1. Introduction

Welcome to the series of E-learning modules on Laspeyer’s, Paasche’s and Marshall Edgeworth’s method of constructing index numbers.

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

- Construct index numbers using the following methods:
  - o Laspeyer’s method
  - o Paasche’s method
  - o Marshall Edgeworth’s method
- List the merits and limitations of each method

Index Number – Recap

Index numbers are commonly used statistical device for measuring the combined fluctuations in a group related variables. Index numbers measure the changing value of a variable over time in relation to its value at some fixed point in time, the base period, when it is given the value of 100.

Many government and private agencies are engaged in computation of index numbers or indices, as they are often required for the purpose of forecasting business and economic conditions, providing general information, etc.

Introduction

The construction of index number is a conscious effort in which the effort is taken to assign weights to each commodity according to their importance in the total phenomenon that the index is supposed to describe.

The unweighted index assigns equal importance to all the items included in the index. They, in reality are weighted, but as weights are being implicit, there is a possibility of getting different results by changing the implicit weights. Hence, the results will be far from reality in most of the cases.

Under the weighted index method, we weigh the price of each commodity by a suitable factor, which is often taken as the quantity or the value weight sold during the base year or the given year or the average of some years. The choice of one or the other will depend on the importance we want to give a period beside the quantity used. Indicates are usually calculated in percentages.

2. Weighted Index Numbers

Weighted index numbers are of two types, namely:

- Weighted aggregative indices and
- Weighted average relatives

Weighted aggregative 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. Consequently, a large number of the formulae for constructing index numbers have been devised.

There are large number of the formulae available for constructing index numbers and some of the important ones are:

- Laspeyer's method
- Paasche's method
- Dorbish and Bowleys method
- Fishers ideal method
- Marshall-Edgeworth's method and
- Kelly's method

All these methods are named after the persons who have suggested this. In today's session, we will focus only on Laspeyer's method, Paasche's method and Marshall-Edgeworth's method.

Laspeyer's method:
Laspeyer's index attempts to answer the question "What is the change in the aggregate value of the base period list of good when valued at a given period prices"?
The Laspeyer's method of price index is a weighted aggregate price index devised by Laspeyer in 1871 and that is why it is called so. In this method, the weights are determined by quantities in the base period. The formula for construction of the index is Price index is equal to summation of the product of the current year price (P_1) and base year quantity (q_0) divided by summation of the product of the base years price (P_0) and quantity (q_0) multiplied by 100.

The steps involved in the calculation are:

1. Multiply the current prices of various commodities with the base year weights and obtain summation P one and q not
2. Multiply the base year prices of various commodities with the weights of the base year and obtain summation of P not and q not
3. Divide summation P one q not by summation P not q not and multiply the quotient by 100. This gives us the price index

Laspeyer's index is the most widely used index number for practical work.
The Laspeyer's index is convenient to use on a continuing basis because the weights remain fixed from one period to the next.
The disadvantage of Laspeyer's index numbers is that it does not consider the consumption pattern.

The Laspeyer’s index has an upward bias as the consumption of items decreases, the prices increase. Hence, by using the base year weights, too much weight will be given to those items, which have increased in price the most.

Similarly, when prices decline, the consumers shift their purchases to those items, which decline the most.By using base period weights, too little weight is given to those items, which decrease most in price again overstating the index.

3. Paasche's Method

The Paasche's method gives us the answer for the question "What would be the value of the given period list of goods when valued at base period prices?"
The Paasche's method index number was devised by a German statistician Paasche and was first used in the year 1874 and hence is named after him. In this method, the price index is a weighted aggregative price index in which the weights are determined by the quantities in the given year. The formula for constructing the index is price index is equal to summation of the product of the price (P_1) and quantity (q_1) of the current year divided by the summation of the product of the price of the base year (P_0) and quantity (q_1) of the current year multiplied by 100.

Steps involved in the calculation of the Paasche's price index are:

1. Multiply the current year prices of various commodities with the current year weights and obtain summation P one and q one
2. Multiply the base year prices with the current year weights and obtain summation of P not and q one
3. Divide summation P one q one by summation P not q one and multiply the quotient with 100. This will give you the price index

The difficulty in computing the Paasche index in practice is that revised weights or quantities must be computed each year or each period by adding the data collection expenses in the preparation of the index. Hence, this method is not used frequently in practice where the number of commodities is large.
People tend to spend less on goods when their prices are rising and the use of Paasche's or current weighing produces an index, which tends to underestimate the rise in price and has a downward bias.

