Quantitative Aptitude & Business Statistics

INDEX NUMBERS

Index Numbers

- An index number is a specialized average designed to measure the changes in a variable with respect to time ,geographical location or characteristics such as income, profession etc.

Features of Index numbers

- specialized averages .
- measure the net change in a group of related variables.
- measures the effect of changes over a period of time.

Uses of Index Numbers

1. A guide to business policy.
2. Indices of industrial production are useful as they are the indicators of business environment .
3. At times, index numbers can be combined into one series that may be relevant to one's own business.

4. Very helpful in finding out whether a business firm's sales are increasing in physical volume as opposed to rupee value.
5. Used to adjust wages or salaries on account of rising prices or inflation.
6. 6.Index numbers can be used for providing incentive to efficient workers.

Problems in Index Number Construction

1. Selection of a Base Year
2. Type of Formula
3. Selection of Weights
4. The Data for Index Numbers

Types of Price Index Numbers

- Simple Index Numbers
- Composite Index Numbers
- Simple Average of Price Relatives
- Weighted Relative Price Index Numbers

Price Relatives

- Price relatives are helpful in understanding and interpreting changing economic and business conditions over time.

Price Relatives

- A price relative shows how the current price per unit for a given item compares to a base period price per unit for the same item.
- A price relative expresses the unit price in each period as a percentage of the unit price in the base period.

$$\text{Price relative in period t} = \frac{\text{Price in period t}}{\text{Base period price}}(100)$$

Aggregate Price Indexes

- An aggregate price index is developed for the specific purpose of measuring the combined change of a group of items.
- An unweighted aggregate price index in period t,

$$I_t = \frac{\sum P_{it}}{\sum P_{i0}}(100)$$

Where,

Pit = unit price for item *i* in period *t*

***Pi* 0 = unit price for item *i* in the base period**

Laspyre's Price index number

$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100$$

Where

- P1=Price of the current year
- P0=Price of the base year
- qo=Quantity of the base year

Paachee's Price index number

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

- Where
- P1=Price of the current year
- P0=Price of the base year
- q1=Quantity of the current year

Dorbish-Bowley's Price index number

$$P_{01} = \frac{L+P}{2} = \frac{\frac{\sum p_1 q_0}{\sum p_0 q_0} + \frac{\sum p_1 q_1}{\sum p_0 q_1}}{2} \times 100$$

Where,

L=Laspyre's Price index number

P=Paachee's Price index number

Marshall-Edgewoths's Price index number

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

- Where
- P1=Price of the current year
- P0=Price of the base year
- qo=Quantity of the current year
- q1=Quantity of the current year

Fisher's Price index number

$$P_{01} = \sqrt{L \times P}$$

$$p_{01} = \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100$$

- Where
- L = Laspyre's Price Index number
- P = Paachee's Price Index number

Kelly's Price index number

$$P_{01} = \frac{\sum p_1 q}{\sum p_0 q} \times 100$$

$$q = \frac{q_1 + q_2}{2}$$

- Where

P1=Price of the current year

P0=Price of the base year

q=Quantity of the current/base year

Weighted Price index number

- If Arithmetic Mean is used

$$P_{01} = \frac{\sum PV}{\sum V} \times 100$$

$$P = \frac{p_1}{p_0} \times 100$$

V=P0q0

- Where
- P1=Price of Current Year
- P0=Price of base year

Weighted Price index number

- If Geometric Mean is used

$$P_{01} = Anti\log\left[\frac{\sum V \log P}{\sum V}\right] \times 100$$

- Where
- P1=Price of Current Year
- P0=Price of base year
- V=P0q0

Quantity Indexes

- An index that measures changes in quantity levels over time is called a quantity index.
- Probably the best known quantity index is the Index of Industrial Production.

- A weighted aggregate quantity index is computed in much the same way as a weighted aggregate price index.

$$I_t = \frac{\sum Q_{it} w_i}{\sum Q_{i0} w_i} (100)$$

Tests of adequacy of Index numbers

1. Unit test
2. Time reversal test
3. Factor reversal test
4. Circular test

Unit test

- The unit test requires that the formula for constructing an index should be independent of the units in which ,or for which ,prices and quantities are quoted. All formulae except the simple (unweighted)aggregate index formula satisfy this test.

Time Reversal Test

- A method satisfies time reversal test if it gives P01 * P10 = 1 where P01 is the price index number for the current year with the base year 100 and P10 is the index number of the base year, taking current year as the base, both the indices without the factor 100.

