# Index Numbers: Characteristics, Formula, Examples, Types, Importance and Limitations

In this article we will discuss about:-

1. Meaning of Index Numbers
2. Features of Index Numbers
3. Steps or Problems in the Construction
4. Construction of Price Index Numbers (Formula and Examples)
5. Difficulties in Measuring Changes in Value of Money
6. Types of Index Numbers
7. Importance
8. Limitations.

**Meaning of Index Numbers:**

The value of money does not remain constant over time. It rises or falls and is inversely related to the changes in the price level. A rise in the price level means a fall in the value of money and a fall in the price level means a rise in the value of money. Thus, changes in the value of money are reflected by the changes in the general level of prices over a period of time. Changes in the general level of prices can be measured by a statistical device known as 'index number.'

Index number is a technique of measuring changes in a variable or group of variables with respect to time, geographical location or other characteristics. There can be various types of index numbers, but, in the present context, we are concerned with price index numbers, which measures changes in the general price level (or in the value of money) over a period of time.

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Price index number indicates the average of changes in the prices of representative commodities at one time in comparison with that at some other time taken as the base period. According to L.V. Lester, "An index number of prices is a figure showing the height of average prices at one time relative to their height at some other time which is taken as the base period."

**Features of Index Numbers:**

The following are the main features of index numbers:

(i) Index numbers are a special type of average. Whereas mean, median and mode measure the absolute changes and are used to compare only those series which are expressed in the same units, the technique of index numbers is used to measure the relative changes in the level of a phenomenon where the measurement of absolute change is not possible and the series are expressed in different types of items.

(ii) Index numbers are meant to study the changes in the effects of such factors which cannot be measured directly. For example, the general price level is an imaginary concept and is not capable of

direct measurement. But, through the technique of index numbers, it is possible to have an idea of relative changes in the general level of prices by measuring relative changes in the price level of different commodities.

(iii) The technique of index numbers measures changes in one variable or group of related variables. For example, one variable can be the price of wheat, and group of variables can be the price of sugar, the price of milk and the price of rice.

(iv) The technique of index numbers is used to compare the levels of a phenomenon on a certain date with its level on some previous date (e.g., the price level in 1980 as compared to that in 1960 taken as the base year) or the levels of a phenomenon at different places on the same date (e.g., the price level in India in 1980 in comparison with that in other countries in 1980).

**Steps or Problems in the Construction of Price Index Numbers:**

The construction of the price index numbers involves the following steps or problems:

1. Selection of Base Year:

The first step or the problem in preparing the index numbers is the selection of the base year. The base year is defined as that year with reference to which the price changes in other years are compared and expressed as percentages. The base year should be a normal year.

In other words, it should be free from abnormal conditions like wars, famines, floods, political instability, etc. Base year can be selected in two ways- (a) through fixed base method in which the base year remains fixed; and (b) through chain base method in which the base year goes on changing, e.g., for 1980 the base year will be 1979, for 1979 it will be 1978, and so on.

2. Selection of Commodities:

The second problem in the construction of index numbers is the selection of the commodities. Since all commodities cannot be included, only representative commodities should be selected keeping in view the purpose and type of the index number.

In selecting items, the following points are to be kept in mind:

(a) The items should be representative of the tastes, habits and customs of the people.

(b) Items should be recognizable,

(c) Items should be stable in quality over two different periods and places.

(d) The economic and social importance of various items should be considered

(e) The items should be fairly large in number.

(f) All those varieties of a commodity which are in common use and are stable in character should be included.

3. Collection of Prices:

After selecting the commodities, the next problem is regarding the collection of their prices:

(a) From where the prices to be collected;

(b) Whether to choose wholesale prices or retail prices;

(c) Whether to include taxes in the prices or not etc.

While collecting prices, the following points are to be noted:

(a) Prices are to be collected from those places where a particular commodity is traded in large quantities.

(b) Published information regarding the prices should also be utilised,

(c) In selecting individuals and institutions who would supply price quotations, care should be taken that they are not biased.

(d) Selection of wholesale or retail prices depends upon the type of index number to be prepared. Wholesale prices are used in the construction of general price index and retail prices are used in the construction of cost-of-living index number.

(e) Prices collected from various places should be averaged.