Comparison of Laspeyer's and Paasche's Method:

Laspeyer's method measures the change in a fixed market basket of goods and services. The same quantities are used in each period. Whereas, Paasche's measure continuously updates the quantities to the levels of current consumption.

In Laspeyer's Method, weights are base period quantities and do not change from one period to another. However, in Paasche's Method, weights are current year quantities and hence change from year to year adding expenses to its calculation.

In Laspeyer's Method, the index is generally expected to overestimate or upward bias. And in Paasche's Method, the index generally tends to underestimate or down ward bias.

Conclusion
The above arguments do not imply that Laspeyer's index must necessarily be larger than Paasche's. The difference will generally be small and serve as a satisfactory measure unless there has been a drastic change taken place between the base year and the current year. We can conclude that the Laspeyer's method is very popular due to its practicability and the ease

for comparison when compared to Paasches method, as we need the recent data for the weights and comparison cannot be done.

Marshall Edgeworth's Method:
In this method also, the current year as well as base year prices and quantities are considered.

The formula for constructing the index is price index is equal to summation of the product of current year price (P_1) with base year quantity (q_0) plus the summation of the product of current year price (P_1) with current year quantity (q_1) divided by the product of base year price (P_0) with base year quantity (q_0) plus the summation of the product of base year price (P_0) with current year quantity (q_1).

It is a simple readily constructed measure giving a very close approximation to the results obtained by the ideal formula.

Let us take an example to understand the calculation of the various price indices.
Construct the index numbers of price from the following data by applying Laspeyer's method, Paasche's method and Marshall Edgeworth's method.

Table 1

Year	**2009**		**2010**	
Commodity	Price (P0)	Quantity(q0)	Price (P1)	Quantity (q1)
A	2	8	4	6
B	5	10	6	5
C	4	14	5	10
D	2	19	2	13

Solution:
As a first step, let us prepare the table with the products of the prices and the quantities in various combinations.

Table 2

Year	**2009**		**2010**					
Commodity	Price (P0)	Quantity(q0)	Price (P1)	Quantity (q1)	**P1q0**	**P0q0**	**P1q1**	**P0q1**
A	2	8	4	6	**32**	**16**	**24**	**12**
B	5	10	6	5	**60**	**50**	**30**	**25**
C	4	14	5	10	**70**	**56**	**50**	**40**
D	2	19	2	13	**38**	**38**	**26**	**26**
Total					**200**	**160**	**130**	**103**

The first column will show us the commodities. The second and third columns are the price and quantity in the year 2009, which we will consider as the base year and hence name it as P not and q not. The fourth and the fifth columns are the price and quantity of the commodities for the year 2010, which are considered as the current year and hence denoted as P one and q one. The sixth column is the result of the product of the price of the current year (P_1) with the quantity of the base year (q_0) that is 32, 60, 70 and 38 which gives the summation of P one q not is equal to 200. In the seventh column, we are taking the product of the price and quantity of the base year that is P not and q not we will get 16, 50, 56 and 38 which gives the summation of P not Q not is equal to 160. In the eighth column, we are taking the product of the price and quantity of the base year that is P one and q one, we will get 24, 30, 50 and 26 and we get the summation of P one Q one is equal to 130. And in the last column, we are taking the product of P not and q one, we will get 12, 25, 40 and 26, which gives the summation of p not and q one is equal to 103.

4. Index Numbers (Laspeyers and Paasches Method)

In the next step, we will calculate the index numbers in each of the methods.

Laspeyer's method:
Price index is equal to summation P one q not divided by summation P not q not multiplied by 100 which is equal to 200 divided by 160 into 100 is equal to 125 (values taken from the table).

Paasche's method:
Price index is equal to summation P one q one divided by summation of P not q one into 100 is equal to 130 divided by 103 into 100 is equal to 126.21 (values taken from the table)

Marshall Edgeworth's method:
Price index is equal to summation of P one q not plus summation of p one q one divided by summation of P not q not plus summation of P not q one into 100 is equal to 200 plus 130 divided by 160 plus 130 is equal to 330 by 263 into 100 is equal to 125.48.

Conclusion
As mentioned, we can see that when there is not much variation between the base year and the current year, the index numbers on an average will not show a huge difference in various methods. We can see here that the price index is on an average close to 125.

