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Unit 1 : Index numbers

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Concept of Index Numbers

An index number is a specialized average designed to measure the change in a group of related variables over a period of time. Thus when we say that the index number of wholesale prices is 112 for January 2016-17 compared to January 2015-16, it means there is a net increase in the prices of wholesale commodities to the extent of 12th percent during the year another period

Index numbers, in effect, relate a variable or a variables in a given period to the same variable or variables in another period, called the base period. An index, the simplified name for index numbers, which is computed from single variable, is called a univariate index, whereas an index which is constructed from a group of variables is considered as a composite index.

Newspapers headline the fact that prices are going up or down, that industrial production is rising or falling, that imports are increasing or decreasing, that crimes are rising in a particular period compared to the previous period as disclosed by index numbers. Index numbers are used to feel the pulse of the economy and they have come to be used as indicators of inflationary or deflationary tendencies. In fact, they are described as “*barometers of economic activity*”, i.e., if one wants to get an idea as to what is happening to an economy, he should look to important indices like the index number of industrial production, agricultural production, business activity, etc.

Important points of Index Numbers:

- i) Index numbers are specialized averages .
- ii) Index numbers measure the net change in group of related variables.
- iii) Index numbers measure the effect of changes over a period of time.

Uses of Index Numbers

Followings are the important uses of index numbers:

- i) Index number help in framing suitable policies: many of the economic and business policies are framed by index numbers. For example, while deciding the increase in dearness allowance (DA) of the employees, the employers have to depend primarily upon the cost of living index.
- ii) Index numbers reveal 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.
- iii) Index numbers are important in forecasting future economic activity: Index numbers are useful not only in studying the past and present workings of our economy, but they are also important in forecasting future economic activity.
- iv) Index numbers are very useful in deflating: Index numbers are highly useful in deflating, i.e., they are used to adjust the original data for price changes, or to adjust wages for cost of living

changes and thus transform nominal wages into real wages. Moreover nominal income can be transformed into real income and nominal sales into real sales through appropriate index numbers.

Classification of Index Numbers

Index numbers may be classified in terms of what they measure. In economics and business the classifications are as follows:

- i) Price index number
- ii) Quantity index number
- iii) Value index number
- iv) Special purpose index number

Problems in the constructions of Index Numbers

Followings are the problems/steps in the construction of index numbers:

1. **Purpose of the Index :** At the very outset the purpose of constructing the index must be very clearly decided. There is no all purpose index. Every index is of limited and particular use. Thus , a price index that is intended to measure consumers' prices must not include wholesale prices. And if such an index is intended to measure the cost of living of poor families, great care should be taken not to include goods ordinarily used by middle class and upper income groups. Failure to decide clearly the purpose of the index would lead to confusion and wastage of time with no fruitful results.
2. **Selection of a base period:** The base period of an index number is the period against which comparisons are made. It maybe a year, a month or a day. The index for base period is always taken as 100. Though the selection of the base period would primarily depend upon the object of the index, the following points need careful consideration of base period:
 - i) The base period should be a normal one, the period that is selected as base should be normal, i.e., it should be free from abnormalities like earthquakes, war, famines, booms, depressions, etc.
 - ii) The base period should not be too distant in the past. It is desirable to have an index based on a fairly recent period, since comparisons with a familiar set of circumstances are more helpful than comparisons with vaguely remembered conditions.
 - iii) Fixed base or Chain base. While selecting the base a decision has to be made as to whether the base shall remain fixed or not, i.e, whether we have a fixed base or chain based index. In the fixed based method, the base year or the period of years to which all other prices are related is constant for all times. On the other hand, in the chain based method the prices of a year are linked with those of the preceding year and not with the fixed year.
3. **Selection of Number of Items:** The items included in an index should be determined by the purpose for which the index is constructed. Every item cannot be included while constructing an index number and hence one has to select a sample. For example, while constructing a price index it is impossible to include each and every commodity. Hence it is necessary to

decide what commodities to include. The commodities should be selected in such a manner that they are representative of the tastes, habits and customs of the people for whom the index is meant. A decision must also be made on the number of commodities to be included and their qualities.

