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INDEX NUMBERS

Of the important statistical devices and techniques, Index Numbers have today become one of the most widely used for judging the pulse of economy, although in the beginning they were originally constructed to gauge the effect of changes in prices. Today we use index numbers for cost of living, industrial production, agricultural production, imports and exports, etc. Index numbers are the indicators which measure percentage changes in a variable (or a group of variables) over a specified time.

OBJECTIVES

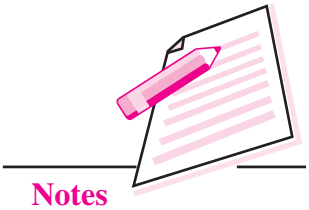
After completing this lesson, you will be able to:

- describe the term index and appreciate its uses;
- differentiate between a weighted and unweighted index;
- construct and interpret a Laspeyer's price index;
- construct and interpret a Paasche's price index;
- construct and interpret a value index;
- explain how the Consumer Price Index is constructed and interpreted;
- explain how industrial production index is constructed; and
- understand its limitations.

11.1 MEANING OF INDEX NUMBER

"An index number is a statistical measure, designed to measure changes in a variable, or a group of related variables".

"Index number is a single ratio (or a percentage) which measures the combined change of several variables between two different times, places or situations".



INDEX NUMBER expresses the relative change in price, quantity, or value compared to a base period. An index number is used to measure changes in prices paid for raw materials; numbers of employees and customers, annual income and profits, etc.

If the index number is used to measure the relative change in just one variable, such as hourly wages in manufacturing, it is referred to as a simple index. An index number can also be used to measure changes in the value of the group of variables such as prices of specified list of commodities, volume of production in different sectors of an industry, production of various agricultural crops, cost of living etc, it is referred to as composite index. Index number measures average change in a group of related variables over two different situations such as prices of specified list of commodities, volume of production in different sectors of an industry, production of various agricultural crops, cost of living etc. Index number does not indicate that the change is uniform for all commodities or group of related variables used to calculate it. It may be noted that in case of, say, Price Index, price of of some of the items may be rising, while it is falling in other items. Price index will only indicate the average change in the price of group of related commodities.

Conventionally, index numbers are expressed in terms of percentage. Of the two periods, the period with which the comparison is to be made, is known as the base period. The value in the base period is given the index number 100. Suppose the change in price in the year 2013 is measured in comparison to the year 2000, then 2000 become the base year and 2013 becomes the current year. For Example By saying that the price index for the year 2013 is 125, taking base year as 2000, it means that there is an increase of 25% in the general price as compared to the corresponding figure for the year 2000. Price index numbers measure and permit comparison of the prices of certain goods. Quantity index numbers measure the changes in the physical volume of production, construction or employment.

11.2 CHARACTERISTICS OF INDEX NUMBERS

Following are some of the important characteristics of index numbers:

- Index numbers are a special type of average that provides a measurement of relative changes in the level of a certain phenomenon from time to time. It is a special type of average because it can be used to compare two or more series which are composed of different types of items or even expressed in different types of units.
- Index numbers are expressed in terms of percentages to show the extent of relative change.
- Index numbers measure relative changes. They measure the relative change in the value of a variable or a group of related variables over a period of time or between places.

Notes

- Index numbers can also measure changes which are not directly measurable. For Example the cost of living, the price level or the business activity in a country are not directly measurable but it is possible to study relative changes in these activities by measuring the changes in the values of variables/factors which affect these activities.

11.3 USES OF INDEX NUMBERS

Index numbers are indispensable tools of economics and business analysis. Following are the main uses of index numbers.

(i) Index numbers are economic barometers. Index numbers measure the level of business and economic activities and are therefore helpful in gauging the economic status of the country. Index number is a special type of averages which helps to measure the economic fluctuations on price level, money market, economic cycle like inflation, deflation etc.

(ii) Index numbers helps in formulating suitable economic policies and planning etc. Many of the economic and business policies are guided by index numbers. For example, while deciding the increase of DA of the employees; the employers have to depend primarily on the cost of living index. If salaries or wages are not increased according to the cost of living it leads to strikes, lock outs etc. The index numbers provide some guide lines that one can use in making decisions.

(iii) Index numbers are used in studying trends and tendencies. Since index numbers are most widely used for measuring changes over a period of time, the time series so formed enable us to study the general trend of the phenomenon under study.

