Index Numbers

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What are Index Numbers ??

It is a statistics which assigns a single number to several individuals statistics in order to quantify trends. Two or more time periods are involved, one of which is the base time period.

- In other words, Index numbers is a statistical tool for measuring relative change in a group of related variables over two or more different times.
- Index numbers measure relative changes in the price of a sum of representative data.
- Index Numbers are expressed in percentage.

Index Time Series

An Index time series is a list of index numbers for two or more periods of time, where each Index Numbers employs the same base years.

Definition

- 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 Rriffin, "Index Numbers are used to measure changes over time in magnitudes which are not capable of direct measurement."
- In the words of Tuttle, " An index number is a single ratio (usually in percentage)which measures the combined (i.e., averaged) change of several variables between two different times, places or situations."
- In the words of Edge worth, "Index number shows by its variation the changes in a magnitude which is not susceptible either of a accurate measurement in itself or of direct valuation in practice."

Features of Index Numbers

- They are expressed in percentages.
- They are special types of averages.
- They measure the effect of change over a period of time.

Steps (or) Problem in the Construction of Index Numbers

1. Defining the purpose of index numbers
2. Selection of items
3. Selection of base period
4. Selection of prices
5. Selection of weights
6. Choice of an average
7. Choice of the formulae

Notation used in Index Numbers

Basis	Narration
Base year	The year selected for the comparison
Current year	The year for which comparison are sought
P_0	Price of commodity in the Base year
P_1	Price of 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 during the Current year
W	Weight assigned to a commodity according to its relative importance in the group

Basis	Narration
P_{01}	Price Index Number for the Base year with reference to the Current year
P_{10}	Price Index Number for the Current year with reference to the Base year
Q_{01}	Quantity Index Number for the Base year with reference to the Current year
Q_{10}	Quantity Index Number for the Current year with reference to the Base year
Price(quantity) Relatives	The Prices(Quantity) corresponding to different time periods with expressed as ratios to the Base year Prices(Quantity) as Price(Quantity) relative Like P_1/P_o, P_2/P_0, P_3/P_0 Q_1/Q_0, Q_2/Q_0, Q_3/Q_0

Types Of Index Numbers

1. Price Index Numbers
2. Quantity Index Numbers
3. Value Index Numbers
4. Simple Index Numbers
5. Composite Index Numbers
6. Cost of Living Index Numbers

Price Index Numbers

Price Index Numbers are most popular and commonly used Index Numbers. These Index Numbers measure the change in price of some commodities or group of commodities consumed in the given period with reference to the Base period.

- There are two types:
  1. Whole sale Price Index: It measures the change in general price level of commodity.
  2. Retail Price Index: It measures the general changes in retail price of commodities.

Construction of Price Index Number

This Compares the prices of group of commodities at a certain time or place with of Base period or place respectively.

- The Simplest Formula for calculating Price Index Number is given by:

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

Quantity Index Numbers

Quantity Index Numbers helps us in measuring and comparing the changes in the physical volume of goods produced or sold or purchased in given amount of year.

Construction of Quantity Index Number

This Index Number measures the changes in the level of quantities of items consumed or produced or distributed during a year under the study with reference to Base year.

- The Simplest Formula for calculating Quantity Index Number is given by:

$$Q_{01} = \frac{Q_1}{Q_0} \times 100$$

Value Index Numbers

Value Index Numbers measure the changes in the value of some commodities or group of commodities consumed or purchased in the given period with reference to base year.

- It is also known as Volume Index Numbers.

Construction of Value Index Number

- This compares the total value of some period with the total value of base periods.
- This Index Number measures the change in the level of value of items consumed during the current year with reference to the value of items consumed in the base year .
- The Simplest Formula for calculating Value Index Number is given by:

$$V_{01} = \frac{\overline{V_1}}{V_0} \times 100$$

$$\left\{ \frac{\overline{V_1}}{V_0} \times 100 \right\} = \left\{ \overline{P_1Q_1} \times 100 \right\}$$

$$\overline{P_1Q_1} = P_0Q_0$$

Simple Index Numbers

A Simple Index Number measures the changes in price or quantity of a single item over time.