4. Selection of Average:

Since the index numbers are, a specialised average, the fourth problem is to choose a suitable average. Theoretically, geometric mean is the best for this purpose. But, in practice, arithmetic mean is used because it is easier to follow.

5. Selection of Weights:

Generally, all the commodities included in the construction' of index numbers are not of equal importance. Therefore, if the index numbers are to be representative, proper weights should be assigned to the commodities according to their relative importance.

For example, the prices of books will be given more weightage while preparing the cost-of-living index for teachers than while preparing the cost-of-living index for the workers. Weights should be unbiased and be rationally and not arbitrarily selected.

6. Purpose of Index Numbers:

The most important consideration in the construction of the index numbers is the objective of the index numbers. All other problems or steps are to be viewed in the light of the purpose for which a particular index number is to be prepared. Since, different index numbers are prepared with specific purposes and no single index number is 'all purpose' index number, it is important to be clear about the purpose of the index number before its construction.

7. Selection of Method:

The selection of a suitable method for the construction of index numbers is the final step.

There are two methods of computing the index numbers:

(a) Simple index number and

(b) Weighted index number.

Simple index number again can be constructed either by – (i) Simple aggregate method, or by (ii) simple average of price relative's method. Similarly, weighted index number can be constructed either by (i) weighted aggregative method, or by (ii) weighted average of price relative's method. The choice of method depends upon the availability of data, degree of accuracy required and the purpose of the study.

**Construction of Price Index Numbers (Formula and Examples):**

Construction of price index numbers through various methods can be understood with the help of the following examples:

1. Simple Aggregative Method:

In this method, the index number is equal to the sum of prices for the year for which index number is to be found divided by the sum of actual prices for the base year.

The formula for finding the index number through this method is as follows:

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

Where $P_{01}$ Stands for the index number

$\Sigma P_1$ Stands for the sum of the prices for the year for which index number is to be found :

$\Sigma P_0$ Stands for the sum of prices for the base year.

| Commodity | Prices in Base Year 1980 (in Rs.) $P_o$ | Prices in current Year 1988 (in Rs.) $P_1$ |
|:---:|:---:|:---:|
| A | 10 | 20 |
| B | 15 | 25 |
| C | 40 | 60 |
| D | 25 | 40 |
| Total | $\Sigma P_0 = 90$ | $\Sigma P_1 = 145$ |

Index Number $(P_{01}) = \dfrac{\Sigma P_1}{\Sigma P_0} \times 100$ ; $P_{01} = \dfrac{145}{90} \times 100$ ; $P_{01} = 161.11$

## 2. Simple Average of Price Relatives Method:

In this method, the index number is equal to the sum of price relatives divided by the number of items and is calculated by using the following formula:

$$P_{01} = \frac{\Sigma R}{N}$$

Where $\Sigma R$ stands for the sum of price relatives i. e. $R = \dfrac{P_1}{P_0} \times 100$ and

N stands for the number of items.

**Example**

| Commodity | Base Year Prices (in Rs.) $P_0$ | Current year Prices (in Rs.) $P_1$ | Price Relatives $R = \dfrac{P_1}{P_0} \times 100$ |
|:---:|:---:|:---:|:---:|
| A | 10 | 20 | $\dfrac{20}{10} \times 100 = 200.0$ |
| B | 15 | 25 | $\dfrac{25}{15} \times 100 = 166.7$ |
| C | 40 | 60 | $\dfrac{60}{40} \times 100 = 150.00$ |
| D | 25 | 40 | $\dfrac{40}{25} \times 100 = 160.0$ |
| N = 4 | | | $\Sigma R = 676.7$ |

Index Number $(p_{01}) = \dfrac{\Sigma R}{N}$

$P_{01} = \dfrac{676.7}{4}$ ; $P_{01} = 169.2$

## 3. Weighted Aggregative Method:

In this method, different weights are assigned to the items according to their relative importance. Weights used are the quantity weights. Many formulae have been developed to estimate index numbers on the basis of quantity weights.

Some of them are explained below:

(i) **Laspeyre's Formula.** In this formula, the quantities of base year are accepted as weights.

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

Where $P_1$ is the price in the current year ; $P_0$ is the price in the base year ; and $q_0$ is the quantity in the base year.

(ii) **Paasche's Formula.** In this formula, the quantities of the current year are accepted as weights.

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

Where $q_1$ is the quantity in the current year.

