Module 4: Index Numbers

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Module 4: Index Numbers

Overview

- Introduction
- Uses of Index Numbers
- Limitations of Index Numbers
- Types of Index Numbers
- Construction of Index Numbers
- Tests of adequacy of Index Numbers

- **Index numbers**

Index numbers are mostly used in the fields of Economics and business for making comparisons of prices, cost of production, purchasing power of money etc. But the most important use of Index Numbers is to compare the prices at different time periods (or time intervals), e.g. Cost of living of a person in 1998 as compared to that of 1997 can be measured with the help of index Numbers.

Definition: An index number is a statistical device designed to show changes in a variable or a group of related variables with respect to time.

- **Uses of Index Numbers:**

1) **Index numbers are useful for forecasting:** These are tools to businessman to predict the behavior of prices and demands.

2) ***It acts as Economic Barometers:*** I.N. measures ups and down in the eco-nomic condition of a country. The I.N. of price, out put, bank deposits, foreign Ex-change etc. shows a nature and variation in general economic and business activity of the country.

3) **It helps in measuring purchasing power of money:** I. N. are used for com-paring the purchase power of money over a period of time to analyze whether the standard of living has increased or decreased.

4) **It helps in formulating new policies:** Many economic and business policies are guided by I. N. to frame new policies.

Limitations of Index Numbers

1) Sampling Error: while constructing I. N. it is not possible to include all the commodities. Thus I. N. are based on sample and hence error may occur while selecting the sample.

2) Selection of Base year create the problem in: I. N. the price of years are compared with the prices of base year. But the selected base year need not be a normal year i.e. It may be affected by various factors like, strike, war depression etc. Thus selection of normal base year is a problem for constructing I. N.

3) Selection of method of Construction I. N. : There are many methods and formulae to construct I. N. and they give different results and answers. Hence it creates the problem to select a proper formula for a particular I. N.

4) Changes in habits and taste : In construction of I.N. we assume that all people have same habits and tastes over a period of time. But which is wrong as-sumption.

5) Comparison over longer period is not reliable : If the time period in base year and current year is too long then the conditions will not remain same and I. N becomes meaningless.

- **Types of Index Numbers** :

1) Price Index Numbers 2) Quantity Index Numbers

3) Value Index Numbers.

1) *Price I. N.*: The price I. N. shows the changes in the prices of commodities produced or consumed in a given period with reference to the base period.

2) *Quantity I. N. :* Quantity I. N. shows the changes in the quantity of goods produced or consumed in a given period with reference to base period.

3) *Value I. N.:* Value I. N. shows the changes in the values of commodities in a given period with reference to base period (Value - Price x Quantity)

- **Method of constructing Index Numbers.**

A) Unweighted Index Number. B) Weighted Index Numbers.

each of two methods are further divided into two classes as

i) Aggregative Method ii) Average Relative Method

- A) Unweighted Index Number. This is the simplest method of constructing I.N.

i) Simple aggregate Price I.N.: It is denoted by P_{01} which is the price I.N. of current year w. r. t. base year and is given by

$$P_{01} = (\sum P_1 / \sum P_0) \times 100$$

Where, $\sum P_1$ = sum of current year prices

$\sum P_0$ = sum of base year prices

ii) Simple average of Price Relative I.N.: It is given by

$$P_{01} = \{[\sum(P_1 / P_0)] \times 100\}/n \quad (\text{ average is A.M.})$$

$$P_{01} = \text{antilog } \{\log [\sum(P_1 / P_0) \times 100]/n\}$$

Where, $\sum(P_1/ P_0)$ = sum of ratio of current year prices to the base year prices

n = number of commodities

Example 1: Compute simple index number using aggregate & average relative methods of 1995 by taking 1993 as base year for the following data.

Prices in Rs.

Commodities	1993	1995
A	10	10.50
B	02	02.75
C	04	04.50
D	03	03.25

Commodities	Prices in 1993	Prices in 1995	$(P_1 / P_0)100$	Log (P_1 / P_0)
A	10	10.5	105.0	2.0212
B	2	2.75	137.5	2.1383
C	4	4.5	112.5	2.051
D	3	3.25	108.3	2.0346
n = 4	19	21	463.3	8.2451

i) Simple aggregate price I.N.

$$P_{01} = (\sum P_1 / \sum P_0) \times 100 = (21/19)*100 = 110.5$$

ii) Simple average of price relative I.N. (using A.M.)

$$P_{01} = \{[\sum (P_1/P_0)] \times 100\}/n = 463.3/4 = 115.8$$

iii) Simple average of price relative I.N. (using G.M.)

$$P_{01} = \text{antilog}\{\log [\sum (P_1/ P_0) \times 100]/n\} = \text{antilog}(8.2451/4)$$

$$= \text{antilog}\,(2.0613) = 115.2$$

- B) Weighted Index Numbers:

  i) Weighted aggregate I.N.: There are four formulae to obtain these I.N.

  a) Laspeyre's I.N b) Paasche's I.N. C) Fisher's Ideal I.N.

  d) Marshall-Edgeworth I.N.

a) Lasperye's Price Index Number: For Lasperye's formula, base year quantities are taken as weights.