Quality Index
We can also calculate the quantity or value index numbers as the price index numbers measure and permit the comparison of the prices of certain goods. The quantity index numbers, on the other hand, measure the physical volume of production, construction or employment. Though the price indices are more widely used, production indices are highly significant as indicators of the level of output in the economy or in parts of it.

In constructing the quantity index numbers, the problems confronting the statistician are analogues to those involved in the price indices. We measure changes in quantities, and when we weigh we use prices or values as weights. Quantity indices can be obtained easily by changing P to q and q to P in the various formulae discussed above.

Thus, by applying these changes we will get the formulae as follows:

In Laspeyer's method, the quantity index is equal to summation of the product of the quantity of the current year and the price of the base year divided by the summation of the quantity and price of the base year multiplied by 100.

In Paasches method, the quantity index is equal to summation of the product of the quantity and price of the current year divided by the summation of the product of the quantity of the base year with the price of the current year into 100.

In Marshall Edgeworth's method, the quantity index is equal to summation of the product of the quantity of the current year and the price of the base year plus the summation of the quantity and price of the current year divided by the summation of the quantity and price of the base year plus the summation of the product of the quantity of the base year with the price of the current year into 100.

5. Calculation of the Quantity Index

Let us take an example to understand the calculation of the quantity index. From the following data, compute the quantity index.

Table 3

Year	2008		2009	
Commodity	Price (P0)	Quantity (q0)	Price(P1)	Quantity (q1)
A	8	10	10	11
B	10	9	12	9
C	16	16	20	17

Solution:
As a first step, let us prepare the table with the products of the prices and the quantities in various combinations.

Table 4

Year	2008		2009					
Commodity	Price (P0)	Quantity(q0)	Price (P1)	Quantity (q1)	**q1P0**	**qoP0**	**q1P1**	**q0P1**
A	8	10	10	11	**88**	**80**	**110**	**100**
B	10	9	12	9	**90**	**90**	**108**	**108**
C	16	16	20	17	**272**	**256**	**340**	**320**
Total					**450**	**426**	**558**	**528**

The first column will show us the commodities. The second and third columns are the quantity and price in the year 2008 and denoted as q not and P not considered as the base year. The fourth and fifth columns are the price and quantity for the year 2009 and hence denoted as P one and q one and considered as the current year. The sixth column is the result of the product of the quantity of the current year(q_1) with the price of the base year (P_0) that is 88, 90, 272 which gives the summation of q one P not is equal to 450. In the seventh column, we are taking the product of the quantity and price of the base year that is q not and P not, we will get 80, 90, 256, which gives the summation of q not P not is equal to 426. In the eight column, we are taking the product of the quantity and price of the current year that is q one and P one we will get 110, 108, 340 and we get the summation of q one P one is equal to 558. In the last column, we are taking the product of q not and P one, we will get 100, 108, 320, which gives the summation of q not and P one is equal to 528.

The next step, we will calculate the index numbers in each of the methods.

Laspeyer's method:
Quantity index is equal to summation q one P not divided by summation q not p not multiplied by 100 which is equal to 450 divided by 426 into 100 is equal to 105.63 (values taken from the table).

Paasche's method:
Quantity index is equal to summation q one P one divided by summation of q not P one into 100 is equal to 558 divided by 528 into 100 is equal to 105.68 (values taken from the table)

Marshall Edgeworth's method:
Price index is equal to summation of q one P not plus summation of q one P one divided by summation of q not P not plus summation of q not P one into 100 is equal to 450 plus 558 divided by 426 plus 528 is equal to 1008 by 954 into 100 is equal to 105.66.

Conclusion
As mentioned, we can see that when there is not much variation between the base year and the current year, the index numbers on an average will not show a huge difference. In various methods, we can see here that the quantity index is on an average close to 105.

Value Index number
Value equals price multiplied by quantity. Thus, a value index equals the total sum of the value of a given year divided by the sum of the values of the base year. It is represented in the formula form, as value index is equal to summation value of current year divided by the summation of value of the base year. The summation of the value of current year is equal to the summation of the product of the price and quantity of the current year and the summation of value in the base year is equal to summation of the product of the price and the quantity of the base year.

Here's a summary of our learning in this session, where we have understood the method of constructing index numbers using:

- Laspeyer's method
- Paasche's method
- Marshall Edgeworth's method