6 Index Numbers

Introduction :

Index numbers are one of the most used statistical tools in economics. An index number is a device to measure changes in an economic variable (or group of variables) over a period of time. Index numbers were originally developed to measure changes in the price level. In the present context, it is also used to measure trends in a wide variety of areas that includes stock market prices, cost of living, industrial and agricultural production, changes in exports and imports etc. Index numbers are not directly measurable, but represent relative changes.

Definitions of Index Numbers :

1) **Spiegel :** "An index number is a statistical measure designed to show changes in a variable or a group of related variables with reference to time, geographical location and other characteristics such as income, profession etc."

2) **Croxton and Cowden :** "Index Numbers are devices for measuring differences in the magnitude of a group of related variables."

Features of Index Numbers :

1) Index numbers are statistical devices.

2) Index numbers are specialized averages which are capable of being expressed in percentages.

3) Index numbers measure the net change in one or more related variables over a period of time or between two different time periods or two different localities.

4) Index number which is computed from a single variable is called a **'univariate index'**, whereas an index which is constructed from a group of variables is called a **'composite index'**.

5) The year for which the index number is prepared is the current year.

6) The year with which the changes are measured is called the base year.

7) The base year's index is assumed as 100 and accordingly the value of the current year is calculated.

8) Index numbers are also referred to as **'barometers of economic activity'**, since it is used to measure the trends and changes in the economy.

current period. It is denoted by the suffix '1'.

Notations

p_0 = Price of the commodity in the base year

p_1 = Price of the commodity in the current year

q_0 = Quantity of the commodity consumed or purchased in the base year

q_1 = Quantity of the commodity consumed or purchased in the current year

Types of Index numbers :

INDEX NUMBERS
- PRICE INDEX NUMBER
- QUANTITY INDEX NUMBER
- VALUE INDEX NUMBER
- SPECIAL PURPOSE INDEX NUMBER

1) **Price Index Number :** It measures the general changes in the prices of goods. It compares the level of prices between two different time periods.

2) **Quantity Index Number :** It is also called volume index number. It measures changes in the level of output or physical volume of production in the economy. For example, changes in agricultural production, industrial production etc. over a period of time.

3) **Value Index Number :** The value of a commodity is the product of its price and quantity (p × q). Value index number measures the changes in the value of a variable in terms of rupee. It is a more informative index as it combines both, changes in the price as well as quantity.

4) **Special Purpose Index Number :** They are constructed with some specific purpose. For example, import-export index numbers, labour productivity index numbers, share price index numbers etc.

Do you know?

Some of the widely used index numbers by the Government of India :

- Consumer Price Index
- Wholesale Price Index
- Index of Agricultural Production
- Index of Industrial Production
- Index of Service Production
- Index of Export/Import
- Human Development Index

Significance of Index Numbers in Economics :

Index numbers are indispensable tools of economic analysis. Following points explain the significance of index numbers :

1) **Framing suitable policies :** Index numbers provide guidelines to policy makers in framing suitable economic policies such as agricultural policy, industrial policy, fixation of wages and dearness allowances in accordance with the cost of living etc.

2) **Studies trends and tendencies :** Index numbers are widely used to measure changes in economic variables such as production, prices, exports, imports etc. over a period of time. For example, by examining the index of industrial production for the last five years, we can draw important conclusions about the trend of industrial production whether it shows an upward tendency or a downward tendency.

3) **Forecasting about future economic activity :** Index numbers are useful for making predictions for the future based on the analysis of the past and present trends in the economic activities. For example, based on the available data pertaining to imports and exports, future predictions can be made. Thus, forecasting guides in proper decision making.

4) **Measurement of inflation :** Index numbers are also used to measure changes in the price level from time to time. It enables the government to undertake appropriate anti-inflationary measures. There is a legal provision to pay the D.A. (dearness

allowance) to the employees in organised sector on the basis of changes in Dearness Index.

