INDEX NUMBERS

M.A. Economics-Semester II
(Module 3)

CC-9 : Statistical Methods

PUJA AGARWAL
Assistant Professor (Guest Faculty)
Department of Economics
Bihar National College, Patna University
E-Mail : pujaagarwal03@yahoo.com

INTRODUCTION

- According to Spiegal, "An index number is a statistical measure designed to show changes in variable or a group of related variables with respect to time, geographical location or other characteristic."

- The first index number was constructed in the year 1764 by an Italian named *'Carli'* to compare the changes in the price for the year 1750 (current year) with the price level of the year 1500 (base year).

- Index numbers are supposed to be barometers which measure the change in the level of a phenomena.

- Index numbers measure only relative changes in the value of a phenomenon.

- In present day situation, changes in price, production, consumption, foreign trade, national income, cost of living, number of road accidents and a wide variety of other phenomena are studied with the help of index numbers.

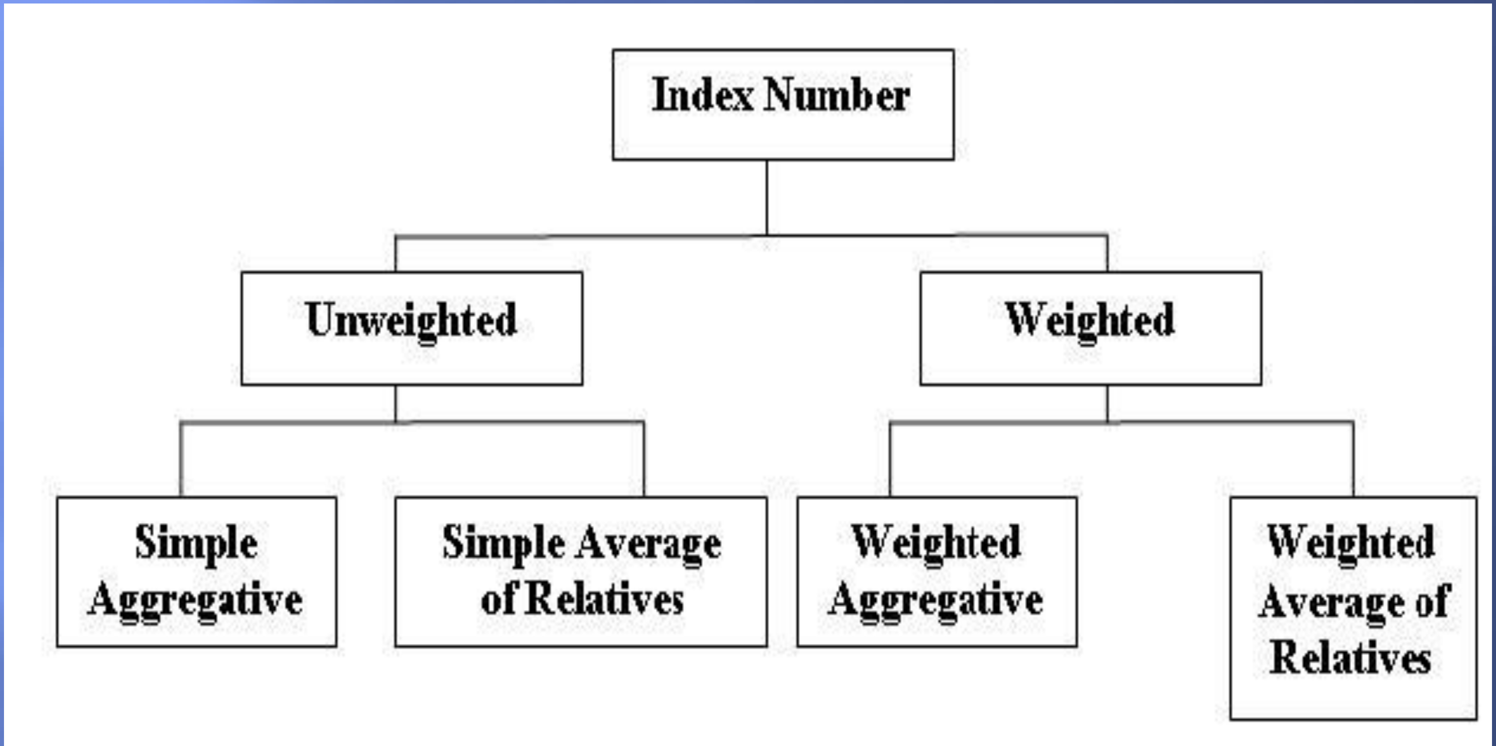
USES OF INDEX NUMBERS

- Help in policy formulation
- Help in Studying trends and tendencies
- Help in forecasting demand and supply
- Act as economic barometers
- Helps in deflating various values
- Indicator of rate of Inflation
- Help us to measure changes in price level
- Used to reduce complex forms of measurement to simple numbers

PROBLEMS IN THE CONSTRUCTION OF INDEX NUMBERS

- The objective or purpose for which the index number is required should be clearly defined.
- The selection of items or commodities from which the index number is to be constructed.
- The selection of base year and the conversion of current prices to price relatives based on the prices of base year.
- The data collected for the construction of index numbers need to be obtained from the reliable sources.
- The selection of average (A.M., G.M., Median) to be used.
- The problem of weighting the index number and of selecting suitable weights.
- Selection of an appropriate formula.

