

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 of variables. According to Croxton and Cowden,

" Index number are device for measuring difference, 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 numbers are special type of average in which the commodities are expressed in different units like wheat is expressed in ~~commodity~~ units like tonnes, cloth in meters, kerosene in litres and so on. but 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 a number which summarize the movements of such harmonized by associated elements for comparative purpose index numbers are represented in the form of percentages with some period as base period.

Uses of Index Number —

Index numbers have become an important tool to measure the changes in economic and business activities and this is sometimes called "Economic Barometer".

Uses: →

(i) Help in studying trend: →

on the basis of index number the trends in industrial production, organizations trade, national income can be studied. So the index number are useful in future forecasting, helps in policy formation, index number are used by government organization, & in individual business organization for efficiency planning and decisions, for example the employed user, cost of living index for decisions, Allowance for the wages.

(ii) Help in deflating various values: →

index numbers are effectively used in deflating national income on the basis of the price of the base year, so we are able to find out whether there is any any changes in real income of the people.

24-01-22

Plan

Basic problems involve in the construction of index number: →

(i) The purpose of index number: →

The first problem is that the object of the index number must be very clear thus means for which 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.

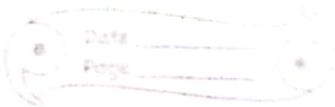
that is why retail price index number is used for studying the problems related to income and saving and general price index number is used for studying.

### (ii) The Selection of base year :-

Index numbers are always considered 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 too far in the past and that period must be a normal period. If the fixed period or reference period is kept fixed for all successive period of comparison it is called fixed base period. In chain base period 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





Types of index numbers : →

(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 numbers 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 commodity in the current year to its price in the base year  
 thus if  $P_i$  is current year price of a single commodity and  $P_o$  is the base year price of the commodity then,

$$\text{Price index number} = \frac{P_i}{P_o} \times 100$$

2.) Quantity index number →

when the relative change in the quantity is studied this 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 if 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.

$$\text{Value} = \text{Price} \times \text{Quantity}$$

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

$$= P_0 q_0$$

$$\text{Value Index Number} = \frac{P_1 q_1}{P_0 q_0} \times 100$$

Ex-5) In

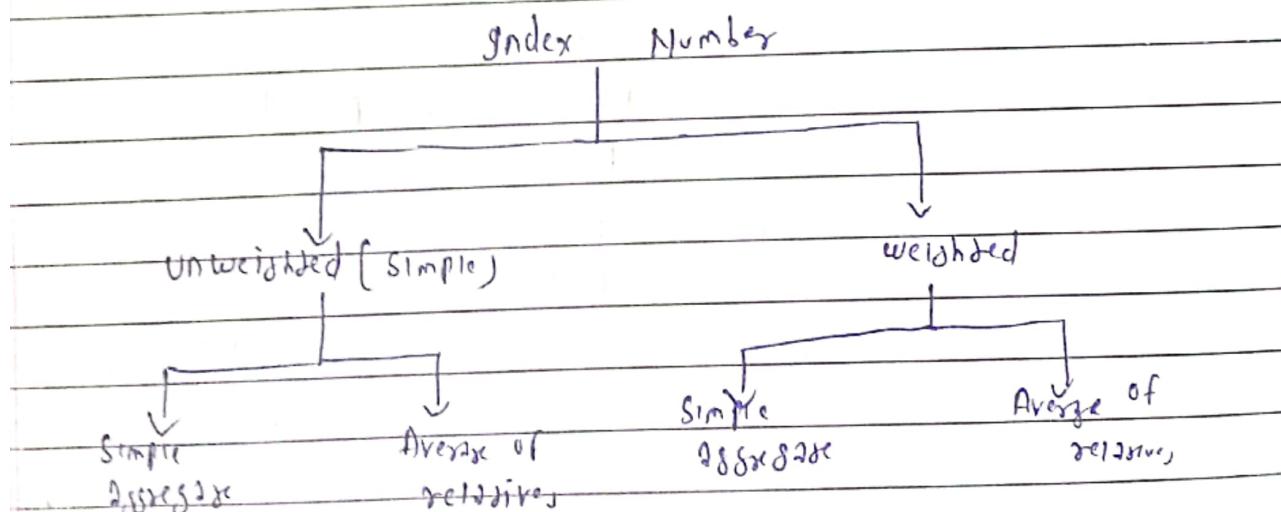
(4.) Special purpose index number -

If index numbers 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 is expressed as a percentage. The other method is to consider the aggregate of goods for example the goods actually bought & sold in a given year and compare their values at base year price.