(iv) Index numbers are useful in forecasting future economic activity. Index numbers are used not only in studying the past and present workings of our economy but also important in forecasting future economic activity.

(v) Index numbers measure the purchasing power of money. The cost of living index numbers determine whether the real wages are rising or falling or remain constant. The real wages can be obtained by dividing the money wages by the corresponding price index and multiplied by 100. Real wages helps us in determining the purchasing power of money.

11.4 CONSTRUCTION OF AN INDEX NUMBER:

The various methods of construction of Index numbers are explained through price index numbers. The methods of construction of price index numbers can be classified into broad categories as shown below:

Table 11.1: Price Indices

Un-weighted Index		Weighted Index	
Simple Aggregative Method	Simple Average of Price Relatives Method	Weighted Aggregative Method	Weighted Average of Price Relatives Method

11.4.1 Un-weighted Index

In the un-weighted index number the weights are not assigned to the various items used for the calculation of index number. Two unweighted price index number are given below:

(i) Simple Aggregate Method

This method is based on the assumption that various items and their prices are quoted in same units. Equal importance is given to all the items. The formula for a simple aggregative price index is given as follows:

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

where ΣP_1 is the total of current year's prices for the various items.

ΣP_0 is the total of base year's prices for the various items.

Example 1: From the following data compute price index number for the year 2014 taking 2013 as the base year using simple aggregative method:

Commodity	Prices in the year 2013	Prices in the year 2014
A	1	5
B	2	4
C	3	3
D	4	2

Solution:

Table 11.2: Computation of price Indian number using Aggregative Method

Commodity	Prices in the year 2013 P_0	Prices in the year 2014 P_1
A	1	5
B	2	4
C	3	3
D	4	2
	$\Sigma P_0 = 10$	$\Sigma P_1 = 14$

The price index number is given by:

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100 = \frac{14}{10} \times 100 = 140$$

From this price index of 140, it can be concluded that the aggregate of the prices of the given group of commodities has increased by 40% over the period from 2013 to 2014.

This price index number calculated by using simple aggregative method has limited use. The reasons are as follows:

(a) This method doesn't take into account the relative importance of various commodities used in the calculation of index number since equal importance is given to all the items.

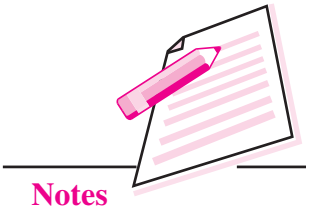
(b) The different items are required to be expressed in the same unit. In practice, however, the different items may be expressed in different units.

(c) The index number obtained by this method is not reliable as it is affected by the unit in which prices of several commodities are quoted.

(ii) Simple Average of Price Relatives Method

This method is an improvement over the previous method as it is not affected by the unit in which the prices of various commodities are quoted. The price relatives are pure number and therefore are independent of original units in which these are quoted. The price index number using price relatives is defined as follows:

$$P_{01} = \frac{\Sigma \frac{P_1}{P_0} \times 100}{N}$$



where P_1 and P_0 indicate the price of the ith commodity in the current period and base period respectively. The ratio $(P_1/P_0) \times 100$ is also referred to as price relative of the commodity and n stands for the number of commodities.

Using the data of Example 1 the index number using price relative method can be calculated as follows:

Table 11.3: Calculation of Index number using Simple Price Relative Method

Commodity	Prices in the year 2013 P_0	Prices in the year 2014 P_1	Price Relatives $\frac{P_1}{P_0} \times 100$
A	1	5	500
B	2	4	200
C	3	3	100
D	4	2	50
	$\Sigma P_0 = 10$	$\Sigma P_1 = 14$	$\Sigma \frac{P_1}{P_0} \times 100 = 850$

$$P_{01} = \frac{\Sigma \frac{P_1}{P_0} \times 100}{N} = \frac{850}{4} = 212.5$$

Thus the price in the year 2014 are112.5% higher in 2013.

The index number based on simple average of price relatives is not influenced by the units in which the prices of the commodities are quoted.

However, this method like simple aggregative method gives equal importance to all the items and thus neglects their relative importance in the group.

11.4.2 Weighted Index Number

In weighted index number rational weights are assigned to all the items or commodities. Such weights indicate the relative importance of the items included in the calculation of the index. In most cases quantity of usage is the best measure of importance.

