிக் கொள்கை, அரசோடு தொடர்புடையது
Finance commission	நிதிக் குழு
Fiscal deficit	நிதிப்பற்றாக்குறை
Free Trade Area	தலையிடா வாணிப பகுதி
Firm	நிறுவனம்
Growth	வளர்ச்சி
General agreement on tariffs and trade	சுங்க வரி மற்றும் வாணிபம் தொடர்பான பொது ஒப்பந்தம்
Goods and services Tax	சரக்கு மற்றும் சேவைவரி
Industry	தொழில்
Investment	முதலீடு
Intrinsic value	அகமதிப்பு
Inflation	பணவீக்கம்
Induced investment	ஊக்குவிக்கப்பட்ட முதலீடு
International economics	பன்னாட்டு பொருளியல்
International monetary fund	பன்னாட்டு பணநிதியம்
Indicative planning	சுட்டிக்காட்டும் திட்டம்
Imperative planning	கட்டாய திட்டமிடல்
Incidence of Taxation	வரி பளு அல்லது வரிச்சுமை
IDBI	தேசிய தொழில் வளர்ச்சி வங்கி
Laissez – Faire capitalist economy	தலையிடாக் கொள்கையைக் கொண்டுள்ள முதலாளித்துவ பொருளாதாரம்
Liquidity	ரொக்கத்தன்மை அல்லது நீர்மைத்தன்மை
Macro economics	பேரினப் பொருளாதாரம்
Mixed economy	கலப்புப் பொருளாதாரம்
Marginal propensity to consume	இறுதிநிலை நுகர்வு விருப்பம்
Marginal propensity to save	இறுதிநிலை சேமிப்பு நாட்டம்
Multiplier	பெருக்கி
Multilateral Trade Agreement	பன்முக வாணிப ஒப்பந்தம்
Monetary policy	பணக் கொள்கை
Moral suasion	அறிவுறுத்தல்
Measure of central Tendency	மையபோக்கு அளவியல்
Measure of dispersion	பரவல் (அல்லது) சிதறல்
National Income	தேசிய வருமானம்
Negative externalities	எதிர்மறை புறவிளைவுகள்

NABARD	தேசிய வேளாண் மற்றும் கிராமப்புற வளர்ச்சி வங்கி
Omitted variable	விடுபட்ட மாறிகள்
Personal income	தனிநபர் வருமானம்
Per capita income	தலைவீத வருமானம்
Proportional Tax	விகிதாச்சார வரி
Progressive Tax	வளர்வீத வரி
Public Debt	பொதுக்கடன்
Positive externalities	நேர்மறை புறவிளைவுகள்
Patrimonial capitalism	பேரிடர் முதலாளித்துவம்
Planning commission	திட்டக் குழு
Primary data	முதனிலை புள்ளி விவரம்
RRB	வட்டார கிராம வங்கி
Regression Coefficients	உடன் தொகை கெழு
Subjective factors	மனஇயல் காரணிகள்
Stagflation	தேக்க வீக்கம்
Speculation	ஊக வாணிகம்
Special Drawing Rights	சிறப்பு எடுப்பு உரிமை
Sustainable development	நிலைத்த மேம்பாடு
Social justice	சமூக நீதி
Statutory liquidity Ratio	சட்ட பூர்வ இருப்பு வீதம்
Statistics	புள்ளியியல்
Secondary data	இரண்டாம் நிலை புள்ளி விவரம்
Terms of Trade	நிபந்தனை
Trade Blocs	வர்த்தக குழுமங்கள்
Tax evasion	வரி ஏய்ப்பு
Tax avoidance	வரி தவிர்ப்பு
Time deposit	கால வைப்பு
Underdeveloped Countries	பின்தங்கிய நாடுகள்
Undeveloped Countries	வளர்ச்சி குறைந்த நாடுகள்
Vicious circle of poverty	வறுமையின் நச்சுச் சுழல்
World Bank	உலக வங்கி
World Trade Centre	உலக வர்த்தக மையம்
World Trade Organisation	உலக வர்த்தக அமைப்பு

Economics – XII

List of Authors and Reviewers

Reviewers

Dr. L.Venkatachalam
Professor, Madras Institute of Developmental Studies, Chennai.

Dr. George V. Kallarackal
Former HOD, Economics Department
CMS College, Kottayam, Kerala.

Dr. S. Iyyam Pillai
Former Professor, Dept. of Economics
Bharathidasan University, Trichy.

Domain Experts

Dr. R. Bernadshaw
Former Professor, Dept. of Economics,
NMSSVN College, Nagamalai, Madurai.

Dr. S. Theenathayalan
Head, Department of Economics,
The Madura College, Madurai.

Subject Coordinator

J. Sornalatha
Post Graduate Assistant, Government Muslim Hr. Sec School.
Chennai-600002.

Authors

Dr. J. Socrates
Head, Department of Economics,
Manonmaniam Sundaranar University, Tirunelveli.

Dr. R. Albert Christopher Dhas
Associate Professor, Dept. of Economics,
The American College, Madurai.

Dr. R.Vaheedha Banu
Assistant Professor, MSS WAKF Board College, Madurai.

Dr. S.Shanthi Getzie,
HOD, Bishop Heber College,
Trichy.

Stephen Elangovan
Post Graduate Assistant,
TVS Matric Higher Secondary School, Madurai.

B. Shunmugam
Post Graduate Assistant
Natarajan Dhamayanthi Higher Secondary School, Nagapattinam.

Dr. K. Sadasivam
Associate Professor, School of Economics,
Madurai Kamaraj University, Madurai-625 021.

Dr. M. Chitra
Assistant Professor, School of Economics,
Madurai Kamaraj University, Madurai.

Dr. K Kaliyamurthy,
HOD,Urumu Dhanalakshmi College,Kattur, Trichy.

K. Karnan
Post Graduate Assistant, Government Girls Higher Secondary School,
Tirumangalam, Madurai.

K. Alamarselvan
Post Graduate Assistant, Government Boys Higher Secondary School,
Bhuvanagiri, Cuddalore.

Art & Design Team

Layout & Illustrations

V2 Innovations, Chennai-86.

In-House QC

Mathan Raj R
Jerald Wilson
Reajesh Thangappan

Cover Design

Kathir Arumugam

Co-ordination

Ramesh Munisamy

Typist

M. Madhavi
SCERT.

Qr Code Management Team

J.F. Paul Edwin Roy, B.T. Asst,
P.U.M.S -Rakkipatty, Veerapandi, Salem.

A. Devi Jesintha, B.T. Asst,

G.H.S, N.M. Kovil, Vellore

M. Murugesan, B.T. Asst,
P.U.M.S. Pethavelankottagam, Muttupettai, Thiruvarur.

ICT- Co-ordinators

D. Vasuraj
P.GT. & H.O.D., (Maths),
KRM Public School, Chennai.

This book has been printed on 80 G.S.M.
Elegant Maplitho paper.

Printed by offset at:

NOTES

NOTES

NOTES

NOTES