- It is calculated by dividing the current year value by the base year value and then multiplying the result by 100.

Construction of Simple Index Number

- **Steps:**
  1. Obtain the prices or quantities for the commodity over the time period of interest.
  2. Select the period used to be as base.
  3. Divide current year price(P_1) of the commodity by the base year(P_0).
  4. Multiply this ratio by 100.
  5. Price Index (I_P)= $\frac{P_1}{P_0} \times 100$
  6. Quantity Index (I_q)= $\frac{Q_1}{Q_0} \times 100$

Composite Index Numbers

The composite index number is a weighted mean of the elementary index numbers in which the weighting represents the "mass" of the elementary numbers(in the case of price indices, this mass is expenditure).

- In Other words, A composite index number measures the variation in the value of a composite number defined as the aggregate of a set of elementary numbers
- For example, the consumer price index measures the variation in the prices of 1,000 varieties of products in a single index number

Methods of Constructing Composite Index Numbers

1. Simple (Unweighted) Index Numbers

(a) Simple Aggregative Method
(b) Simple Average of Price Relatives Method

2. weighted Index Numbers

(a) Simple Average of Price
(b) Weighted Average of Price Relatives Method

Simple Index Numbers

- A simple arithmetic or geometric average used to calculate stock indexes.
- Equal weight is invested in each of the stocks in an index with equal dollar amounts invested in each underlying stock.
- Because the stocks are equally weighted, one stock's performance will not have a dramatic effect on the performance of the index as a whole.
- This differs from weighted indexes, where some stocks are given more weight than others, usually based on their market capitalizations.

Simple Index Method

1. Simple Aggregative Method

2. Simple Average of Price Relatives Method

Simple Aggregative Method

This is the simplest method of constructing index numbers. In this method, aggregate prices of all the selected commodities in the current year are divided by the aggregate prices in the base year and Multiplied by 100 to get Index.

Steps Involved in the constructions of Simple Aggregative Method

1. Add up the current year prices of various commodities and denote by $\sum P_1$.
2. Add up the base year prices of various commodities $\sum P_0$.
3. Use the following formula:

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

Simple Average of Price Relative Method

This index is an improvement over the simple aggregative price index because it is not affected by the unit in which prices are quoted.

- One way to rectify the drawbacks of a simple aggregate index is to construct a simple average of relatives.

➢ Price relative: A price relative is percentage ratio between price of commodity in the current year and that in the base year

Constructions of Simple Average Of Price relative Method

- In this method the price relative of each item is calculated .
- Price Index number of the Current year find out by using the following formula :