5) **Useful to present financial data in real terms :** Deflating means to make adjustments in the original data. Index numbers are used to adjust price changes, wage changes etc. Thus, deflating helps to present financial data in real terms (at constant prices).

Construction of Index Numbers :

Following steps are involved in the construction of index numbers :

1) **Purpose of index number :** The purpose for constructing the index number, its scope as well as which variable is intended to be measured should be clearly decided to achieve fruitful results.

2) **Selection of the base year :** Base year is also called the reference year. It is the year against which comparisons are made. The base year should be normal i.e. it should be free from natural calamities. It should not be too distant in the past.

Do you know?

In 2015, the Central Statistical Organisation (CSO) under the Ministry of Statistics changed the base year for tabulating Gross Domestic Product from 2004-05 to 2011-12. Periodic rebasing of GDP series every seven to ten years is carried out to account for the changing economic structure and relative prices. Besides this, the base year of Index of Industrial Production (IIP) and the base year of Wholesale Price Index (WPI) has also been changed from 2004-05 to 2011-12. At present, the process of further rebasing the base year is underway.

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3) **Selection of items :** It is necessary to select a sample of the number of items to be included in the construction of a particular index number. For example, in the construction of price index numbers it is impossible to include each and every commodity. The commodities to be selected should represent the tastes, habits and customs of the people. Besides this, only standardized or graded items should be included to give better results.

4) **Selection of price quotations :** Prices of the selected commodities may vary from place to place and shop to shop in the same market. Therefore, it is desirable that price quotations should be obtained from an unbiased price reporting agency. To achieve accuracy, proper selection of representative places and persons is required.

5) **Choice of a suitable average :** Construction of index numbers requires choice of a suitable average. Generally, Arithmetic mean is used in the construction of index numbers because it is simple to compute compared to other averages.

6) **Assigning proper weights :** Weight refers to the relative importance of the different items in the construction of an index number. Weights are of two types i.e. quantity weights (q) and value weights (p x q). Since all items are not of equal importance, by assigning specific weights, better results can be achieved.

7) **Selection of an appropriate formula :** Various formulae are devised for the construction of index numbers. Choice of a suitable formula depends upon the purpose of index number and availability of data.

Methods of Constructing Index Numbers :

There are two methods of constructing index numbers:

a) Simple Index Number

b) Weighted Index Number

The following chart explains the methods of constructing index numbers :
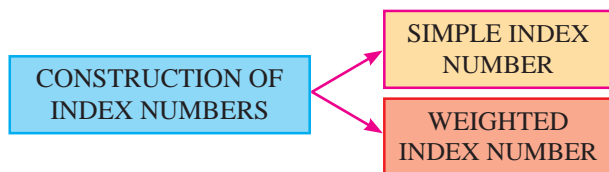
A) Simple Index Number : In this method, every commodity is given equal importance. It is the easiest method of constructing index numbers. This method can be applied to determine

1) Price Index Number
2) Quantity Index Number
3) Value Index Number

Some Solved Examples :

1) Price index number : It is measured as:

Price Index Number $P_{01} = \dfrac{\Sigma p_1}{\Sigma p_0} \times 100$

where, Σp_1 = sum total of the prices of the current year

Σp_0 = sum total of the prices of the base year

Ex 1 : Construct a Price index number using the simple method from the given data :

Steps : 1) Add the prices of the different commodities of the base year to derive Σp_0

2) Add the prices of the different commodities of the current year to derive Σp_1

3) Apply the formula :

Price Index Number $P_{01} = \dfrac{\Sigma p_1}{\Sigma p_0} \times 100$

Commodities	Prices in 2010 (in ₹) Base year) p_0	Prices in 2015 (in ₹) (Current year) p_1
A	20	30
B	60	80
C	100	130
D	40	60
Total	$\Sigma p_0 = 220$	$\Sigma p_1 = 300$