(i) Weighted Aggregative Price Indices

In weighted aggregative price indices, the weights are assigned to each item in the basket in various ways and the weighted aggregates are also used in different ways

to calculate an index. In most cases quantity of usage is used to calculate price index number. Laspeyre's price index and Paasche's price index are the two most important methods of calculating weighted price indices. Laspeyre's price index number is the weighted aggregative price index number which uses base year's quantity as the weights. It is given by:

$$P_{01} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \times 100$$

In general, Laspeyre's index number answers the question, it provides an explanation to the question that if the expenditure on base period basket of commodities was ₹100, how much should be the expenditure in the current period on the same basket of commodities?

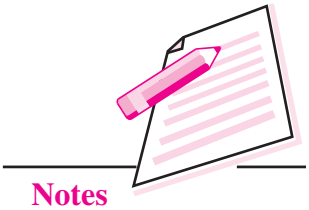
Example 2: From the following data compute Laspeyre's index number for the current year:

Items	Base Year		Current Year	
	Prices (in ₹)	Quantity (in kg.)	Prices (in ₹)	Quantity (in kg.)
A	1	6	5	8
B	2	7	4	7
C	3	8	3	6
D	4	9	2	5

Solution:

Table 11.4: Computation of Laspeyre's Index Number

Items	Base Year		Current Year			
	Price (P_0)	Quantity (q_0)	Price (P_1)	Quantity (q_1)	P_1q_0	P_0q_0
A	1	6	5	8	30	6
B	2	7	4	7	28	14
C	3	8	3	6	24	24
D	4	9	2	5	18	36
					$\Sigma P_1q_0 = 100$	$\Sigma P_0q_0 = 80$



Laspeyre's Price index number is given by:

$$P_{01} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \times 100 = \frac{100}{80} \times 100 = 125$$

As can be seen here that the value of base period quantities has risen by 25 per cent due to price rise. It means that the price is said to have risen by 25 percent.

Paasche's price index number is the weighted aggregative price index number which uses current year's quantity as the weights. It is given by:

$$P_{01} = \frac{\sum P_1 q_1}{\sum P_0 q_1} \times 100$$

In general, Paasche's index number answers the question, if the current period basket of commodities was consumed in the base period and if we were spending ₹100 on it, how much should be the expenditure in the current period on the same basket of commodities.

In the above example 2 Paasche's price index number can be calculated as follows:

Table 11.5: Computation of Paasche's Price Index Number

Items	Base Year		Current Year			
	Price (P_0)	Quantity (q_0)	Price (P_1)	Quantity (q_1)	P_1q_1	P_0q_1
A	1	6	5	8	40	8
B	2	7	4	7	28	14
C	3	8	3	6	18	18
D	4	9	2	5	10	20
					$\Sigma P_1q_1 = 96$	$\Sigma P_0q_1 = 60$

paasche's price index number is given by:

$$P_{01} = \frac{\sum P_1 q_1}{\sum P_0 q_1} \times 100 = \frac{96}{60} \times 100 = 160$$

Paasche's price index of 160 means the price rise of 60 percent using current year quantities as weights.

INTEXT QUESTION 11.1

1. The paasche index number is based on:
   (a) Base Year Quantity
   (b) Current Year Quantity
   (c) Average of Base and Current Year Quantity
   (c) none of the above
2. What is an index number?
3. Write one use of index numbers.
4. State any two characteristics of index numbers.

(ii) Weighted Price Relative Method

Under this method price index is constructed on the basis of price relatives and not on the basis of absolute prices. The price index is obtained by taking the average of all weighted price relatives. It is given by

$$P_{01}(\text{weighted arithemetic mean}) = \frac{\sum W\left(\frac{p_1}{p_0}\times 100\right)}{\sum W}$$

Where W = weights

In a weighted price relative index, weights may be determined by the proportion or percentage of expenditure on them in total expenditure during the base or current period. In general, the base period weight is preferred to the current period weight. It is because calculating the weight every year is inconvenient.

