Unit - V

INDEX NUMBERS

Meaning and Definitions of Index Number :

- An index Number is a ratio or an average of ratios expressed as a percentage.
- It is a statistics which assigns a single number to several individual statistics in order to quantify trends.
- Two or more time periods are involved, one of which is the base time period.
- The values at the base time period serves as the standard point of comparison.

According to Maslow :

"It is a numerical value characterizing the change in complex economic phenomena over a period of time or space."

According to John Riffin :

"Index numbers are used to measure changes over time in magnitude which are not capable of direct measurement."

According to Spiegal : -

"An index number is a statistical measure designed to show changes in variable or a group of related variables with respect to time, geographical location or other characteristic."

According to Croxton and Cowden :

" Index number is a device for measuring differences in the magnitude of a group of related variables."

Uses of Index Numbers:

Index numbers are today one of the most widely used statistical measure. They are particularly useful in measuring related changes.

The uses of index numbers are :

i. They measure the relative change

ii. They are of better comparison

iii. They are good guides

iv. They are Economic barometers

v. They are the pulse of the economy

vi. They are the wage adjuster

vii. They compare the standard of living

viii. They are a special type of averages

ix. They help in formulating policies

x. They measure the purchasing power of money

Characteristics of Index Numbers

Below are the characteristics of index numbers:

1. Specialized Average
2. Expressed in percentages
3. Measure changes not capable of Direct Measurement
4. Index Numbers are for Comparison

1. Specialized Average:

- They measure the central tendency of a time series or a spatial series.
- Averages are used to compare two or more series as they represent their central tendencies.
- But there is a very great limitation in the use of averages.
- Averages are used to compare those series, which are expressed in the same units.
- If the units in which two or more series are expressed are different, or if the series are composed of different types of items, averages cannot be used to compare them.
- However the device of index numbers help in comparing change in series, which are in different units

2. Expressed in Percentages:

- Index numbers are expressed in terms of percentages so as to show the extent of relative change.
- However, percentage sign (%) is not used.

3. Measure changes not capable of Direct Measurement:

The technique of index number is utilized in measuring changes in magnitudes, which are not capable of direct measurement due to composite and complex character of the phenomenon.

Examples of such phenomena are 'price level', 'cost of living', 'business or economic activity', etc.

4. Index Numbers are for Comparison:

The index numbers by their very nature are comparative.

They compare changes taking place over time or between places

Notations:

Base Year: The year selected for which comparison i.e. the year with reference to which comparison are made. It is denoted by '0'.

Current Year : The year for which comparisons are sought or required.

P_0 -- Price of a commodity in the Base Year

P_1 – Price of a commodity in the Current Year

q_0 -- Quantity of a commodity consumed or purchased during the Base Year

q_1 -- Quantity of a commodity consumed or purchased in the Current Year

w -- weight assigned to a commodity according to its relative importance in the group

P_{01} – Price Index Number for the current year with reference to the base year

P_{10} -- Price Index Number for the base year with reference to the current year

q_{01} -- Quantity Index Number for the current year with reference to the base year

q_{10} -- Quantity Index Number for the base year with reference to the current year

Weighted Index Number

In this method relative importance for the weights is assigned to different commodities.

This is further divided into two categories:

i. Weighted Aggregative Method

ii. Weighted Average of Price Relative Method

Construction of Weighted Index Number:

To meet the weakness of the simple or unweighted methods, we weigh the price of each commodity by a suitable factor often taken as the quantity or the volume of the commodity sold during the base year or some typical year. These indices can be classified into broad groups:

i. Weighted Aggregative Index

ii. Weighted Average of Relatives

I **Weighted Aggregative Index**

- Under this method we weight the price of each commodity by a suitable factor often taken as the quantity or value weight sold during the base year or the given year or an average of some years.
- The choice of one or the other will depend on the importance we want to give to a period besides the quantity used.
- The various alternative formulae which are commonly used are:

1. Laspeyres Method
2. Paasche's Method
3. Fisher's Ideal Index

1 **Laspeyres Method**

- The Laspeyres Price Index is a weighted aggregate price index, where the weights are determined by quantities in the base period.
- The distinctive feature of the Laspeyres index is that it uses a group of commodities purchased in the base period as the basis for comparison.
- In other words , in computing the index, a commodity's relative price (the ratio of the current price to the base-period price) is weighted by the commodity's relative importance to all purchases during the base period.
- The Laspeyres price index tends to overstate price increases because, as price change, consumers typically alter their purchasing decisions by selecting fewer products with large price increases while buying more products that show low or no price increases.