Price Index Number $P_{01} = \dfrac{\Sigma p_1}{\Sigma p_0} \times 100$

$P_{01} = \dfrac{300}{220} \times 100 = 136.36$

$P_{01} = 136.36$

2) Quantity index number : It is measured as :

Quantity Index Number $Q_{01} = \dfrac{\Sigma q_1}{\Sigma q_0} \times 100$

where, Σq_1 = sum total of the quantities of the current year

Σq_0 = sum total of the quantities of the base year

Ex 2 : Construct a Quantity index number using the simple method from the given data :

Steps : 1) Add the quantities of the different commodities of the base year to derive Σq_0

2) Add the quantities of the different commodities of the current year to derive Σq_1

3) Apply the formula :

Quantity Index Number $Q_{01} = \dfrac{\Sigma q_1}{\Sigma q_0} \times 100$

Commodities	Qty. in 2000 (Base year) q_0	Qty. in 2001 (Current year) q_1
A	30	45
B	55	70
C	90	105
D	35	60
Total	$\Sigma q_0 = 210$	$\Sigma q_1 = 280$

Quantity Index Number $Q_{01} = \dfrac{\Sigma q_1}{\Sigma q_0} \times 100$

$Q_{01} = \dfrac{280}{210} \times 100 = 133.33$

$Q_{01} = 133.33$

3) Value Index Number : It is measured as :

Value Index Number $V_{01} = \dfrac{\Sigma p_1 q_1}{\Sigma p_0 q_0} \times 100$

where, $\Sigma p_1 q_1$ = sum total of the product of the prices and quantities of the current year.

$\Sigma p_0 q_0$ = sum total of the product of the prices and quantities of the base year.

Ex 3 : Construct a Value index number using the simple method from the given data :

Steps : 1) Find the product of prices and their respective quantities of the different commodities for the base year to derive $p_0 q_0$. Take the sum total of the products to derive $\Sigma p_0 q_0$.

2) Find the product of prices and their respective quantities of the different commodities for the

current year to derive p_1q_1. Take sum total of the products to derive Σp_1q_1.

3) Apply the formula :

Value Index Number $V_{01} = \dfrac{\Sigma p_1q_1}{\Sigma p_0q_0} \times 100$

Commodities	Base year			Current year		
	p_0	q_0	p_0q_0	p_1	q_1	p_1q_1
P	5	4	20	20	10	200
Q	10	3	30	30	8	240
R	15	2	30	40	6	240
S	20	1	20	50	4	200
Total	Σp_0q_0	=	100	Σp_1q_1	=	880

Value Index Number $V_{01} = \dfrac{\Sigma p_1q_1}{\Sigma p_0q_0} \times 100$

$V_{01} = \dfrac{880}{100} \times 100 = 880$

$V_{01} = 880$

B) **Weighted Index Number :** In this method, suitable weights are assigned to various commodities. It gives relative importance to the commodity in the group. In most of the cases 'quantities' are used as weights. There are various methods of constructing weighted index number such as Laaspeyre's Price Index, Paasche's Price Index etc.

Some Solved Examples :

Étienne Laspeyres : German economist Étienne Laspeyres (1834–1913) formulated an index for measuring current prices or quantities in relation to those of a selected 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.

1) **Laaspeyre's Price Index Number :** In this technique, 'base year' quantities are considered as weights. Laaspeyre's price index is calculated as :

$P_{01} = \dfrac{\Sigma p_1q_0}{\Sigma p_0q_0} \times 100$

Ex. 1 : Construct Laaspeyre's Index for the given data :

Commodities	Base year		Current year	
	p_0	q_0	p_1	q_1
A	20	4	30	6
B	10	5	20	8
C	40	8	60	5
D	30	4	40	4

Solution :

Commodities	Base year		Current year			
	p_0	q_0	p_1	q_1	p_1q_0	p_0q_0
A	20	4	30	6	120	80
B	10	5	20	8	100	50
C	40	8	60	5	480	320
D	30	4	40	4	160	120
Total					860	570

Steps : 1) Find out the product p_1q_0 of the different commodities.

