20 - Jan

Index number :→ An index number is a statistical device for measuring the magnitude of relative changes in a series of data. It is an indicator of changing tendency in a variables. According to Croxtones and Cowden.

" Index number are device for measuring differences in the magnitude of a group of related variables, i.e. An index number is a relative number or relative which express relationship between two figures. Actually index number are special type of average in which the commodities are expressed in different units like wheat is expressed in ~~different~~ units ~~are~~ Controles, Cloth in metres, kerosene in litres and so on. here the price pattern may be different for different commodities, for some it may be upward while, for some it may be downward. our main aim is to get a complete expression of this type of complete variations, thus an index number is an number which summarise the movement of such heterogeneous but associated element for comparative purpose index number are represented in the form of percentages with some period taken as standard.

Uses of Index Number →

Index number have become an important tool to measure the changes in economic and business activities, and thus it is sometime called " economic barometers "

Uses :→

(i) Help in studying trend :→

On the basis of index number the trends in industrial production, foreign national trade, national income can be studied. Also the index number are useful in future forecasting., Helps in policy formation, index number are used by any government organisation, or an individual business organisation for efficiency planning and decisions, for example the employeed uses, cost of living index for declaring, allowance for the wages.

(ii) Help in deflating various values →

index number are effectively used in deflating national income on the basis of the price of the base year two unable us to find out whether there is any any changes in real income of the people.

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Basic problems involve in the construction of index number :→

(i) the purpose of index number :→

The first measure problem is that the object of the index number must be very clear that means for what kind of change we are going to construct an index number. the main reason is that there is no single index number which can be used for all the purpose that is why retail price index number is used for studying the problems related to income and salary and general price index number is used for studying.

(ii) The selection of base year :→

Index numbers are always constructed with reference to some base period. The point of reference is called base. While selecting a base period we should be careful that the base period should not be distance in the past and that period must be a normal period. If the based period or reference period is caped fixed for all current period of comparision it is called fixed based period. In chain base method the change in the level of phenomena for any given period is compared with the level of phenomena in the preceding period and not in base period

(iii) Selection of representative items →

There are the no of items which are sold and purchased. But all the items are not taken into consideration, only those items

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Types of index number :→

(N.B) In economics and business the index numbers are classified into four heads

(i) Price index number
(ii) quantity index number
(iii) value index number
(iv) Special purpose index number

1.) Price index numbers :→

when the relative change in the price is studied it is called price index number.

Such index number are further classified as

(i) whole sale price index number
(ii) retail or cost of living price index number

Price relative is an simplest example of index number. it is defined as the ratio of the price of a single community in the current year to it's price in the base year

thus if P_1 is current year price of a single community and P_0 is the base year price of the community then,

$$\text{Price index number} = \frac{P_1}{P_0} \times 100$$

2.) quantity index number →

when the relative change in the quantity is studied that is called quantity index number. by quantity we mean the volume of quantity such as quantity of production, consumption etc.

quantity relative is an simplest example of index number it is defined as the ratio of the quantity of a single commodity in the base year. thus if q_1 is current year quantity of a single commodity and q_0 is the base year quantity of a single commodity and q_0 is the base year quantity of the commodity then

$$\text{quantity index number} = \frac{q_1}{q_0} \times 100$$

(3.) Value index number →

the value is defined as the product of price and quantity.

$$\boxed{\text{Value} = \text{Price} \times \text{quantity}}$$

these are intended to study the change in the total value in current year in comparison to base year. thus if

Value of current period

$= p_1 q_1$

value of base period

$= p_0 q_0$

$$\boxed{\text{Value index number} = \frac{p_1 q_1}{p_0 q_0} \times 100}$$

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(4.) Special Purpose Index number →

If index number are prepared for some specific purpose, then they are called special purpose index number such as index number of national income, productivity, growth rate, etc.