- If consumers can do this without reducing their total satisfaction, the use of base-period commodity selections tends to overstate declines in the stand of living.

- Similar to the price index, the Laspeyres quantity index uses base-period to compare aggregate production levels in two periods.

The formula for constructing the index is:

$$L = P_{01} = (\sum p_1 q_0 \ / \ \sum p_0 q_0) \times 100$$

2 **Paasche's Method**

- The Paasche price index is a weighted aggregate price index in which the weights are determined by quantities in the given year.
- This index is a ratio that compares the total purchase cost of a specified bundle of current-period commodities (commodities valued at current prices) with the value of those same commodities at base-period prices; this ratio is multiplied by 100.
- The Paasche price index tends to understate price increased, since it already reflects some of the changes in consumption pattern that occur when consumers respond to price increases
- – i.e., increased consumption of goods will indicate reduced relative prices.

The formula for constructing the index is :

$$P = P_{01} = (\sum p_1 q_1 / \sum p_0 q_1) \times 100$$

3 **Fisher's 'Ideal' Index:**

Prof. Irving Fisher has given a number of formulae for constructing index number and of these he calls on as the 'ideal' index. The Fisher's ideal index is given by the formula:

$P_{01} = \sqrt{(\sum p1q0 \ / \sum p0q0) \times (\sum p1q1 \ / \sum p0q1)}$ x 100 or $P_{01} = \sqrt{L \times P}$

The above formula is known as 'Ideal' because of the following reasons

1. It is based on geometric mean which is theoretically considered to be the best average for constructing index numbers
2. It takes into account both current year as well as base year prices and quantities
3. It satisfies both the time reversal test as well as the factor reversal test as suggested by Fisher
4. It is free from bias

Example : 1

The following data relate to the prices and quantities of 3 commodities in the years 2004 and 2005. Construct the following index numbers of price for the year 2005 by using 2004 as the base year.

1. Laspeyres Index
2. Paasches Index
3. Fisher Ideal Index

Data

	2004		2005	
	Kilo	Rate (Rs.)	Kilo	Rate (Rs.)
Bread	10	3	8	3.25
Meat	20	15	15	20
Tea	2	25	3	23

Solution :

	2004		2005		p_1q_0	p_0q_0	p_1q_1	p_0q_1
	Kilo	Rate (Rs.)	Kilo	Rate (Rs.)				
	q_0	p_0	q_1	p_1				
Bread	10	3	8	3.25	32.50	30	26	24
Meat	20	15	15	20.00	400.00	300	300	225
Tea	2	25	3	23.00	46.00	50	69	75
				Total	$\sum p_1q_0 =$ 478.50	$\sum p_0q_0 =$ 380	$\sum p_1q_1 =$ 395	$\sum p_0q_1 =$ 324

1. Laspeyres Index : $P_{01} = (\sum p_1q_0 \ / \ \sum p_0q_0) \times 100 = (478.50 / 380) \times 100 = 125.9$

2. Paasche's Index : $P_{01} = (\sum p_1q_1 \ / \ \sum p_0q_1) \times 100 = (395 / 324) \times 100 = 121.9$

3. Fisher's Ideal Index : $P_{01} = \sqrt{L \times P} = \sqrt{(\sum p1q0 \ / \sum p0q0) \times (\sum p1q1 \ / \ \sum p0q1)} \times 100$

$$= \sqrt{(478.50 / 380) \times (395 / 324)} \times 100$$

$$= \sqrt{1.259 \times 1.219} \times 100 = 123.9$$

Example : 2

Calculate quantity index by (i) Laspeyre's method, (ii) Paasche's method, (iii) Fisher's method

Year Commodity	Price p_0	2000 Total Value (p_0q_0)	Price p_1	2002 Total Value (p_1q_1)
A	10	100	12	144
B	12	144	14	196
C	14	196	16	256
D	16	256	18	324
E	18	324	20	400