$$P_{01} = \frac{\sum \left[\frac{P1}{P0} \times 100 \right]}{N}$$

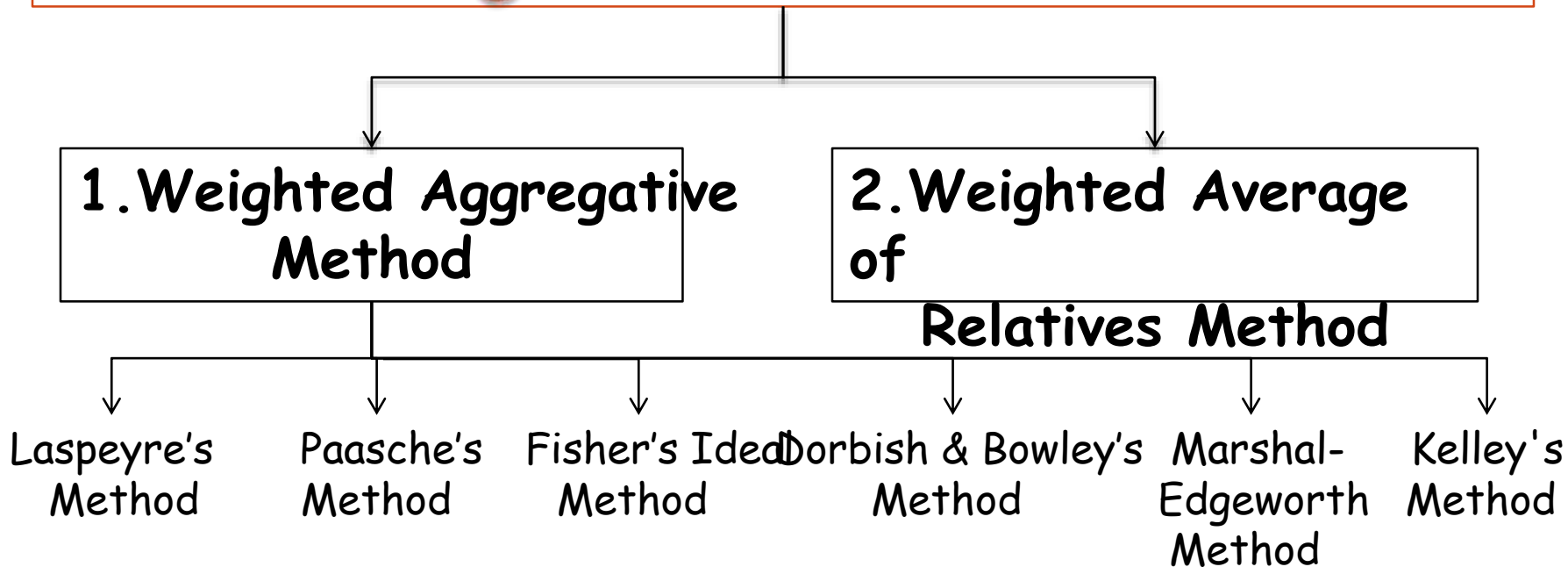
N = Number of goods

$$\text{Price relative} = \frac{P1}{P0} \times 100$$

Weighted Index Numbers

- When all commodities are not of equal importance. We assign weight to each commodity relative to its importance and index number computed from these weights is called weighted index numbers.

Weighted Index Numbers



Weighted Aggregate Numbers

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 formula's in use are:

1. Laspeyer's Method
2. Paasche's Method
3. Fisher's Ideal Method
4. Dorbish & Bowley's Method
5. Marshall-Edgeworth Method
6. Kelley's Method

Laspeyer's Method

The Laspeyre's Price Index is a weighted aggregate price index, where the weights are determined by quantities in the base period. The distinctive feature of the Laspeyre's index is that it uses a group of commodities purchased in the base period as the comparison.

- Mr. Laspeyre's in 1871 constructed this method.

Steps:

1. Multiply the current year prices (P_1) by base year quantity weights (Q_0) and total all such products to get $\sum P_1Q_0$.
2. Similarly, Multiply the base year prices (P_0) by base year quantity weights (Q_0) and obtain the total to get $\sum P_0Q_0$.
3. Divided $\sum P_1Q_0$ by $\sum P_0Q_0$ and multiply the quotient by 100. This will be the index number of the current year.

$$\text{Formula: } P_{01} = \frac{\sum P_1Q_0}{\sum P_0Q_0} \times 100$$

Paache's Method

The German statistician Paasche in 1874 constructed an index number, in which weights are determined by quantities in the given year. It helps in answering the question that, if the current period basket of commodities was consumed in the base period and if we were spending Rs 100 on it, how should be the expenditure in current period on the same basket of commodities.

Steps:

1. Multiply the current year prices (P_1) by current year quantities (Q_1) and total all such products to get $\sum P_1Q_1$.
2. Similarly , multiply the base year prices (P_0) by current year quantities (Q_1)and obtain the total to get $\sum P_0Q_1$.
3. Divide $\sum P_1Q_1$ by $\sum P_0Q_1$ and multiply the quotient by 100. This will be the index number of the current year.

$$\text{Formula: } P_{01} = \frac{\sum P_1Q_1}{\sum P_0Q_1} \times 100$$

Fisher's Ideal Method

Fisher has combined the techniques of Laspeyres and Paasches Method. He used both base year as well as Current Year quantities (Q_0, Q_1) as weight. Prof. Irving fisher has given a number of formulae for constructing index numbers and of these, he calls one as the 'ideal' index.