4. **Price Quotations:** It is a well known fact that prices of many commodities vary from place to place and even from shop to shop in the same market. It is impracticable to obtain price quotations from all the places where a commodity is dealt in. A selection must be made of representative places and persons. These places should be those which are well known for trading for that particular commodity. After the places from where the price quotations are to be obtained is decided, the next thing is to appoint some person or institution who can supply price quotations as and when required. Great care must be exercised to see that the price reporting agency is unbiased.
5. **Choice of an Average:** Since Index numbers are specialized averages a decision has to be made as to which particular average (i.e., arithmetic mean, median, mode, geometric mean or harmonic mean) should be used for constructing the index. Median, mode and harmonic mean are almost never used in the constructions of index numbers. Basically a choice has to be made between arithmetic mean and geometric mean. Theoretically speaking, geometric mean is the based average in the construction of index numbers because of the following reasons:
 - i) In the construction of index numbers we are concerned with ratios of change;
 - ii) Geometric mean is less susceptible to major variations as a result of violent fluctuations in the values of the individual items; and
 - iii) Index numbers calculated by using this average are reversible and therefore, base shifting is easily possible. The geometric mean index always satisfies the time reversal test.Despite theoretical justification for favouring geometric mean, arithmetic mean is more popularly used while constructing index numbers. This is for the reason that arithmetic mean is much more simple to compute than the geometric mean.

6. **Selection of Appropriate weights.** The term “weight” refers to the relative importance of the different items in the constructions of the index. All items are not of equal importance and hence it is necessary to devise some suitable method whereby the varying importance of the different items is taken into account. This is done by allocating weights. Thus we have broadly two types of indices-- unweighted indices and weighted indices. In unweighted indices no specific weights are assigned where as in weighted indices, weights are assigned to various items.

There are two methods of assigning weights: i) implicit, and ii) explicit.

In implicit weighting, a commodity or its variety is included in the index a number of times. In case of explicit weighting some outward evidence of importance of the various items in the index is given.

Weights are of two types: quantity weights and value weights. A quantity weight, symbolized by q , means the amount of commodity produced, distributed, or consumed in some time period. A value weight, on the other hand combines price with quantity “produced”, “distributed” or “consumed”. Value is in terms of rupees and is symbolized by $p \times q$ where p stands for the price and q stands for the quantity.

7. **Selection of an appropriate Formula:** A large number of formulae have been devised for constructing the index. The problem very often is that of selecting the most appropriate formula. The choice of the formula would depend not only on the purpose of the index but also on the data available. Theoretically, Fisher's method is considered as "Ideal" for constructing index number. However, from a practical point of view there are certain limitations of this index. As such, no one particular formula can be regarded as the base under all circumstances. On the basis of this knowledge of the characteristics of different formulae, a discriminating investigator will choose technical methods adapted to his data and appropriate to his purposes.

Methods of Constructing Index Numbers.

A large number of formulae have been devised for constructing index numbers. Broadly speaking, they can be grouped under two heads:

- A) **Unweighted indices:** In the unweighted indices weights are not expressly assigned. Unweighted indices are of two types:

- i) **Simple Aggregative method:**

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

Where

$\sum P_1$ = Total of current year prices for various commodities

$\sum P_0$ = Total of base year prices for various commodities

This method of constructing the index is the simplest of all the methods.

- ii) **Simple average of relatives method**

$$P_{01} = \frac{\sum \left(\frac{P_1}{P_0} \times 100 \right)}{N}$$

Where N refers to the number of items (commodities) whose price relatives are thus averaged.