Method of Constructing Index Number

The method of calculating an index number are broadly classified into two categories, one based on price relatives and the other on Aggregative. As calculated above a price relative is simply the current price of a commodity divided by base price. Like the index itself it is expressed as a percentage. The other method is to consider the aggregative of goods for example the goods actually brought or sold in a given year and compared their values at base year price. Construction given in following chart →

- Index Number
  - Unweighted (Simple)
    - Simple Aggregate
    - Average of relatives
  - Weighted
    - Simple aggregate
    - Average of relatives

① Unweighted (Simple Index number) →

(i) Simple aggregate method → this is the simplest method of construction of index number. In this method we express the total of commodity prices in the given year as a percentage of total commodity prices in the base year thus,

Simple aggregate price index (P_{01})

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

where,

P_{01} = index number of current year

ΣP_1 = sum of all the commodity price in current year

ΣP_0 = sum of all ~~the~~ commodity prices in base year

Q.) obtain index number for 2000 taking 1998 as the base year by using simple aggregate method

Commodities	Prices	
	1998	2000
A	100	140
B	80	120
C	160	180
D	220	240
E	40	40

$\therefore$ Price index number of 1998

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

$$= \frac{720}{600} \times 100$$

$$= 120$$

Q4.) For the data given below, calculate the index number by taking

(i) 1990 as the base year

(ii) 1997 as the base year

(iii) 1990 to 1992 as the base year.

Year	Price of wheat (per kg)	Year	Price of wheat
1990	4	1995	10
1991	5	1996	9
1992	6	1997	10
1993	7	1998	11
1994	8		

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Paasche's Index number :→

In this method quantities of the current year i.e. q_1 taken as weights.

The formula is :

$$P_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \times 100$$

Marshall Edgeworth's Index number :→

This formula was suggested by Fisher and was supported by Marshall Edgeworth. In this method average quantity of current and base year is taken as weights. The formula is

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

Fisher's ideal Index number :→

In this method the geometric mean of Laspeyre and Paashe's formulae is taken.

The formula is

$$P_{01} = \sqrt{\left(\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \right)} \times 100$$

Dorbish and Bowley's Index Number :→

In this method, the arithmetic mean of Laspeyre's and Paashe's formulae is taken. The formula is

$$P_{01} = \frac{1}{2} \left(\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} + \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \right) \times 100$$

Walsh Index Number :→

In this method, the geometric mean of the current and base year quantities is taken as weights. The formula is

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

Ex-) 3.1 → 3.6

Weighted average method →

This method is used to overcome the limitation of simple average of relative method. In this method the price relatives for the current year are calculated on the basis of the price of the base year that is

$\frac{P_1}{P_0} \times 100$. These price relative are assigned sum weights W. The weights are multiplied by the price relatives and these products are added up and are divided by the sum of weights

$$\text{Weighted Index Number} = P_{01} = \frac{\Sigma\left(\frac{P_1}{P_0} \times 100\right) W}{\Sigma W}$$

$$= \frac{\Sigma PW}{\Sigma W}$$

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

Similarly, the index number based on geometric mean of price relatives is given by.

$$P_{01} = \text{Antilog}\left(\frac{\Sigma W \log P}{\Sigma W}\right)$$

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Test for index number →

Professor Fisher has made a careful study of different formula's which are used to compute index numbers. He suggested that a good formula should satisfies the following test are :-

1. Time reversal test
2. Factor " "
3. Circular test

1. Time reversal test → according to fisher "the formula for calculating an index number should be such that it will give the same ratio as bet" one point of comparison and the other, no matter which of two is taken as base."

Ex →

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i.e., product of two index numbers must be equal to 1. this follow that a formula should permit interchange of two times (or period) without causing any change in the results. In other words,

If the two periods, the base and the current period are interchange. the product of two index number should be unitary. that means the two index number should be reciprocal to each other.