Formula:

$$P_{01} = \sqrt{\frac{\sum P_1Q_0}{\sum P_0Q_0} \times \frac{\sum P_1Q_1}{\sum P_0Q_1}} \times 100$$

Fisher's Method is considered as ideal Method because:

1. It is based on variable weights.
2. It takes into consideration the price and quantities of both the base year and current year.
3. It is based on geometric mean which is regarded as best mean for calculating Index number.
4. It satisfies both the time reversal test and Factor reversal test.

Dorbish & Bowley's Method

- Dorbish and Bowley have suggested simple arithmetic mean of the two indices (Laspeyre's and Paasche's) mentioned above so s to take into account the influence of both the periods, i.e., current as well as base periods. The formula for constructing the Index is:

$$P_{01} = \frac{L + P}{2}$$

Where , L = Laspyre's Index, P = Paasche's Index

Formula:

$$P_{01} = \frac{\frac{\sum p_1 q_0}{\sum p_0 q_0} + \frac{\sum p_1 q_1}{\sum p_0 q_1}}{2} \times 100$$

Marshall - Edgeworth Method

The formula enunciated by Marshall and Edgeworth for constructing an index number is known as Marshall-Edge worth's method. In this method, they have suggested to take the arithmetic average of the quantities of the quantities of the base year, and the current year as the weights of the items.

- In this method, the current year as well as the base year prices are considered.

Formula:

$$P_{01} = \frac{\sum (Q_0 + Q_1) P_1}{\sum (Q_0 + Q_1) P_0} \times 100$$

$$P_{01} = \frac{\sum P_1 Q_0 + \sum P_1 Q_1}{\sum P_0 Q_0 + \sum P_0 Q_1} \times 100$$

Kelley's Method

In this method, weights are the quantities which may refer to some period, not necessarily the base year or current year. Thus the average quantity of two or more years may be used as weights.

- This Method was given by Truman L. Kelly.

Formula:

$$P_{01} = \frac{\sum p_1 q}{\sum p_0 q} \times 100: \text{ where } q = \frac{q_0 + q_1}{2}$$

Weighted Average of Relatives Method

- It Can be classified into two types:
    1. Weighted Average of Price Relatives Method
    2. Weighted Average of Quantity Relatives Method

Weighted Average of Price Relatives Method

Weighted average of price relative's index is obtained by multiplying the relatives with the weights assigned to each commodity and then summing these products year by year finally dividing the totals for each year by sum of the weights.

Formula :

$$P_{01} = \frac{\Sigma PV}{\Sigma V}$$

Where, V= Value Weight (P_0Q_0)

$\overline{P}$ **= Price Relative =** $\frac{P_1}{P_0} \times 100$

Steps:

1. Find the price relatives for each commodity.
2. Multiply the price relatives with their corresponding weights to get PV.
3. Obtain the sum of products for all commodities to get ΣPV.
4. Divide the sum by ΣV

Weighted Average of Quantity Relatives Methods

The formula for computing a weighted average of quantity relative index is also same as used to compute a price index.

Formula : $\frac{\Sigma QV}{\Sigma V}$ Where V = Value Weight(Q_0P_0)

Q= Quantity Relative= $\frac{Q_1}{Q_0} \times 100$

Steps:

1. Find the quantity relatives for each commodity.
2. Multiply the Quantity relatives with their corresponding weights to get PV.
3. Obtain the sum of products for all commodities to get ΣQV.
4. Divide the sum by ΣV

Consumer Price Index Numbers

Consumer price Index is also known as Cost of Living index or Price of Living Index. It represents the average change over time in the prices paid by the ultimate consumer of a specified basket of goods & services.

- A change in price affects the cost of living of different classes of people differently.
- The general Index numbers fails to reveal this. So there is a need to construct consumer price Index.
- Peoples consumption habits are also different from man to man, place to place and class to class. Like rich class or poor class etc

Objectives of Consumer Price Index:

1. To measure the impact of 'price' change on the purchasing power of the after tax money incomes of wage & salary earner households.
2. Its main objective is to track inflation.
3. Its focus remains on controlling inflation with the help of monetary policies to take decisions.