- B) **Weighted indices :** In the weighted indices weights are assigned to the various items. Weighted index numbers are of two types :

- i) **Weighted Aggregative Indices :** These indices are of the simple aggregative type with the fundamental difference that weights are assigned to the various items included in various methods of assigning weights and consequently a large number of formulae for constructing index numbers have been devised of which some of the more important ones are:

- a) **Laspeyres Method:**

The Laspeyres Price Index is a weighted aggregate price index, where the weights are determined by quantities in the base period. The formula for constructing the index is:

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

Steps

- Multiply the current year prices of various commodities with base year weights and obtain $\sum P_1 q_0$
- Multiply the base year prices of various commodities with base year weights and obtain $\sum P_0 q_0$
- Divide $\sum P_1 q_0$ by $\sum P_0 q_0$ and multiply the quotient by 100. This gives us the price index.

b) **Paasche's Method:**

The Paasche's price index is a weighted aggregate price index in which the weights are determined by quantities in the given year. The formula for constructing the index is :

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

Steps

- Multiply the current year prices of various commodities with current year weights and obtain $\sum P_1 q_1$
- Multiply the base year prices of various commodities with current year weights and obtain $\sum P_0 q_1$
- Divide $\sum P_1 q_1$ by $\sum P_0 q_1$ and multiply the quotient by 100.

Comparison of Laspeyres and Paasche's Methods

Laspeyres index measures change in a "fixed market basket" of goods and services. The same quantities are used in each period. The Paasche index continually updates the quantities to the levels of current consumptions. These two approaches tend to produce opposite extremes in index values computed from the same data.

An interesting property of Laspeyres and Paasche indices is that the former is generally expected to overestimate or to leave an upward bias whereas the latter tends to underestimate, i.e., shows a downward bias. When the prices increase there is usually a reduction in the consumption of those items for which the increase has been the most pronounced and hence, by using base year quantities we will be giving too much weight the prices that have increased the most and the numerator of the Laspeyres index will be too large. When the prices go down, consumers often shift their preference to those items which have declined the most and, hence by using base period weights in the numerator of the Laspeyres index we shall not be giving sufficient weight to the prices that have gone down the most and the numerator will again be too large. Similarly because people tend to spend less on goods when their prices are rising the use of the Paasche or current weighting produces an index which tends to underestimate the rise in prices, i.e, it has a downward bias.

c) **Dorbish and Bowley's Method**

Dorbish and Bowley have suggested simple arithmetic mean of the two indices (Laspeyres and Paasche) to take into account the influence of both the current as well as base periods. The formula for constructing the index is :

$$P_{01} = L + P/2$$

Where L= Laspeyres index, P= Paasche index

Or

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

d) **Fisher's "Ideal" Index** : The Fisher's ideal index is given by the formula:

$$P_{01} = \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100 \text{ or } P_{01} = \sqrt{L \times P}$$

It is clear from the above formula that Fisher's ideal index is the geometric mean of the Laspeyres and Paasche indices. Thus in the Fisher's method we average geometrical formulae that err in opposite directions.

The Fisher's method of constructing index number is known as ideal because of the following reasons:

- i) It based on the geometric mean which is theoretically considered to be the best average for constructing index numbers
 - ii) It takes into account both current year as well as base year prices and quantities.
 - iii) It satisfies both the time reversal test as well as the factor reversal test.
 - iv) It is free from biased.
- e) **Marshall- Edgeworth method**: In this method also both the current year as well as base year prices and quantities are considered. The formula for constructing the index is:

$$P_{01} = \frac{\sum (q_0 + q_1) P_1}{\sum (q_0 + q_1) P_0} \times 100$$

On opening the brackets

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

- f) **Kelley's Method**: Truman Lee Kelley has suggested the following formula for constructing index numbers:

$$P_{01} = \frac{\sum p_1q}{\sum p_0q} \times 100: \text{ where } q = \frac{q_0 + q_1}{2}$$

Here 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.