Construction given in following chart →



### 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 ( $P_{01}$ )

$$P_{01} = \frac{\sum P_i}{\sum P_0} \times 100$$

where,

$P_{01}$  = index number of current year

$\sum P_i$  = sum of all the commodity price  
in current year

$\sum P_0$  = sum of all <sup>commodity</sup> prices in base  
year

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

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

$\therefore$  Price index number of 1998

$$= P_{01} = \frac{\sum P_i}{\sum P_0} \times 100$$

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

$$= 120$$

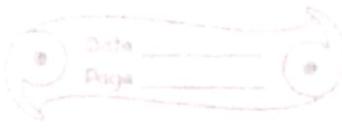
(Q4.) For the data given below, calculate the index numbers by taking

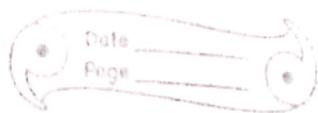
(i) 1990 as the base year

(ii) 1992 as the base year

(iii) 1990 to 1992 as the base year.

Year	Price of wheat (Rs/kg)	Year	Price of wheat (Rs/kg)
1990	4	1995	10
1991	5	1996	9
1992	6	1997	10
1993	7	1998	11
1994	8		12





Handwriting practice lines. The page contains 20 sets of horizontal lines for practicing letter formation and alignment.





( $\frac{1}{2}$ )  $\frac{1}{2}$

fraction

whole

Paasche's Index Number :-

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

The formula is :

$$P_{01} = \frac{\sum P_1 q_1}{\sum P_0 q_1} \times 100$$

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

$$P_{01} = \frac{\sum (q_0 + q_1) P_1}{\sum (q_0 + q_1) P_0} \times 100$$

Fisher's Index Number :-

In this method the geometric mean of Laspeyres and Paasche's formula is taken.

The formula is

$$P_{01} = \sqrt{\left[ \frac{\sum P_1 q_0}{\sum P_0 q_0} \times \frac{\sum P_1 q_1}{\sum P_0 q_1} \right]} \times 100$$

Dobish and Bowley's Index Number :-

In this method, the geometric mean of Laspeyres' and Paasche's formulae is taken. The formula is

$$P_{01} = \frac{1}{2} \left[ \frac{\sum P_1 q_0}{\sum P_0 q_0} + \frac{\sum P_1 q_1}{\sum P_0 q_1} \right] \times 100$$

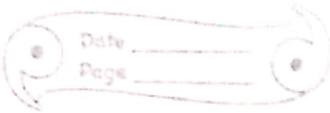
Wish Index Number  $\rightarrow$

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

$$P_{01} = \frac{\sqrt[n]{q_{190}}}{\sqrt[n]{q_{190}}} P_1 \times 100$$

(Ex-)

$$3.1 \rightarrow 3.6$$



### Weighted Average method →

This method is used to overcome the limitation of simple average of relatives 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

$$\frac{P_1}{P_0} \times 100. \text{ These price relatives}$$

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

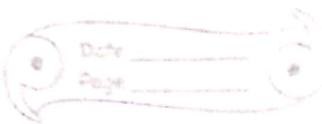
$$\begin{aligned} \text{Weighted Index Number} &= P_0 I = \frac{\sum \left( \frac{P_1}{P_0} \times 100 \right) w}{\sum w} \\ &= \frac{\sum P_1 w}{\sum w} \end{aligned}$$

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

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

$$P_0 I = \text{Antilog} \left( \frac{\sum w \log P_1}{\sum w} \right)$$

~~Notes~~



Handwriting practice lines. The top portion contains 20 horizontal lines for uppercase letter tracing. The bottom portion contains 10 horizontal lines for lowercase letter tracing.

Prof. Fisher's theory -  
 Prof. Fisher by making a careful  
 study of different formulas which are used to  
 compute index numbers. He suggested that a  
 good formula should satisfy the following des-  
 irae :-

- (1) Time reversal test
- (2) Factor " "
- (3) Circularity test

(1) Time reversal test - According to Fisher  
 "The formulas for calculation of index numbers  
 should be such that it will give the  
 same result as before one period of comparison  
 and the other, no matter which of two is  
 taken as base."