Solution: Construction of various Indices

p_0	q_0	p_1	q_1	p_0q_0	p_0q_1	p_1q_1	p_1q_0
10	10	12	12	100	120	144	120
12	12	14	14	144	168	196	168
14	14	16	16	196	224	256	224
16	16	18	18	256	288	324	288
18	18	20	20	324	360	400	360
			Total	1020	1160	1320	1160

Laspeyres Index : $P_{01} = (\sum p_1q_0 \ / \ \sum p_0q_0) \times 100 = (1160 / 1020) \times 100 = 113.7$

Paasche's Index : $P_{01} = (\sum p_1q_1 \ / \ \sum p_0q_1) \times 100 = (1320 / 1160) \times 100 = 113.8$

Fisher's Ideal Index : $P_{01} = \sqrt{L \times P} = \sqrt{(\sum p1q0 \ / \sum p0q0) \times (\sum p1q1 \ / \ \sum p0q1)} \times 100$

$= \sqrt{113.7 * 113.8} = 113.75$

Cost Of Living Indices :

- Cost of living indices are used to adjust fixed incomes and contractual income to maintain the real value of such incomes.
- Cost of living indices are similar to the CPI; these are often used to adjust fixed incomes and contractual incomes to maintain the real value of such incomes.
- In fact wage indexation is based on such indices.
- Cost of living indices are used for wage determination.
- They reveal the change in price level of some important commodities which are necessary for daily life.
- These indices are guide to the trade union authorities for their wage bargaining procedure.

Different Cost of Living Indices

Three different types of cost of living indices are :

1. Home Based Index
2. Adapted Expenditure Index
3. Host Based Index

1. Home Based Index :

- It is calculated on the basis of the consumption pattern of the home city.
- It is usually used for short-term expatriations or for expatriations to countries where lifestyle differs radically from the one in the home country.

2. Adapted expenditure Index :

- It takes into account the consumption pattersn in both the home and foreign cities.
- It can be applied without restriction and presents advantages for successive international expatriations since it is the only reversible index.

3. **Host Based Index :**

- It is calculated using the consumption pattern of long-term expatriates.
- It might be used for very long-term assignments to countries geographically and/or culturally close to the country of origin.

<u>Construction of Cost of Living Index</u> :

Cost of living index number is constructed by the following formulae:

Aggregate Expenditure (or Weighted Aggregates) Method. In this method weights to be assigned to various commodities are provided by the quantities consumed in the base year.

Formula

Cost of Living Index = $(\sum p_{ij} q_{oj} / \sum p_{0j} q_{0j}) \times 100$

= [(Total expenditure in current year with the base year quantities as weights) / (Total expenditure in base year)] X 100

Price Relative = $P_j = [p_{ij} / p_{0j}] \times 100$ and $w_j = p_{0j} q_{0j}$; j = 1,2,3,…….,n.

then Cost of Living Index = $\sum w_j p_j / \sum w_j$

Example For the data in table below, construct the cost of living index for the year 2005 (Base 2001 = 100) using method of weighted price relatives

Item	Unit	Price (in Rs.)		Weight
		2001	2005	
A	Kg.	50	75	10%
B	Litre	60	75	25%
C	Dozen	200	240	20%
D	Kg.	80	100	40%
E	One pair	160	200	5%

Formula

Cost of Living Index = $(\sum p_{ij} q_{oj} / \sum p_{0j} q_{0j}) \times 100$

= [(Total expenditure in current year with the base year quantities as weights) / (Total expenditure in base year)] X 100

Price Relative = $P_j = [p_{ij} / p_{0j}] \times 100$ and $w_j = p_{0j} q_{0j}$; j = 1,2,3,…….,n.

then Cost of Living Index = $\sum w_j p_j / \sum w_j$

Solution

CALCULATIONS OF COST OF LIVING INDEX NUMBER

Item	Price (in Rs.)		Price Relatives (Base 2001 =100)	Weight	Pw
	2001 (p_0)	2005 (p_1)			
A	50	75	(75/50) X 100 = 150	10	1500
B	60	75	(75/60) X 100 = 125	25	3125
C	200	240	(20/200) X 100 = 120	20	2400
D	80	100	(100/80) X 100 = 125	40	5000
E	160	200	(200/160) X 100 = 125	5	625
Total				100	12650

Cost of Living Index = $\sum PW / \sum W$ = 12,650 / 100 = 126.50