2) Find out the product p_0q_0 of the different commodities.

3) Add all the products p_1q_0 obtained to derive Σp_1q_0.

4) Add all the products p_0q_0 obtained to derive Σp_0q_0.

5) Apply the given formula :

$P_{01} = \dfrac{\Sigma p_1q_0}{\Sigma p_0q_0} \times 100$

$P_{01} = \dfrac{860}{570} \times 100 = 150.87$

Thus, Laaspeyre's index $P_{01} = 150.87$

Do you know?

Sensex and Nifty are stock market indices which represent Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) respectively.

Sensex, also called BSE 30, is the market index consisting of 30 well-established and financially sound companies listed on Bombay Stock Exchange (BSE). The base year of Sensex is 1978-79.

Nifty, also called NIFTY 50, is the market

Hermann Paasche : German economist Hermann Paasche (1851-1925) developed an index for measuring current price or quantity levels relative to those of a selected base period. Paasche's index uses current-period weighting.

2) **Paasche's Price Index Number :** In this technique, quantities of the 'current year' are considered as weights. Paasche's Price Index is calculated as :

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

Ex. 2 : Construct Paasche's Index for the given data :

Commodities	Base year		Current year	
	p_0	q_0	p_1	q_1
M	2	10	5	8
N	4	5	8	3
O	1	7	2	10
P	5	8	10	5

Solution :

Commodities	Base year		Current year			
	p_0	q_0	p_1	q_1	$p_1 q_1$	$p_0 q_1$
M	2	10	5	8	40	16
N	4	5	8	3	24	12
O	1	7	2	10	20	10
P	5	8	10	5	50	25
Total					134	63

Steps : 1) Find out the product $p_1 q_1$ of the different commodities.

2) Find out the product $p_0 q_1$ of the different commodities.

3) Add all the products $p_1 q_1$ obtained to derive $\Sigma p_1 q_1$.

4) Add all the products $p_0 q_1$ obtained to derive $\Sigma p_0 q_1$.

5) Apply the given formula :

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

$$P_{01} = \frac{134}{63} \times 100 = 212.69$$

Thus, Paasche's index $P_{01} = 212.69$

Find out :
- List of crops included in the Index of Agricultural Production in India.
- List of products included in the Index of Industrial Production in India.

Limitations of index numbers :

Index numbers are useful in practice. However they suffer from certain limitations. Therefore, they are not completely reliable.

1) **Based on samples :** Index numbers are generally based on samples. We cannot include all the items in the construction of the index numbers. Hence they are not free from sampling errors.

2) **Bias in the data :** Index numbers are constructed on the basis of various types of data which may be incomplete. There may be bias in the data collected. This is bound to affect the results of the index numbers.

3) **Misuse of Index Numbers :** Index numbers can be misused. They compare a situation in the current year with a situation in the base year. Hence a person may choose a base year which will be suitable for his purpose. For example, a businessman may choose a year in which his profit is high as the base year and show that his profit is falling in the current years.

4) **Defects in formulae :** There is no perfect formula for the construction of an index number. It is only an average and so it has all the limitations of an average.

5) **Changes in the economy :** The habits, tastes and expectations of the people in

a country are always changing and all these changes cannot be included in the estimation of index numbers.

6) **Qualitative changes :** The price or quantity index numbers may ignore the changes in qualities of the products. At any given time, a better quality commodity will have a higher production cost and a higher price than an ordinary commodity which is a substitute for the better product.

7) **Arbitrary weights :** The weights assigned to different commodities may be arbitrary.

8) **Limited scope :** An index number has limited scope because if it is constructed for one purpose then it cannot be used for any other purpose.

