## 1. Introduction

Welcome to the series of E-learning modules on Mathematical formulae for computation of index numbers-based on arithmetic mean.

By the end of this session, you will be able to:

- Explain the methods of construction of index numbers based on arithmetic mean
- Explain the merits and demerits of each method

Today, index numbers are one of the most widely used statistical devices to feel the pulse of the economy, indicators of inflationary or deflationary tendencies.

It is a single figure, which reveals the change in the related variables. Thus, index number performs the function similar to that of an average and hence, is rightly called as a specialized type of average.

Index numbers are briefly called as indices and are specialized averages, which measures the net changes in a group of related variables over a period of time. It is expressed numerically in relative terms that is, percentages. It is not always the case that the comparison should be over time, but most common types of index numbers measure changes over time.

Similarly, index numbers may be constructed for studying changes in any variable, such as intelligence, aptitude, efficiency, production, etc. However, the time series of prices is most frequently used.

The principles of construction are however, quite general in nature, and may thus be applied to other areas of interest. Our subsequent discussion on index numbers will therefore be made with special reference to prices of commodities.

There are various uses of price index numbers.

- The wholesale price index number indicates the price changes taking place in wholesale markets
- On the other hand, the consumer price index number or the cost of living index number tells us about the change in the prices faced by an individual consumer
- Its major application is in the calculation of dearness allowance so that real wage does not decrease; or in comparing the cost of living in different regions
- It is also used to measure changes in purchasing power of money

The reciprocal of a general price index is known as purchasing power of money with reference to the base period.

For example, if the price index number goes up to 150, it means that the same amount of money will be able to purchase 100/150 which is equal to 0.67 times or 67% of the volume of goods being purchased in the base period.

Now, we know that an index number is of great utility if constructed properly; otherwise, they

are a dangerous device. A variety of problems are involved in the construction of the index number which can be understood under the following six heads:

- Defining the purpose, nature and scope of an index number
- Selection of items and their numbers
- Price quotation
- Selection of suitable weights
- Selection of base year
- Choice of suitable average

# 2. Methods of Constructing the Index Numbers

Let us discuss the methods of constructing the index numbers.

The index numbers can be constructed through the following methods: Un-Weighted index numbers and Weighted index numbers.

The Un-Weighted index numbers are further classified as Simple Aggregative Method and Simple Average of Relative Method.

The Weighted index numbers are classified as Weighted Aggregative Methods and Weighted Average of Relative Methods. In this module, we will focus only on the Un-Weighted index numbers.

Let us discuss the Simple Aggregative Method or Un-Weighted Aggregative method:

Price index (P): In this method, the prices of all the commodities included in the number are added separately for the current year and the base year. Then, the total of prices of current year are divided by the total of prices of the base year and then multiplied by 100.

In the notional form we write the price index P not one is equal to summation of P one divided by summation of P not multiplied by 100 where, P not one denotes the current year price index to the base year price index and summation P one indicates the total of the current year prices of all the commodities and summation of P not indicates the total of the base year prices of all the commodities.

Steps in calculation;

- Add the current year prices for different goods to get summation P one
- Add the base year prices for the same goods to get summation P not
- Divide summation P one by summation P not and multiply the quotient by 100

Similarly, the index number can be calculated for other relative measures like quantity, volume of consumption, exports, etc.

The formula for calculation will be based on the relative measures of the current year and base year like quantity indices is equal to summation of Q one divided by summation of Q not multiplied by 100 where Q one and Q not are the quantities in the current year and base year respectively.

## 3. Simple Aggregative Method

To understand the calculation of the simple aggregative method for both price and quantity let us take an example.

For the data given below, compare the series of Simple Aggregative Price and Quantity Indices for the two fuels by using (i) 1995 as the base year (ii) 1996 as the base year and (iii) 1995 to 1997 as the base period.