Ex - →  
 Ex No → 3.1, 3.2, ~~3.3~~, 3.4, 3.5, 3.6,  
 3.12, 3.13, 3.14

2-Feb  
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i.e., product of two index numbers must  
 be equal to 1. This follows that ?  
 Formula should permit interchange of two times  
 (or periods) without causing any change in the results.  
 In other words,  
 If the two periods, the base and the  
 current period are interchanged. The product of two

Index number should be unity. That means the two index numbers should be reciprocals 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 → (2 steps)

~~$P_{01} = \frac{\sum P_1 Q_0}{\sum P_0 Q_0}$~~

~~$\times \frac{\sum P_1 Q_1}{\sum P_1 Q_1}$~~

$$P_{01} = \frac{\sum P_1 Q_0}{\sum P_0 Q_0}$$

$$P_{10} = \frac{\sum P_0 Q_1}{\sum P_1 Q_1}$$

$$P_{01} \times P_{10} = \cancel{\frac{\sum P_1 Q_0}{\sum P_0 Q_0}} \times \cancel{\frac{\sum P_0 Q_1}{\sum P_1 Q_1}}$$

$$= \frac{\sum P_1 Q_0}{\sum P_0 Q_0} \times \frac{\sum P_0 Q_1}{\sum P_1 Q_1}$$

Passes →

~~$P_{01} = \frac{\sum P_1 Q_1}{\sum P_0 Q_1}$~~

~~$P_{10} = \frac{\sum P_0 Q_0}{\sum P_1 Q_0}$~~

$$P_{01} \times P_{10} = \frac{\sum P_1 Q_1}{\sum P_0 Q_1} \times \frac{\sum P_0 Q_0}{\sum P_1 Q_0} \neq 1$$

Marshall →

$$P_{01} = \frac{\varepsilon (P_0 + q_1) P_1}{\varepsilon (q_0 + q_1) P_0} \quad (\text{cancel})$$

$$P_{10} = \frac{\varepsilon (P_1 + q_0) P_0}{\varepsilon (q_1 + q_0) P_1} \quad (\text{cancel})$$

$$P_{01} \times P_{10} = \frac{\varepsilon (P_0 + q_1) P_1}{\varepsilon (q_0 + q_1) P_0} \times \frac{\varepsilon (P_1 + q_0) P_0}{\varepsilon (q_1 + q_0) P_1} = 1$$

Fisher →

$$P_{01} = \sqrt{\left[ \frac{\varepsilon P_1 q_0}{\varepsilon P_0 q_1} \times \frac{\varepsilon P_1 q_1}{\varepsilon P_0 q_0} \right]}$$

$$P_{10} = \sqrt{\left[ \frac{\varepsilon P_0 q_1}{\varepsilon P_1 q_0} \times \frac{\varepsilon P_0 q_0}{\varepsilon P_1 q_1} \right]}$$

$$P_{01} \times P_{10} = \sqrt{\left[ \frac{\varepsilon P_1 q_0}{\varepsilon P_0 q_1} \times \frac{\varepsilon P_1 q_1}{\varepsilon P_0 q_0} \times \frac{\varepsilon P_0 q_1}{\varepsilon P_1 q_0} \times \frac{\varepsilon P_0 q_0}{\varepsilon P_1 q_1} \right]} = 1$$

$$= 1$$

Thus, fishing index number satisfies the reversal test.  
 It can be seen that marshall edgeworth and  
 fisher's index number also satisfy the reversal test.

(Pioneering question)

Page No - 2.12

Ex - 2.1 , Ex - 2.2 , 2.3 , 2.4 , 2.5 , 2.6  
2.7 ,

P2010 do second method

Page - No - 2.43

Ex - 2.16

3- Feb - 2022

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Factor reversable Test →  
— — — —

In the words of Fisher,

" just 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 multiplying 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 id's simplest form, we conclude that a change in price (denoted by  $P_{01}$ ) is always followed by a change in quantity denoted by  $Q_{01}$ .