Example 3: From the following data compute an index number by using weighted average of price relative method:

Items	Base Year		Current
	Price (P_0)	Quantity (q_0)	Year Price (P_1)
A	1	6	5
B	2	7	4
C	3	8	3
D	4	9	2

Solution:

Calculation of price index number by weighted average of price relatives method using arithmetic mean:

Table 11.6: Calculation of price Index Number

Items	Base Year		Current Year		$W = P_0q_0$	$W\left(\frac{p_1}{p_0}\times 100\right)$
	Price (P_0)	Quantity (q_0)	Price (P_1)	Relatives $= \frac{P_1}{P_0}\times 100$		
A	1	6	5	500	6	3000
B	2	7	4	200	14	2800
C	3	8	3	100	24	2400
D	4	9	2	50	36	1800
					$\Sigma W=80$	$\Sigma W\left(\frac{p_1}{p_0}\times 100\right) = 1000$

$$P_{01}(\text{weighted arithemetic mean}) = \frac{\Sigma W\left(\frac{p_1}{p_0}\times 100\right)}{\Sigma W} = \frac{10000}{80} = 125$$

The weighted price index is 125. The price index has risen by 25 percent.

It may be noted that the values of the unweighted price index and the weighted price index differ.

INTEXT QUESTIONS 11.2

1. From the following data compute an index number by using weighted average of price relative method:

Commodities	Base Year Prices (in ₹)	Current Year Prices (in ₹)	Weights (W)
A	100	90	30
B	20	20	15
C	7	60	20
D	20	15	10
E	40	55	25

11.5 SOME OTHER IMPORTANT INDEX NUMBERS

11.5.1 Consumer price index

A consumer price index (CPI) measures changes in the price level of a basket of consumer goods and services purchased by households. CPI measures changes in the price level for the specified consumers in the particular region. CPI can be calculated for industrial workers, urban labours, Agricultural workers etc. Suppose the CPI for agricultural workers with base year of 2000 is 560 in the April 2012.It means that if the agricultural worker was spending 100 in 2000 for a typical basket of commodities, he needs ₹ 560 in April 2012 to be able to buy an identical basket of commodities. It is not necessary that he/she buys the

basket. CPI only indicates the capability to buy it. It may be noted that there cannot be one CPI for any class or group of the whole country as the retail prices in different places differ. Similarly, we cannot have a cost of living index number for the whole population of a particular town because there exists different group of persons in the town purchasing different baskets of commodities.

CPI is given by :

$$\text{Cost of Living Index} = \frac{\sum WP}{\sum W}$$

where $P=\frac{P_1}{P_0}\times 100$ and W are the weights

Example 4: Construct the consumer price index number for the year 2012 on the basis of 2010 from the following data:

Commodities	Rice	Wheat	Pulses	Butter	Oil
Weights	40	20	15	20	5
Price (per unit in ₹) 2010	16	40	0.50	5.12	2
Price (per unit in ₹) 2012	20	60	0.5	6.25	1.5

Solution:

Table 11.7: Constructing Consumer Price Index Number

Commo-dities	Weights (W)	Price (per unit in ₹) 2010	Price (per unit in ₹) 2012	$P = \frac{P_1}{P_0} \times 100$	WP
Rice	40	16	20	125	5000
Wheat	20	40	60	150	3000
Pulses	15	0.50	0.5	100	1500
Butter	20	5.12	6.25	122	2440
Oil	5	2	1.5	75	375
	ΣW =100				ΣWP =12315

$$\text{Cost of Living Index for 2012} = \frac{\sum WP}{\sum W} = \frac{12315}{100} 123.15$$

INTEXT QUESTIONS 11.3

1. Suppose a person was earning 1500 per month in 2005, what should be his salary in 2010, if the cost of living index number in 2010 with base year 2005 is 170.30?

11.5.2 Wholesale Price Index Number

The Wholesale Price Index or WPI is the price of a representative basket of wholesale goods. The wholesale price index number indicates the change in the general price level. Unlike the CPI, it does not have any reference consumer category. WPI with 2011 as base is 156 in March, 2014 means that the general price level has risen by 56 percent during this period.

11.5.3 Industrial production index

The industrial production index indicates the change in the level of industrial production in the given period comprising many industries. It is a weighted average of quantity relatives. The formula for the index is given by:

$$\text{Industrial Production Index } (IIP_{01}) = \frac{\sum q_1 \times W}{\sum W}$$

Notes

11.6 ISSUES IN THE CONSTRUCTION OF INDEX NUMBERS

There are certain issues that should be kept in mind for the construction of index number which are explained as follows:

Purpose of Index Numbers

An index number, which is designed keeping, specific objective in mind, is a very powerful tool. For example, an index whose purpose is to measure consumer price index, should not include wholesale rates of items and the index number meant for slum-colonies should not consider luxury items like A.C., Cars refrigerators, etc.