		Price		Quantity			
Item and Unit	Produ	cers Pric	e (Rs)	Production (million tons)			
	1995	1996	1997	1995	1996	1997	
Coal (tons)	5	3	4	3	2	2	
Oil (barrel)	2	3	4	4	4	3	
Total	7	6	8	7	6	5	

Let us first calculate the price indices for 1996 and 1997 by taking 1995 as the base period then we will get Price indices of 1996 is equal to summation of P one divided by summation of P not into 100. Here, as we are taking 1995 as the base year we will take the total of price for the year 1995 as P not and its summation is equal to 7 the summation of the price in 1996 is taken as the current year which is P one and the total is 6. Therefore, price indices for 1996 is equal to 6 divided by 7 into 100 is equal to 85.71.

Similarly, for price indices 1997 we are taking 1995 as the base year we will take the total of price for the year 1995 as P not and its summation is equal to 7 the summation of the price in 1997 is taken as the current year which is P one and the total is 8. Therefore, price indices for 1997 is equal to 8 divided by 7 into 100 is equal to 114.28.

Now let us see the solution for the second part of the question. Let us take the base year as 1996 and calculate the price indices.

The price indices for 1995 will be equal to summation of P one divided by summation of P not into 100. Here, as we are taking 1996 as the base year we will take the total of price for the year 1996 as P not and its summation is equal to 6 the summation of the price in 1995 is taken as the current year which is P one and the total is 7. Therefore, price indices for 1995 is equal to 7 divided by 6 into 100 is equal to 116.67.

The price indices for 1997 will be equal to summation of P one divided by summation of P not into 100. Here, also we are taking 1996 as the base year we will take the total of price for the year 1996 as P not and its summation is equal to 6 the summation of the price in 1997 is taken as the current year which is P one and the total is 8. Therefore, price indices for 1997 is equal to 8 divided by 6 into 100 is equal to 133.34.

Let us see the solution for the third part of the question. Here, we will calculate the price indices taking 1995 to 1997 as the base period. In this solution we will define P not as the average price of the three years which is equal to 7 plus 6 plus 8 divided by 3 is equal to 21 by 3 is equal to 7. Next, we will calculate the price indices for 1995, 1996 and 1997.

The price indices for 1995 is equal to summation of P one divided by summation of P not into 100. Here, as we are taking the average as the base year P not and its summation is equal to 7 the summation of the price in 1995 is taken as the current year which is P one and the total is 7. Therefore, price indices for 1995 is equal to 7 divided by 7 into 100 is equal to 100.

The price indices for 1996 is equal to summation of P one divided by summation of P not into 100. Here, as we are taking the average as the base year P not and its summation is equal to 7 the summation of the price in 1996 is taken as the current year which is P one and the total is 6. Therefore, price indices for 1999 is equal to 6 divided by 7 into 100 is equal to 85.71.

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Let us now calculate the quantity indices for 1996 and 1997 by taking 1995 as the base period then we will get quantity indices of 1996 is equal to summation of Q one divided by summation of Q not into 100. Here, as we are taking 1995 as the base year we will take the total of quantity for the year 1995 as Q not and its summation is equal to 7 the summation of the quantity in 1996 is taken as the current year which is Q one and the total is 6. Therefore, quantity indices for 1996 is equal to 6 divided by 7 into 100 is equal to 85.71.

Similarly, for quantity indices 1997 we are taking 1995 as the base year we will take the total of quantity for the year 1995 as Q not and its summation is equal to 7 the summation of the quantity in 1997 is taken as the current year which is Q one and the total is 5. Therefore, quantity indices for 1997 is equal to 5 divided by 7 into 100 is equal to 71.43.

Now we will see the solution for the second part of the question. Let us take the base year as 1996 and calculate the quantity indices. The quantity indices for 1995 will be equal to summation of Q one divided by summation of Q not into 100. Here, as we are taking 1996 as the base year we will take the total of quantity for the year 1996 as Q not and its summation is equal to 6 the summation of the quantity in 1995 is taken as the current year which is Q one and the total is 7. Therefore, quantity indices for 1995 is equal to 7 divided by 6 into 100 is equal to 116.67.

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Solution for the third part of the question. To calculate the quantity indices taking 1995 to 1997 as the base period. In this solution, we will define Q not as the average quantity of the three years which is equal to 7 plus 6 plus 5 divided by 3 is equal to 18 by 3 is equal to 6. Next, we

will calculate the quantity indices for 1995, 1996 and 1997.