Hence,

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

where P_{01} = Price change in current year

P_{10} = Price change in base year (based on current year)

Check → Laspeyre's

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

$$P_{10} = \frac{\sum P_0 q_1}{\sum P_1 q_1}$$

$$P_{01} \times P_{10} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \times \frac{\sum P_0 q_1}{\sum P_1 q_1}$$

Paasche's →

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

$$P_{10} = \frac{\sum P_0 q_0}{\sum P_1 q_0}$$

$$P_{01} \times P_{10} = \frac{\sum P_1 q_1}{\sum P_0 q_1} \times \frac{\sum P_0 q_0}{\sum P_1 q_0} \neq 1$$

Marshall →

$$P_{01} = \frac{\Sigma (p_0 + q_1)\, p_1}{\Sigma (q_0 + q_1)\, p_0}$$

$$P_{10} = \frac{\Sigma (p_1 + q_0)\, p_0}{\Sigma (q_1 + q_0)\, p_1}$$

$$P_{01} \times P_{10} = \frac{\Sigma (p_0 + q_1)\, p_1}{\Sigma (q_0 + q_1)\, p_0} \times \frac{\Sigma (p_1 + q_0)\, p_0}{\Sigma (q_1 + q_0)\, p_1} \neq 1$$

Fisher →

$$P_{01} = \sqrt{\left[\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \right]}$$

$$P_{10} = \sqrt{\left(\frac{\Sigma p_0 q_1}{\Sigma p_1 q_1} \times \frac{\Sigma p_0 q_0}{\Sigma p_1 q_0} \right)}$$

$$P_{01} \times P_{10} = \sqrt{\left[\frac{\cancel{\Sigma p_1 q_0}}{\cancel{\Sigma p_0 q_0}} \times \frac{\cancel{\Sigma p_1 q_1}}{\cancel{\Sigma p_0 q_1}} \times \frac{\cancel{\Sigma p_0 q_1}}{\cancel{\Sigma p_1 q_1}} \times \frac{\cancel{\Sigma p_0 q_0}}{\cancel{\Sigma p_1 q_0}} \right]}$$

$$= 1$$

Thus, Fisher's index number satisfies time reversal test. It can be seen that Marshall-Edgeworth's and Walsh's index number also satisfy time reversal test.

Timeseries question

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Ex - 2.1, Ex - 2.2, 2.3, 2.4, 2.5, 2.6

2.7,

Ratio to trend method

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Ex - 2.16

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Factor reversable Test →

In the words of fisher,

" just as a formula should permit interchange of two times without giving inconsistent results, so, it oughts to permit interchanging the prices and quantities without giving inconsistent results, that means the two results multiply together should give the true value ratio".

It means that as a formula should permit interchange of two times, it should also permit interchange of prices and quantities without causing any change in the ratio of their true value. In it's simplest form, we conclude that a change in price (denoted by P_{01}) is always followed by a change in quantity denoted by Q_{01}.

Symbollicy the factor reversal test satisfy if,

$$P_{01} \times Q_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0} = \frac{\text{value in the given year (1)}}{\text{value in the base year (0)}}$$

Let us see whether the Laspeyre's index satisfies factor reversal test or not. For which

$$P_{01} = \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \quad \text{and} \quad Q_{01} = \frac{\Sigma q_1 p_0}{\Sigma q_0 p_0}$$

Thus,

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

$$\neq \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0}$$

Thus, Laspeyre's index does not satisfy factor reversal test.