Steps:

1. Decide the class of people for whom Index numbers is intended.
2. Conduct 'family budget enquiry' in the base period relating to the class of people concerned.
3. Items of expenditure to be classified.
4. Price quotation to be taken.
5. For each item there will be a number of Price quotations covering different qualities and markets. The simple average of price relatives of different quotations is taken as the price relative for the particular item.

6. A separate Index is computed for each group

$$\text{Group Index (I)} = \frac{\sum W \; P_n \; X \; 100}{P_0} \left(\quad \right)$$

$$\frac{}{100}$$

$$\text{Where, } W = \frac{P0Q0 \; X \; 100}{\sum POQO}$$

7. The weighted average group index numbers gives the

Final Consumer Index Number.

$$\text{Consumer Index} = \frac{\sum IW}{100}$$

100

Methods of Constructing Consumer Price Index

1. Aggregate Expenditure Method
2. Family Budget Metho

Aggregate Expenditure Method

This method is similar to the Laspeyre's method of constructing weighted index. To apply this method, the quantities of commodities by the particular group in the base year are estimated and these figures are used as weights. Then, the total expenditure on each commodity for each year (base and current) are calculated.

Formula:

$$CPI = \frac{\sum P_1 Q_0}{\sum P_0 Q_0} \times 100$$

Steps:

1. Similarly, Multiply the base year prices (P_0) by base year quantity weights (Q_0) and obtain the total to get $\sum P_0Q_0$.
2. Multiply the current year prices (P_1) by base year quantity weights (Q_0) and total all such products to get $\sum P_1Q_0$.
3. Divided $\sum P_1Q_0$ by $\sum P_0Q_0$ and multiply the quotient by 100. This will be the consumer price index number.

$$\underline{\text{Formula}}: \quad CPI = \frac{\sum P_1Q_0}{\sum P_0Q_0} \times 100$$

Family Budget Method

In this method, the family budgets of a large number of people, for whom the index is meant, are carefully studied. Then, the aggregate expenditure of an average family on various commodities is estimated. These values constitute the weights.

Formula:

$$CPI = \frac{\sum RW}{\sum W}$$

- Where, R = Current years Price relatives of various items

W = weights of various items

Steps:

1. Calculate price relatives for the current year ($P_1/P_0 \times 100$) and denote it by R.
2. Multiplying the price in the base year (P_0) with quantity in the base year (Q_0) to calculate the weight of a commodity, i.e. to get W.
3. Multiply the price relatives (R) with weight (W) of each commodity and obtain its total to get $\sum RW$.
4. Obtain the sum total of weights to get $\sum W$.
5. Apply the formula:

$$\text{Consumer Price Index} = \frac{\sum RW}{\sum w}$$

Test for an Ideal Index Numbers

1. Unit Test
2. Time Reversibility Test
3. Factor Reversibility Test
4. Circular Test

Uses Of Index Numbers

1. Helps in Policy Formulation.
2. Index numbers act as Economic Barometers.
3. Help in studying trends and forecasting demand and supply.
4. To measure and compare changes.
5. Index numbers help to measure purchasing power.
6. Index numbers help in deflating various values.
7. Indicator of rate of Inflation.
8. It is very useful in deflating.
9. Helps us to measure changes in price level.

10. It helps us to know changes in cost of living .
11. It helps government in adjustment of salaries and allowances.
12. It is Useful to Business Community .
13. It gives Information to Politicians.
14. It gives Information regarding foreign trade.

Limitations Of Index Numbers

1. Provides relative changes only
2. Lack of Perfect Accuracy
3. Difference between purpose and method of construction
4. Ignores qualitative changes
5. Manipulations are possible
6. There may be errors in the choice of base periods or weights.
7. Comparisons of changes in variables over long periods are not reliable
8. They are not capable of being used for any other purpose than the one for which they have been constructed particularly.

Thank You

By

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