B) (ii) **Weighted Average of Relatives** : The steps in the computation of the weighted arithmetic mean of relatives index number are as follows:

- i) Express each item of the period for which the index number is being calculated as a percentage of the same item in the base period.
- ii) Multiply the percentages as obtained in step (i) for each item by the weight which has been assigned to that item.
- iii) Add the results obtained from the several multiplications carried out in step (ii)
- iv) Divide the sum obtained in step (iii) by the sum of the weights used. The result is the index number. Symbolically,

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

Where- $P = \frac{P_1}{P_0} \times 100$

P=Price relative
V=Value weights= P_0q_0

Chain Base Index Number: When Chain Base index method is used the comparisons are not made with a fixed base; rather the base changes from year to year. For example, For 2017, 2016 will be the base; for 2016, 2015 will be the base, and so on. If, however, it is desired to associate these relatives to a common base the results may be chained to obtain chain indices. Thus in its simplest form, the chain index is one in which the figures for each year are first expressed as percentages of the preceding years. These percentages are then chained together by successive multiplication to form a chain index.

In constructing a chain index following steps are desirable:

- i) Express the figures for each year as percentages of the preceding year. The results so obtained are called link relatives.
- ii) Chain together these percentages by successive multiplication to form a chain index. Chain index of any year is the average link relative of that year multiplied by chain index of previous year divided by 100.

Chain Relatives differ from fixed base relatives in computation. Chain relatives are computed from link relatives where as fixed base relatives are computed directly from the original data. The results obtained by the two different methods should be the same, but they may differ from each other slightly due to rounding off of decimal places. Since the process of computing chain relatives is quite

complicated and the results are same as the fixed base relatives obtained from the original data, chain relatives should be used when the original data are not available but the link relatives are.

Wholesale Price and Cost of Living Index Numbers: Cost of living index numbers are generally intended to represent the average change over time in the prices paid by the ultimate consumer of a specified basket of goods and services. The need for constructing consumer price indices arises because the general index numbers fail to give an exact idea of the effect of the change in the general price level on the cost of living of different classes of people in different manners. Different classes of people consume different types of commodities and even the same type of commodities are not consumed in the same proportion by different classes of people. Not only this, the consumption habits of the people of the same class differ from place to place. The consumer price index helps us in determining the effect of rise and fall in prices on different classes of consumers living in different areas. The construction of such an index is of great significance because very often the demand for a higher wage is based on the cost of living index and the wages and salaries in most countries are adjusted in accordance with the consumer price index.

Utility of Consumer Price Indices: The Consumer Price Indices are of great significance as can be seen from the following:

- i) The most common use of these indices is in wage negotiations and wage contracts. Automatic adjustments of wage or dearness allowance component of wages are governed in many countries by such indices.
- ii) At governmental level, the index numbers are used for wage policy, price policy, rent control, taxation and general economic policies.
- iii) The index numbers are also used to measure changing purchasing power of the current, real income etc.
- iv) Index numbers are also used for analyzing markets for particular kinds of goods and services.

Construction of a Consumer Price Index

The following are the steps in constructing a consumer price index

- i) **Decision about the class of people for whom the index is meant.** It is absolutely essential to decide clearly the class of people for whom the index is meant, i.e., whether it relates to industrial workers, teachers, officers, etc. The scope of the index must be clearly defines. It is also necessary to decide the geographical area covered by the index.
- ii) **Conducting Family budget enquiry :** the object of conducting a family budget enquiry is to determine the amount that an average family of the group included in the index spends on different items of consumptions. While conducting such an enquiry therefore, the quantities of commodities consumed and their prices are taken into account. The consumption pattern can thus be easily ascertained . The items on which the money is spend are classified into certain well-accepted groups, namely :
 - Food
 - Clothing
 - Fuel and Lighting
 - House Rent

- Miscellaneous

Each of these groups is further divided into sub groups.

- iii) **Obtaining price quotations** : Retail prices may vary from place to place, shop to shop and person to person. Price quotations should be obtained from the localities in which the class of people concerned reside or from where they usually make their purchases.

Method of Constructing Consumer Price Index:

1. Aggregate expenditure method or Aggregative method

$$\text{Cost of Living Index Number} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \times 100$$

2. Family Budget Method

$$\text{Cost of Living Index Number} = \frac{\sum PV}{\sum V}$$

where $P = \frac{P_1}{P_0} \times 100$

$$V = P_0 q_0$$