Symbolically the factor reversal test stands

if,

$$P_{01} \times Q_{01} = \frac{E P_1 q_1}{E P_0 q_0} = \frac{\text{Value in the dimensions (1)}}{\text{Value in the base year (0)}}$$

Let us see whether the Laspeyres' Index satisfied  
factor reversal test or not for which

$$P_{01} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \quad \text{and} \quad Q_{01} = \frac{\sum q_1 p_0}{\sum q_0 p_0}$$

Thus,

$$P_{01} \times Q_{01} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \times \frac{\sum q_1 p_0}{\sum q_0 p_0}$$

$$\neq \frac{\sum P_1 q_1}{\sum P_0 q_1}$$

Thus, Laspeyres' Index does not pass the factor  
reversal test.

Fisher index number  $\longrightarrow$

$$P_{01} = \sqrt{\left[ \frac{\sum P_1 q_0}{\sum P_0 q_0} \times \frac{\sum P_1 q_1}{\sum P_0 q_1} \right]}$$

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

$$P_{01} \times Q_{01} = \sqrt{\frac{\sum P_1 q_0}{\sum P_0 q_0} \times \frac{\sum P_1 q_1}{\sum P_0 q_1} \times \frac{\sum q_1 p_0}{\sum q_0 p_0} \times \frac{\sum q_1 p_1}{\sum q_0 p_1}}$$

$$= \sqrt{\frac{(\sum P_1 q_1)^2}{(\sum P_0 q_0)^2}}$$

$$= \frac{\sum P_1 q_1}{\sum P_0 q_0}$$

(1) Page 1

### Circum Test →

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

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

where,

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

$P_{12}$  = Price change of the current year  
on the second base year

$P_{02}$  = 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	9
D	5	16	5	14

So:

Commodity	Base year		Current year	
	P <sub>0</sub>	q <sub>0</sub>	P <sub>1</sub>	q <sub>1</sub>
A	12	10	15	12
B	15	5	20	5
C	34	7	20	9
D	5	16	5	14

$$\begin{aligned}\sum P_0 q_0 &= 120 + 75 + 238 + 80 \\ &= 513\end{aligned}$$

$$\begin{aligned}\sum P_1 q_1 &= 180 + 100 + 180 + 70 \\ &= 530\end{aligned}$$

$$\begin{aligned}\sum P_0 q_1 &= 144 + 75 + 306 + 70 \\ &= 595\end{aligned}$$

$$\begin{aligned}\sum q_0 P_1 &= 150 + 100 + 190 + 80 \\ &= 470\end{aligned}$$

Fisher's index number →

$$P_{01} = \sqrt{\left[ \frac{\sum P_1 q_0}{\sum P_0 q_0} \times \frac{\sum P_1 q_1}{\sum P_0 q_1} \right]}$$

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

Given data will satisfy the time reversal test  
 IFF condition for Fisher's index number →  
 IFF,

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

Now →

$$P_{01} = \sqrt{\frac{E P_1 q_0}{E P_0 q_1}} \times \frac{E P_1 q_1}{E P_0 q_0}$$

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

$$P_{10} = \sqrt{\frac{E P_0 q_1}{E P_1 q_0}} \times \frac{E P_0 q_0}{E P_1 q_1}$$

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

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

$$= \sqrt{1}$$

$$= 1$$

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

∴ Given data ,

satisfy the time reversal test .

for factor reversal test, given data should  
satisfy the given condition  $\rightarrow$

$$P_{01} \times Q_{01} = \frac{\epsilon P_1 q_1}{\epsilon P_0 q_0}$$

Now  $\rightarrow$

$$P_{01} = \sqrt{\frac{\epsilon P_1 q_0}{\epsilon P_0 q_0} \times \frac{\epsilon P_1 q_1}{\epsilon P_0 q_1}}$$

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

$$Q_{01} = \sqrt{\frac{\epsilon q_1 p_0}{\epsilon q_0 p_0} \times \frac{\epsilon q_1 p_1}{\epsilon q_0 p_1}}$$

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

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

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

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

$$= \frac{\epsilon P_1 q_1}{\epsilon P_0 q_0}$$

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) Laspeyres (ii) Paasche's (iii) Marshall - Edgeworth and (iv) Fisher's formula:

Commodities	1995	2005		
	Price	Quantity	Price	Quantity
A				
B				
C				
D				