(iii) **Dorbish and Bowley's Formula.** Dorbish and Bowley's formula for estimating weighted index number is as follows :

$$P_{01} = \frac{\dfrac{\Sigma P_1 q_0}{\Sigma P_0 q_0} + \dfrac{\Sigma P_1 q_1}{\Sigma P_0 q_1}}{2} \times 100 \quad \text{or} \quad P_{01} = \frac{L + P}{2}$$

Where L is Laspeyre's index and P is paasche's Index.

(iv) **Fisher's Ideal Formula.** In this formula, the geometric mean of two indices (i.e., Laspeyre's Index and paasche's Index) is taken :

$$P_{01} = \sqrt{\frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times \frac{\Sigma P_1 q_1}{\Sigma P_0 q_1}} \times 100 \quad \text{or} \quad P_{01} = \sqrt{L \times P} \times 100$$

where L is Lespeyre's Index and P is paasche's Index.

### Example

| Comm-odity | Base Year | | Current Year | | $P_0 q_0$ | $P_1 q_0$ | $P_0 q_1$ | $P_1 q_1$ |
|---|---|---|---|---|---|---|---|---|
| | $P_0$ | $q_0$ | $P_1$ | $q_1$ | | | | |
| A | 10 | 5 | 20 | 2 | 50 | 100 | 20 | 40 |
| B | 15 | 4 | 25 | 8 | 60 | 100 | 120 | 200 |
| C | 40 | 2 | 60 | 6 | 80 | 120 | 240 | 360 |
| D | 25 | 3 | 40 | 4 | 75 | 120 | 100 | 160 |
| Total | | | | | 265 $\Sigma P_0 q_0$ | 440 $\Sigma P_1 q_0$ | 480 $\Sigma P_0 q_1$ | 760 $\Sigma P_1 q_1$ |

(i) Laspeyre's Formula :

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

$$P_{01} = \frac{440}{265} \times 100 = 166.04$$

(*ii*) Paasche' Formula :

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

$$P_{01} = \frac{700}{480} \times 100 = 158.3$$

(*iii*) Dorbish and Bowley's Formula :

$$P_{01} = \frac{\dfrac{\Sigma P_1 q_0}{\Sigma P_0 q_0} + \dfrac{\Sigma P_1 q_1}{\Sigma P_0 q_1}}{2} \times 100 = 162.2$$

$$P_{01} = \frac{\dfrac{440}{265} + \dfrac{760}{480}}{2} \times 100 = 162$$

(*iv*) Fisher's Ideal Formula :

$$P_{01} = \sqrt{\frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times \frac{\Sigma P_1 q_1}{\Sigma P_0 q_1}} \times 100$$

$$P_{01} = \sqrt{\frac{440}{265} \times \frac{760}{480}} \times 100 = 162.1$$

4. Weighted Average of Relatives Method:

In this method also different weights are used for the items according to their relative importance.

The price index number is found out with the help of the following formula:

$$P_{01} = \frac{\Sigma RW}{\Sigma W}$$

where $\Sigma W$ stands for the sum of weights of different commodities :
and $\Sigma R$ stands for the sum of price relatives.

| Commodity | Weights W | Base Prices Year $P_0$ | Current Year Prices $P_1$ | Price Relatives $R = \dfrac{P_1}{P_0} \times 100$ | RW |
|---|---|---|---|---|---|
| A | 5 | 10 | 20 | 20/10 × 100 = 200.0 | 1000.0 |
| B | 4 | 15 | 25 | 25/15 × 100 = 166.7 | 666.8 |
| C | 2 | 40 | 60 | 60/40 × 100 = 150.0 | 300.0 |
| D | 3 | 25 | 40 | 40/25 × 100 = 160.0 | 480.0 |
| Total | $\Sigma W = 14$ | | | | $\Sigma RW = 2446.8$ |

Index Number $(P_{01}) = \dfrac{\Sigma RW}{\Sigma W}$

$$P_{01} = \frac{2446.8}{14} = 174.8$$

**Difficulties in Measuring Changes in Value of Money:**

Measurement of changes in the value of money through price index number is not an easy and reliable technique. There are a number of theoretical as well as practical difficulties in the construction of price index numbers. Moreover, the index number technique itself has many limitations.