$$P_{01}(La) = (\sum p_1 q_0 / \sum p_0 q_0) \text{ x } 100$$

b) Paasche's Price Index Number: For Paasche's formula, current year quantities are taken as weights.

$$P_{01}(Pa) = (\sum p_1 q_1 / \sum p_0 q_1) \text{ x } 100$$

c) Fisher's Ideal Price Index Number: Fisher's formula is the geometric mean of Lasperye's & Paasche's index numbers.

$$P_{01}(F) = [P_{01}(La)* P_{01}(Pa)]^{(1/2)}$$

d) Marshall-Edgeworth Index Number: For this formula, sum of quantities of current year and the base year are taken as weights $P_{01} = [\sum p_1 (q_0 + q_1)/ \sum p_0 (q_0 + q_1)] \text{ x } 100$

Ex. 2. Compute all the weighted aggregate price index numbers from the following data.

Commodities	Prices		Quauntities		p_0q_0	p_0q_1	p_1q_0	p_1q_1
	1990	1992	1990	1992				
	p_0	p_1	q_0	q_1				
A	4	5	3	4	12	16	15	20
B	6	6	5	6	30	36	30	36
C	9	10	6	7	54	63	60	70
D	10	12	8	8	80	80	96	96
				Totals	176	185	201	222

a) Lasperye's Price Index Number = $P_{01}(La) = (\sum p_1 q_0 / \sum p_0 q_0) \times 100$

$= (201/176)*100 = 114.20$

b) Paasche's Price Index Number = $P_{01}(Pa) = (\sum p_1 q_1 / \sum p_0 q_1) \times 100$

$= (222/185)*100 = 120$

c) Fisher's Ideal Price Index Number = $P_{01}(F)$ = $[P_{01}(La) * P_{01}(Pa)]^{(1/2)}$

$= [114.20 * 120]^{(1/2)} = 117.06$

d) Marshall-Edgeworth Index Number $= P_{01} = [\sum p_1(q_0 + q_1) / \sum p_0 (q_0 + q_1)] \times 100$

$= [\sum(p_1q_0 + p_1q_1) / \sum(p_0q_0 + p_0q_1)] \times 100$

$= [(201+222)/(176+185)]*100 = 117.17$

- **Tests of adequacy of Index Numbers:**

We have seen that there are a number of formulae for constructing index numbers. Thus the problem would be to select a proper formula. The following four tests are suggested to compare the adequacy of a formula. (1) Unit Test, (2) Time Reversal Test, (3) Factor Reversal Test, (4) Circular Test.

1. Unit Test: It is natural to expect that the index number should be free from units of measurement of quantities and the units of prices. All the above formulae, except the aggregative index formula satisfy this test. In this respect all of them are equally good.

2. Time Reversal Test: It states that if we calculate first P_{01} and then P_{10} by interchanging base year and the current year the product of the principal factors in the two index numbers should be equal to unity. Symbolically, $P_{01} \times P_{10} = 1$. Of the various index numbers studied above only the factor in Fisher's index number satisfies this test.

3. Factor Reversal Test : It states that the product of the factors of the index number of price and the index number of quantity should be equal to value ratio. Let P_{01} be the price index number and Q_{ol} be the quantity index number obtained by interchanging prices and quantities of the respective years. With usual notation value ratio means the ratio of the total expenditure for the current year to the total expenditure for the base year, *i.e.,* $V_{01} = \sum p_1 q_1 / \sum p_0 q_0$

Hence, symbolically the factor reversal test demands that

$$P_{01} \text{ x } Q_{ol} = \sum p_1 q_1 / \sum p_0 q_0 = V_{01}$$

Only Fisher's index satisfies this test.

4. Circular Test: Another test of adequacy of index number is called circular test. It is a sort of extension of time reversal test. If we calculate an index number of year *a* with *b* as base year and of year *b* with *c* as base what will be the index of year c with the base *a*. Then the circular test states that if the index is a good one then the product of the three indexes should be equal to unity.

Symbolically, $P_{01} \text{ x } P_{12} \text{ x } P_{20} = 1$

Most of the indexes do not satisfy the above test. Even Fisher's index number does not satisfy the test. However, if the quantities remain constant for all years then fisher's index number also satisfies this test.

7. Weighted Average of Price Relatives

If the weights of all items are given explicitly or if the value weights are calculated, then the index number can be calculated either by using A.M. A.M. is used then index number is given by

$$P_{01} = \sum PW / \sum W$$

where, $P = (P_1/P_0) \times 100$ and W = weight

It should be noted that when the value weights are calculated (or given) as percentages of the total expenditure the sum of all the weights will be obviously equal to 100.

Since, the group index number is essentially the price relative the above formula is of the same form as the previous one.

If G. M. used then the index number given by

$$P_{01} = \text{antilog}\{\sum W \log P / \sum W\}$$

Summary:

At the end of this module student must be able to

- **Define various Index Numbers**
- **State uses of Index Numbers**
- **Describe limitations of Index Numbers**
- **Construction of various Index Numbers**
- **Apply tests of adequacy of Index Numbers**