Selection of Items

After the objective of construction of index numbers is defined, only those items which are related to and are relevant with the purpose should be included.

Choice of Average

As index numbers are themselves specialized averages, it has to be decided first as to which average should be used for their construction. The arithmetic mean, being easy to use and calculate, is preferred over other averages (median, mode or geometric mean). In this lesson, we will be using only arithmetic mean for construction of index numbers.

Assignment of weights

Proper importance has to be given to the items used for construction of index numbers. It is universally agreed that wheat is the most important cereal as against other cereals, and hence should be given due importance.

Choice of Base year

The index number for a particular future year is compared against a year in the near past, which is called base year. It may be kept in mind that the base year should be a normal year and economically stable year.

11.7 CONCLUSION

An index number is a statistical measure, designed to measure relative changes in a variable(s) with time/geographical location/other criteria. Index Numbers can be calculated for price, quantity, volume etc. The index numbers need to be interpreted carefully as there are several methods of calculating the index number. The items

to be included and the choice of the base period are important for the calculations. The index numbers are indispensable in economic policy making.

WHAT YOU HAVE LEARNT

- An index number is a statistical measure, designed to meaasure changes in a variable or a group of related variables.
- Conventionally, index numbers are expressed in terms percentage.
- Main characteristics of index numbers are :
  - (i) Index numbers are a special type of average that provide a measurement of relative changes in the level of certain phenomenon from time to time
  - (ii) Index numbers are expressed in terms fo percentages to show the extent of relative change
  - (iii) They measure relative changes.
  - (iv) They can also measure changes which are not directly measureable.
- Index numbers are economic barometers. They help in formulating economic policies and planning etc. They are used in studying trends adn tendencies. Index numbers are useful in forecasting future economic activity. They measure the purchasing power of money.
- The formula to obtain index number by simple average of price relatives method is:

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

- The formula to obtain index number by simple average of price relatives method is:

$$P_{01} = \frac{\Sigma \frac{P_1}{P_0} \times 100}{N}$$

- The formula to get Laspeyre's price index is $P_{01} = \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times 100$
- Formula to get Paasche's index number is:

$$P_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \times 100$$

- Formula to get index number by weighted price relative method is:

$$P_{01} = \frac{\Sigma W\left(\frac{p_1}{p_0} \times 100\right)}{\Sigma W}$$

- Consumer price index (cost of living index = $\frac{\Sigma WP}{\Sigma W}$

TERMINAL EXERCISES

1. Use the following to answer questions a-d:

   A company buys four products with the following characteristics:

	Number of units bought		Price paid per unit (£)	
Items	**Year 1**	**Year 2**	**Year 1**	**Year 2**
A	20	24	10	11
B	55	51	23	25
C	63	84	17	17
D	28	34	19	20

   (a) Find the simple price indexes for the products for year 2 using year 1 as the base year:

   (b) Find the simple aggregate index for year 2 using year 1 as the base year:

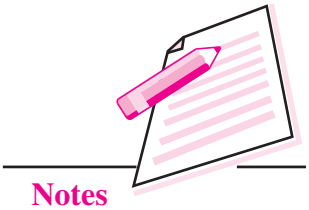
   (c) Find the base-weighted aggregate index, the Laspeyres index, for year 2 using year 1 as the base year.

   (d) Find the current period-weighted aggregate index, the Paasche index, for year 2 using year 1 as the base year.

2. During a certain year, Cost of Living Index Number goes up from 110 to 200 and the salary of worker is also raised from 3250 to 5000. Does the worker really gain?

3. The price relatives and weights of the set of commodities are given in the following table:

Commodities	A	B	C	D
Price Relatives	125	120	127	119
Weights	W1	2 W1	W2	W2+3



If the sum of weights is 40 and the index number for the set is 122, find the numerical value of W1 and W2.

ANSWERS TO INTEXT QUESTIONS

11.1

1. (b)
2. Read section 11.2
3. Read section 11.3
4. Read section 11.2

11.2

1. 101.017

11.3

1. ₹ 2554.5