(A) Conceptual Difficulties:

The following are the conceptual difficulties during the construction of price index numbers:

1. Vague Concept of Value of Money:

The concept of money is vague, abstract and cannot be clearly defined. The value of money is a relative concept which changes from person to person depending upon the type of goods on which the money is spent.

2. Inaccurate Measurement:

Price index numbers do not measure the changes in the value of money accurately and reliably. A rise or fall in the general level of prices as indicated by the price index numbers does not mean that the price of every commodity has risen or fallen to the same extent.

3. Reflect General Changes:

Price index numbers are averages and measure general changes in the value of money on the average. Therefore, they are not of much significance for the particular individuals who may be affected by the changes in the actual prices quite differently from that indicated by the index numbers.

4. Limitations of Wholesale Price Index:

The wholesale price index numbers, which are generally used to measure changes in the value of money, suffer from certain limitations:

(a) They do not reflect the changes in the cost of living because retail prices are generally higher than the wholesale prices.

(b) They ignore some of the important items concerning the urban population, such as, expenditure on education, transport, house rent, etc.

(c) They do not take into consideration the changes in the consumers' preferences.

(B) Practical Difficulties:

The practical difficulties in the way of constructing price index numbers, and therefore, in measuring changes in the value of money are as follows:

## 1. Selection of Base Year:

While preparing the index number, first difficulty arises regarding the selection of base year. The base year should be a normal year. But, it is very difficult to find out a fully normal year free from any unusual happening. There is every possibility that the selected base year may be an abnormal year, or a distant year, or may be selected by an immature or biased person.

## 2. Selection of Items:

The selection of the representative commodities is the second difficulty in the construction of index numbers:

(a) With the passage of time the quality of the product may change ; if the quality of a product changes in the year of enquiry from what it was in the base year, the product becomes irrelevant,

(b) The relative importance of certain commodities may change due to a change in the consumption pattern of the people in the course of time; for example, Vanaspati Ghee was not an important item of consumption in India in the pre-war period, but today it has become an item of necessity. Under such conditions, it is not easy to select the appropriate commodities.

## 3. Collection of Prices:

It is also difficult to obtain correct, adequate and representative data regarding prices. It is not an easy job to select representative places from which the information about prices to be collected and to select the experienced and unbiased individuals or institutions who will supply price quotations. Moreover, there is the problem of deciding which prices (wholesale or retail) are to be taken into consideration. It is comparatively easy to get information about wholesale prices which vary considerably.

## 4. Assigning Weights:

Another important difficulty that arises in preparing the index numbers is that of assigning proper weights to different items in order to arrive at correct and unbiased conclusions. As there are no hard and fast rules to weights for the commodities according to their relative importance, there is very likelihood that the weights are decided arbitrarily on the basis of personal judgement and involve biasness.

## 5. Selection of Averages:

Another major problem is that which average should be employed to find out the price relatives. There are many types of averages such as arithmetic average, geometric average, mean, median, mode, etc. The use of different averages gives different results. Therefore, it is essential to select the method with great care. Dr. Marshall has advocated the use of chain index number to solve the problem of averaging and weighing.

6. Problem of Dynamic Changes:

In the dynamic world, the consumption pattern of the individuals and the number and varieties of goods undergo continuous changes.

They create difficulties for preparing index numbers and making temporal comparisons:

(a) Since, in the course of time, old commodities may disappear and many new ones come into existence, the long-run comparison may become difficult,

(b) The quantity and quality of commodities may also change over the period of time, thus making the choice of commodities for constructing index numbers difficult,

(c) A number of factors, like income, education, fashion, etc., bring changes in the consumption pattern of the people which render the index numbers uncomparable.

**Types of Index Numbers:**

Index numbers are of different types.

Important types of index numbers are discussed below:

1. Wholesale Price Index Numbers:

Wholesale price index numbers are constructed on the basis of the wholesale prices of certain important commodities. The commodities included in preparing these index numbers are mainly raw-materials and semi-finished goods. Only the most important and most price-sensitive and semi- finished goods which are bought and sold in the wholesale market are selected and weights are assigned in accordance with their relative importance.

The wholesale price index numbers are generally used to measure changes in the value of money. The main problem with these index numbers is that they include only the wholesale prices of raw materials and semi-finished goods and do not take into consideration the retail prices of goods and services generally consumed by the common man. Hence, the wholesale price index numbers do not reflect true and accurate changes in the value of money.