The quantity indices for 1995 is equal to summation of Q one divided by summation of Q not into 100. Here, as we are taking the average as the base year Q not and its summation is equal to 6 the summation of the quantity in 1995 is taken as the current year which is Q one and the total is 7. Therefore, quantity indices for 1995 is equal to 7 divided by 6 into 100 is equal to 116.67.

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The quantity indices for 1997 is equal to summation of Q one divided by summation of Q not into 100. Here, as we are taking the average as the base year Q not and its summation is equal to 6 the summation of the quantity in 1997 is taken as the current year which is Q one and the total is 5. Therefore, quantity indices for 1997 is equal to 5 divided by 6 into 100 is equal to 83.33.

### 4. Demerits of Simple or Un-Weighted Aggregative Method

Demerits of Simple Aggregative Method or Un-Weighted Aggregative method:

Since some items are quoted in a particular unit, these items get importance over the others. For example, if we take butter it is expressed in Kg, milk is in liter, cheese per tin, bread per piece and egg per dozen. So, the units in which prices of goods are given affect the price index.

In this method, equal importance is given to all the items irrespective of their relative importance. Under this circumstance, such an index cannot be an objective measure of change in prices.

Now, let us discuss about the Simple Average of Relatives Method or Un-Weighted Average of Price Relatives Method:

This method is the simplest method for constructing the index numbers. In this method, the price relatives of all the commodities included in the index numbers are taken and then the average of those price relatives are taken by using any measure of central tendency. Here, we are using the arithmetic mean to calculate the simple average of relative's method.

The formula for computing index number is Price indices is equal to summation of current year price P one divided by the base year price P not multiplied by 100 and the whole thing divided by N.

Let us look at the steps involved in the calculation.

- First divide the current year price (P1) of each commodity by its base year price (P0) and multiply it by 100. This gives the price relative of each commodity.
- Similarly, find price relatives of all other commodities
- Add these values of the price relative
- Divide the sum of price relatives by the total number of the commodities (N) and the result would be required index number

Let us take an example to understand this calculation.

Using simple Average of relative's method, compute index number for the year 1997 using 1990 prices as base.

Table 2

Commodities	I	II	III	IV	V	VI
Prices in 1990 (P <sub>0</sub> )	15	18	16	14	25	40
Prices in 1997 (P <sub>1</sub> )	30	24	20	21	35	30

Let us calculate the index number using the arithmetic mean.

#### Table 3

Commodities	I	II	III	IV	v	VI	N=6
Prices in 1990 (P <sub>0</sub> )	15	18	16	14	25	40	
Prices in 1997 (P <sub>1</sub> )	30	24	20	21	35	30	
Price relative (P <sub>1</sub> /P <sub>0</sub> ) X100	200	133.33	125	150	140	75	Σ(P1/P0 x100)= 823.33

In the table, we will see that the first row is the commodities, the second row shows the prices in 1990 and the third row shows the prices in the year 1997. Let us calculate the price relative of each commodity in column four. Price relative is equal to current price (P1) divided by (P0) multiplied by 100, while substituting the values for each commodities we will get the values 200, 133.33, 125, 150, 140 and 75. Take the total of the price relative column to get summation of P one divided by P not multiplied by 100 which is equal to 823.33. The total number of commodities in this data is 6. Therefore, N is equal to 6.

Let us calculate the value of the price index by substituting the values in the formula summation P one by P not multiplied by 100 whole divided by N which is equal to 823.3 divided by 6 is equal to 137.22.

# 5. Merits of Simple Average of Relatives Method

Merits of Simple Average of Relatives Method:

The method of simple average of price relative's is superior to the method of simple aggregative method on the following grounds:

- Equal importance is given to all the items and that way extreme items cannot influence the index
- The undue influence of different units is completely removed

Shortcomings of simple average of relative method:

- The unit of prices of commodities will affect the price index number
- Importance of the commodities in questions is ignored

Here's a summary of our learning in this session where we have understood the:

- The method of construction of index numbers based on arithmetic mean
- Merits and demerits of each method