Fisher index number $\longrightarrow$

$$P_{01} = \sqrt{\left[\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}\right]}$$

$$Q_{01} = \sqrt{\left[\frac{\Sigma q_1 p_0}{\Sigma q_0 p_0} \times \frac{\Sigma q_1 p_1}{\Sigma q_0 p_1}\right]}$$

$$P_{01} \times Q_{01} = \sqrt{\frac{\cancel{\Sigma p_1 q_0}}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\cancel{\Sigma p_0 q_1}} \times \frac{\cancel{\Sigma q_1 p_0}}{\Sigma q_0 p_0} \times \frac{\Sigma q_1 p_1}{\cancel{\Sigma q_0 p_1}}}$$

$$= \sqrt{\frac{(\Sigma p_1 q_1)^2}{(\Sigma p_0 q_0)^2}}$$

$$= \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0}$$

Circular Test →

It is often desire to shift the base hence the formula for the construction of an index number should be such that it ensure that new index number which may be obtained by the shifting process should be equal to the original index number thus

$$P_{01} \times P_{02} \times P_{12} = 1$$

where,

P_{01} = Price change of the current year of the base year

P_{02} = Price change of the current year on the second base year

P_{12} = Price change of the base year on some other base

Practical question

Q10.) Calculate Fisher's index number from the data given below and show that it satisfies the time reversal and factor reversal test :

Commodity	Base year		Current year	
	Price	Quantity	Price	Quantity
A	12	10	15	12
B	15	5	20	5
C	34	7	20	8
D	5	16	5	14

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Soln :-

Commodity	Base year		Current year	
	p_0	q_0	p_1	q_1
A	12	10	15	12
B	15	5	20	5
C	34	7	20	9
D	5	16	5	14

$\Sigma p_0 q_0 = 120 + 75 + 238 + 80$
$= 513$

$\Sigma p_1 q_1 = 180 + 100 + 180 + 70$
$= 530$

$\Sigma p_0 q_1 = 144 + 75 + 306 + 70$
$= 595$

$\Sigma q_0 p_1 = 150 + 100 + 140 + 80$
$= 470$

Fisher's index number →

$$P_{01} = \sqrt{\boxed{\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}}}$$

$$= \sqrt{\frac{470}{513} \times \frac{530}{595}}$$

Given data will satisfy the time reversal test ~~PDD~~ ~~cos~~ for Fisher's index number →

iff,

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

Now →

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

$$= \sqrt{\frac{470}{513} \times \frac{530}{595}}$$

$$P_{10} = \sqrt{\frac{\Sigma p_0 q_1}{\Sigma p_1 q_1} \times \frac{\Sigma p_0 q_0}{\Sigma p_1 q_0}}$$

$$= \sqrt{\frac{595}{530} \times \frac{513}{470}}$$

$$\therefore P_{01} \times P_{10} = \sqrt{\frac{\cancel{470} \times \cancel{530}}{\cancel{513} \times \cancel{595}}} \times \sqrt{\frac{\cancel{595}}{\cancel{530}} \times \frac{\cancel{513}}{\cancel{470}}}$$

$$= \sqrt{1}$$

$$= 1$$

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

$\therefore$ Given data,

satisfy the time reversal test.

for factor reversal test, given data should satisfy the given Condition →

$$P_{01} \times q_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0}$$

Now →

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

$$= \sqrt{\frac{470}{513} \times \frac{530}{595}}$$

$$q_{01} = \sqrt{\frac{\Sigma q_1 p_0}{\Sigma q_0 p_0} \times \frac{\Sigma q_1 p_1}{\Sigma q_0 p_1}}$$

$$= \sqrt{\frac{595}{513} \times \frac{530}{470}}$$

$$\therefore P_{01} \times q_{01} = \sqrt{\frac{\cancel{470}}{513} \times \frac{530}{\cancel{595}}} \times \sqrt{\frac{\cancel{595}}{513} \times \frac{530}{\cancel{470}}}$$

$$= \sqrt{\left(\frac{530}{513}\right)^2}$$

$$= \frac{530}{513}$$

$$= \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0}$$

Hence, verified

Afternoon class

Practical question

EX-3.1 (a) From the following data calculate price index numbers for 2005 with 1995 as base by (i) Laspeyre's (ii) Paasche's (iii) Marshall-Edgeworth and (iv) Fisher's formulae:

Commodities	1995		2005	
	Price	Quantity	Price	Quantity
A				
B				
C				
D				

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