2. Retail Price Index Numbers:

These index numbers are prepared to measure the changes.in the value of money on the basis of the retail prices of final consumption goods. The main difficulty with this index number is that the retail price for the same goods and for continuous periods is not available. The retail prices represent larger and more frequent fluctuations as compared to the wholesale prices.

3. Cost-of-Living Index Numbers:

These index numbers are constructed with reference to the important goods and services which are consumed by common people. Since the number of these goods and services is very large, only

representative items which form the consumption pattern of the people are included. These index numbers are used to measure changes in the cost of living of the general public.

4. Working Class Cost-of-Living Index Numbers:

The working class cost-of-living index numbers aim at measuring changes in the cost of living of workers. These index numbers are consumed on the basis of only those goods and services which are generally consumed by the working class. The prices of these goods and index numbers are of great importance to the workers because their wages are adjusted according to these indices.

5. Wage Index Numbers:

The purpose of these index numbers is to measure time to time changes in money wages. These index numbers, when compared with the working class cost-of-living index numbers, provide information regarding the changes in the real wages of the workers.

6. Industrial Index Numbers:

Industrial index numbers are constructed with an objective of measuring changes in the industrial production. The production data of various industries are included in preparing these index numbers.

**Importance of Index Numbers:**

Index numbers are used to measure all types of quantitative changes in different fields.

Various advantages of index numbers are given below:

1. General Importance:

In general, index numbers are very useful in a number of ways:

(a) They measure changes in one variable or in a group of variables.

(b) They are useful in making comparisons with respect to different places or different periods of time,

(c) They are helpful in simplifying the complex facts.

(d) They are helpful in forecasting about the future,

(e) They are very useful in academic as well as practical research.

2. Measurement of Value of Money:

Index numbers are used to measure changes in the value of money or the price level from time to time. Changes in the price level generally influence production and employment of the country as well as various sections of the society. The price index numbers also forewarn about the future inflationary tendencies and in this way, enable the government to take appropriate anti- inflationary measures.

### 3. Changes in Cost of Living:

Index numbers highlight changes in the cost of living in the country. They indicate whether the cost of living of the people is rising or falling. On the basis of this information, the wages of the workers can be adjusted accordingly to save the wage earners from the hardships of inflation.

### 4. Changes in Production:

Index numbers are also useful in providing information regarding production trends in different sectors of the economy. They help in assessing the actual condition of different industries, i.e., whether production in a particular industry is increasing or decreasing or is constant.

### 5. Importance in Trade:

Importance in trade with the help of index numbers, knowledge about the trade conditions and trade trends can be obtained. The import and export indices show whether foreign trade of the country is increasing or decreasing and whether the balance of trade is favourable or unfavourable.

### 6. Formation of Economic Policy:

Index numbers prove very useful to the government in formulating as well as evaluating economic policies. Index numbers measure changes in the economic conditions and, with this information, help the planners to formulate appropriate economic policies. Further, whether particular economic policy is good or bad is also judged by index numbers.

### 7. Useful in All Fields:

Index numbers are useful in almost all the fields. They are specially important in economic field.

Some of the specific uses of index numbers in the economic field are:

(a) They are useful in analysing markets for specific commodities.

(b) In the share market, the index numbers can provide data about the trends in the share prices,

(c) With the help of index numbers, the Railways can get information about the changes in goods traffic.

(d) The bankers can get information about the changes in deposits by means of index numbers.

Limitations of Index Numbers:

Index number technique itself has certain limitations which have greatly reduced its usefulness:

(i) Because of the various practical difficulties involved in their computation, the index numbers are never cent per cent correct.

(ii) There are no all-purpose index numbers. The index numbers prepared for one purpose cannot be used for another purpose. For example, the cost-of-living index numbers of factory workers cannot be used to measure changes in the value of money of the middle income group.

(iii) Index numbers cannot be reliably used to make international comparisons. Different countries include different items with different qualities and use different base years in constructing index numbers.

(iv) Index numbers measure only average change and indicate only broad trends. They do not provide accurate information.

(v) While preparing index numbers, quality of items is not considered. It may be possible that a general rise in the index is due to an improvement in the quality of a product and not because of a rise in its price.

# For tests of Index numbers go to this link

https://youtu.be/G3us8yEhMyE