METHODS OF CONSTRUCTING INDEX NUMBERS



In unweighted index numbers, each item is supposed to have the same weight whereas in weighted index numbers the weights are assigned to various items in accordance with their importance.

SIMPLE AGGREGATIVE METHOD

It consists in expressing the aggregate price of all commodities in the current year as a percentage of the aggregate price in the base year.

$$P_{01} = (\Sigma p_1 / \Sigma p_0) \times 100$$

where

P_{01} = Price Index of the current year

p_1 = Total of current year's price of all commodities

p_0 = Total of base year's price of all commodities

Example:

From the following data construct the index number by Simple Aggregate Method:

Commodity	Price (in Rupees)	
	1984 (p_0)	**1985(p_1)**
A	160	172
B	256	186
C	260	196
D	141	152
Total	$\Sigma p_0 =$ 817	$\Sigma p_1 =$ 706

Therefore, the price index number using Simple Aggregate Method

$$P_{01} = (\Sigma p_1/\Sigma p_0) \times 100$$

$$= (706/ 817) \times 100 = 86.41$$

It means that the prices in 1985 were 13.59 % lower than the prices of 1984.

Note : Based on this method, the quantity index is given by the formula:

$$Q_{01} = (\Sigma q_1/\Sigma q_0) \times 100$$

SIMPLE AVERAGE OF RELATIVES METHOD

In this method the prices of the items in the base year are assumed to be 100 and the current year's prices are expressed as percentages of the base year's price.

The formula for the construction of the index number when **arithmetic mean (A.M.)** is used

$$P_{01} = \Sigma(p_1/p_0 \times 100) \div N$$

Where N is the number of items from which the index number is constructed.

When **geometric mean (G.M.)** is used

$$P_{01} = \text{Antilog}\ \Sigma \log P / N$$

Here, $P = (p_1 / p_0) \times 100$

Example :

From the data given below construct the index number for the year 2013 taking 2012 as base by using Arithmetic Mean (A.M.) and Geometric Mean (G.M.)

Commodities	Price in 2012 (₹) P_0	Price in 2013 (₹) P_1	Price Relatives $(p_1/p_0) \times 100$	Log P
A	6	10	166.7	2.2201
B	2	2	100	2.0000
C	4	6	150	2.1761
D	10	12	120	2.0792
E	8	12	150	2.1761
Total			**686.7**	**10.6515**

Using A.M., $P_{01} = \Sigma(p_1/p_0 \times 100) / N = 686.7 / 5 = 137.34$

Using G.M., P_{01} = Antilog Σlog P / N = Antilog (10.6515 / 5)
= Antilog 2.1303 = 134.9

Here, $P = (p_1/p_0)$

WEIGHTED AGGREGATIVE METHOD

Laspeyre's Price Index or Base Year Method

- Devised by Laspeyre in 1871
- Widely used method
- Gives a Weighted Aggregate Index
- In this method, the weights are determined by quantities in the base.
- The formula given by Laspeyre

$$P_{01} = (\Sigma p_1 q_0 / \Sigma p_0 q_0) \times 100$$

where

P_{01} = Price Index of the current year

p_1 = Current year's price

p_0 = Base year's price

q_0 = Base Year Quantity

Paasche's Price Index

- Devised by Paasche (a German Statistician) in 1874
- The weights of current year are used (instead of base year's weights)
- Paashe's formula is given by

$$\mathbf{P_{01} = (\Sigma p_1 q_1 / \Sigma p_0 q_1) \times 100}$$

where

P_{01} = Price Index of the current year

p_1 = Current year's price

p_0 = Base year's price

q_1 = Current Year Quantity

Note : *In general, Laspeyre's price index is greater than Paasche's Price Index. In other words, Laspeyre's Price Index has an upward bias in general,with rise in price.*

Fisher's Ideal Index

- It is the geometric mean of the Laspeyre and Paasche's index numbers (lies between L-P index numbers).

- Fisher's index is supposed to be an Ideal (best) Index Number because it satisfies both the time reversal as well as the factor reversal tests. In fact, it is the only Index number satisfying the two tests.

- It takes into account both the current year's as well as base year's weights .