Find out :

Newspaper headlines related to the following types of index numbers :

- Price Index
- Agricultural Productivity Index
- Index of Industrial Production
- Equity Share Price Index

EXERCISE

Q. 1. Choose the correct option :

1) Statements that are incorrect in relation to index numbers.
   a) Index number is a geographical tool.
   b) Index numbers measure changes in the air pressure.
   c) Index numbers measure relative changes in an economic variable.
   d) Index numbers are specialized averages.

   Options : 1) c and d   2) a and b
   3) b and c   4) a and d

2) Statements that highlight the significance of index numbers.
   a) Index numbers are useful for making future predictions.
   b) Index numbers help in the measurement of inflation.
   c) Index numbers help to frame suitable policies.
   d) Index numbers can be misused.

   Options : 1) b, c and d   2) a, c and d
   3) a, b and d   4) a, b and c

3) Statements that apply to weighted index numbers.
   a) Every commodity is given equal importance.
   b) It assigns suitable 'weights' to various commodities.

c) In most of the cases, quantities are used as weights.
d) Laaspeyre's and Paasche's method is used in the calculation of weighted index numbers.

Options : 1) b, c and d   2) a, c and d
   3) a, b and d   4) a, b, c and d

4) Statements related to limitations of index numbers.
   a) Index numbers are not completely reliable.
   b) There may be a bias in the data collected.
   c) Every formula has some kind of defect.
   d) Index numbers ignore changes in the qualities of products.

   Options : 1) a, c and d   2) a, b, c and d
   3) a, b and d   4) b, c and d

5) Choose the correct pair :

Group A		Group B
1) Price Index	a)	$\dfrac{\Sigma p_1 q_1}{\Sigma p_0 q_0} \times 100$
2) Value Index	b)	$\dfrac{\Sigma q_1}{\Sigma q_0} \times 100$
3) Quantity Index	c)	$\dfrac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \times 100$
4) Paasche's Index	d)	$\dfrac{\Sigma p_1}{\Sigma p_0} \times 100$

Options : 1) 1-d, 2-c, 3-a, 4-b   2) 1-d, 2-a, 3-b, 4-c
   3) 1-b, 2-c, 3-d, 4-a   4) 1-c, 2-d, 3-a, 4-b

Q. 2. Complete the Correlation :

1) Price Index : Inflation :: [_____] : Agricultural production

2) [_____] : Base year prices :: P_1 : Current year prices

3) Laaspeyre's index : [_____] :: Paasche's index : Current year quantities

4) [_____] : Single variable :: Composite index : Group of variables

Q. 3. Solve the following :

1) Calculate Price Index number from the given data :

Commodity	A	B	C	D
Price in 2005 (₹)	6	16	24	4
Price in 2010 (₹)	8	18	28	6

2) Calculate Quantity Index number from the given data :

Commodity	P	Q	R	S	T
Base year quantities	170	150	100	195	205
Current year quantities	90	70	75	150	95

3) Calculate Value Index number from the given data :

Commodity	Base Year		Current Year	
	Price	Quantity	Price	Quantity
A	40	15	70	20
B	10	12	60	22
C	50	10	90	18
D	20	14	100	16
E	30	13	40	15

4) Calculate Laaspeyre's and Paasche's index from the given data :

Commodity	Base Year		Current Year	
	Price	Quantity	Price	Quantity
X	8	30	12	25
Y	10	42	20	16

Q. 4. Distinguish between :

1) Simple Index Numbers and Weighted Index Numbers.

2) Price Index and Quantity Index.

3) Laaspeyre's Index and Paasche's Index.

Q. 5. State with resons whether you agree or disagree with the following statements :

1) Index numbers measure changes in the price level only.

2) Index numbers are free from limitations.

3) Index numbers can be constructed without the base year.

Q. 6. Answer the following :

1) Explain the features of index numbers.

2) Explain the significance of index numbers in economics

Q. 7. Answer in detail :

1) Explain the steps involved in the construction of index numbers.

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