- Fisher's formula is given by

$$P_{01} = \sqrt{\Sigma p_1 q_0 / \Sigma p_0 q_0 \times \Sigma p_1 q_1 / \Sigma p_0 q_1} \times 100$$

Dorbish-Bowley Price Index

It is the arithmetic mean of the Laspeyre and Paasche's index numbers.

$$P_{01} = \{(\Sigma p_1 q_0 / \Sigma p_0 q_0 \; + \; \Sigma p_1 q_1 / \Sigma p_0 q_1) / 2 \} \times 100$$

Marshall- Edgeworth Price Index

It is obtained by taking the arithmetic cross of the quantities in the base year and the current year as weights ,i.e., w = $(q_0 + q_1)$

$$P_{01} = \{ \Sigma p_1 (q_0 + q_1) /2 \div \Sigma p_0 (q_0 + q_1) /2 \} \times 100$$

$$= (\Sigma p_1 q_0 \; + \; \Sigma p_1 q_1 \; / \; \Sigma p_0 q_0 \; + \; \Sigma p_0 q_1) \times 100$$

Walsch Price Index

Instead of taking the arithmetic mean of base year and current year quantities as weights, we take their geometric mean , i.e., $w = \sqrt{q_0 q_1}$

$$P_{01} = \Sigma p_1 \sqrt{q_0 q_1} \div \Sigma p_0 \sqrt{q_0 q_1} \times 100$$

Kelly's Price Index or Fixed Weight Index

It requires the weights to be fixed for all periods

$$P_{01} = (\Sigma p_1 q / \Sigma p_0 q) \times 100$$

Example:

Calculate Laspeyre's, Paasche's and Fisher's indices for 1980 with 1970 as base from the following data:

Commodity	1970(Base Year)		1980(Current Year)	
	Price	Quantity	Price	Quantity
A	20	8	40	6
B	50	10	60	5
C	40	15	50	15
D	20	20	20	25

N. B. Solution to the question lies in the next slide

Continued....

Sol$^{n.}$

Commodities	1970		1980					
	p_0	q_0	p_1	q_1	p_0q_0	p_0q_1	p_1q_0	p_1q_1
A	20	8	40	6	160	120	320	240
B	50	10	60	5	500	250	600	300
C	40	15	50	15	600	600	750	750
D	20	20	20	25	400	500	400	500
					$\Sigma p_0q_0 = 1660$	$\Sigma p_0q_1 = 1470$	$\Sigma p_1q_0 = 2070$	$\Sigma p_1q_1 = 1790$

Laspeyre's Price Index or Base Year Method

$P_{01} = (\Sigma p_1q_0 / \Sigma p_0q_0) \times 100 = (2070 / 1660) \times 100 = 1.24699 \times 100 = 124.699$

Paasche's Price Index

$P_{01} = (\Sigma p_1q_1 / \Sigma p_0q_1) \times 100 = (1790 / 1470) \times 100 = 1.2177 \times 100 = 121.77$

Fisher's Price Index, $P_{01} = \sqrt{\Sigma p_1q_0 / \Sigma p_0q_0 \times \Sigma p_1q_1 / \Sigma p_0q_1} \times 100$

$P_{01} = \sqrt{2070/1660 \times 1790/1470} \times 100 = 1.23226 \times 100 = 123.23$

TEST OF CONSISTENCY OF INDEX NUMBER FORMULAE

- **Unit Test :** This test requires that the index number formula should be independent of the units in which the prices or quantities of various commodities are quoted.

- **Time Reversal Test :**
  - Proposed by Prof. Irving Fisher
  - It requires the index number formula to possess time consistency by working both forward and backward w.r.t. time.

$$P_{01} \times P_{10} = 1$$

- **Factor Reversal Test :**
  - This is second of the two important tests of consistency proposed by Prof. Irving Fisher

$$P_{01} \times Q_{01} = \Sigma p_1 q_1 / \Sigma p_0 q_0$$

- **Circular Test :**

$$P_{01} \times P_{12} \times P_{20} = 1$$

KEY POINTS

Unit Test is satisfied by almost all the Index Number except the index number based on simple Aggregate of Prices

- **Time Reversal Test** is satisfied by the following index number formulae :
  - Marshall-Edgeworth formula
  - Fisher's ideal formula
  - Walsch formula
  - Kelly's fixed weight formula
  - Simple aggregate index
  - Simple Geometric mean of Price Relatives formula
  - Weighted Geometric mean of Price Relatives formula with fixed weights

- **Factor Reversal**

  Fisher's index is satisfied only by the Fisher's Ideal Index Number

- **Circular test** (first suggeted by 'Westergaard' is fulfilled only by the index number formulae based on:
  - Simple geometric mean of the price relatives
  - Kelly's fixed base method

COST OF LIVING INDEX NUMBER (CPI)

- Cost of Living Index Numbers are designed to measure the effect of changes in the price of a basket of goods and services on the purchasing power of a particular section or class of the society during any given (current) period w.r.t. some fixed (base) period.

- Cost of Living index number enable us to find if the real wages are rising or falling, the money wages remaining the same.

Real Wages = (Money Wages / Cost of Living Index) x 100

Cost of Living Index = $P_{01} = (\Sigma p_1 q_0 / \Sigma p_0 q_0) \times 100$

$$= \frac{\text{Total Expenditure in current year}}{\text{Total expenditure in base year}} \times 100$$

REFERENCES

- Gupta, S.C. (2018). *Fundamentals of Statistcs*, Himalaya Publishing House, 7th Revised & Enlarged Edition

- Gupta, S.P.(2014). *Statistical Methods*, Sultan Chand, 43rd Edition

- Elhance, D.N., Elhance, V., Aggarwal, B.M. (2009). *Fundamentals of Statistics* ,53rd Edition


Thank You