Methods which satisfy the time reversal test

- The Fisher's ideal index number.
- Simple geometric mean of price relatives.
- Aggregate with fixed weights.
- Marshal-Edge worth Price index number.

Factor Reversal Test

- A method satisfies factor reversal test if it gives

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

- where P01 is the price index for the current year (without the factor 100) and Q01 is the quantity index for the current year (without the factor 100).

- Fishers index number only satisfies the factor reversal test.

Circular Test

- There is another test with respect to index numbers. This is known as the circular test. It is an extension of the time reversal test. Symbolically, the circular test may be written as

  $P_{01} \cdot P_{12} \cdot P_{23} \ldots P_{n-1n} \cdot P_{n0} = 1$

  Circular test satisfies the simple geometric mean of price relatives and weighted aggregate of fixed weights.

Chain base index numbers

- Chain base index numbers is one in which the figures for each are first expressed as percentage of the preceding year. The percentage are chained together by successive multiplication to form a series of chain index, in chain base year index method the base year changes from year to year .

- Link relative= Current Year Price index / Immediate preceding previous Year Price relative X100

Advantages of Chain Base Index Numbers

1. The chain base index numbers facilitate the introduction of new items as also the deletion of absolute items in a smooth manner.
2. In business, often, comparisons are made in the current period with the immediately preceding period rather than any distant period in the past.

Limitations of Chain Base Index Numbers

1. If the data for any one year are not available, the chain index number for subsequent period cannot be computed.
2. If an error in the computation of any link relative takes place, then such an error gets compounded and the entire series gives a distorted picture.

3)to splice two overlapping indices together;

4) construct a chain index and

5)facilitate comparison with some date of special interest.

Splicing and Shifting the Base of Index Numbers

When two or more overlapping series of index numbers are combined into one series, then this process is known as splicing.

Splicing

- Splicing is a technique of linking two or more index number series with the same items and a common overlapping year but with different base period in order to form a continuous series. Splicing may be forward or backward

Splicing	Index no. of old series	Index no. of New series
Forward Splicing	={100/Overlapping index number of old series }*Given index of No .of old series	No change

Splicing	Index no. of old series	Index no. of New series
Backward Splicing	No change	={Index number of old series/100}*Given index No.of new series

Shifting the Base Year

At times it is preferable to shift the base of an existing index on account of several reasons.

These reasons are:

1) to make the base more recent, which will increase its utility;
2) to ensure better comparison with some other index that is available on some other base;

- **New index Number using new base=**

$$\frac{\text{Old Index number using old base}}{\text{Index number Corresponding new base year}} \times 100$$

Deflating Prices and Incomes

The process of adjusting prices and incomes by a price index and expressing them in terms of base-year rupees is called deflating prices and income.

$$\text{Purchasing power of Money} = \frac{1}{\text{Price index number}}$$

- Money wage= $\frac{Money\,wage}{Price\,index} \times 100$
- Money wage index = $\frac{Real\,wage}{Money\,wage\ 'of\,the\ 'base\,year\ '} \times 100$
- Real Wage index = $\frac{Money\,wage\,index}{Price\,index} \times 100$

Caution in using Index Numbers

- If the index numbers are defective on account of one or more reasons, their interpretation will lead to drawing of wrong inferences from them. Even if index numbers are constructed on sound statistical principles, but we interpret them in the wrong manner, our conclusions will be wrong.

- As far as construction of index numbers is concerned, it is the domain of the statistician who has to ensure that the index numbers are based on sound statistical principles. As regards proper use of index numbers, it is the user who should ensure that he interprets index numbers properly

Limitations of Index Numbers

Index numbers are based on sample data. In case sample size is extremely limited and its selection is faulty in the sense that the sample units have not been selected randomly, index numbers will give wrong figures.

At times, index numbers can be manipulated by those who are in authority. This is purposely done to support their viewpoint.

A number of formulae can be used in index number construction. These will give different results. One who is using the index should know a little more about different formulae and their effect on the magnitude of the index.

Limitations of Index Numbers

Index numbers with the same base and items are useful for a short period. One has, therefore, to ensure that index does not use a very remote year as the base.

One who is interpreting an index must be familiar with general aspects of the economy and the factors relevant in this regard.

As we know, our indices are of prices and quantities. The question is: does our index reflect a change in the quality of a product or item?

Apart from quality changes, there are other aspects, that are pertinent while we are interpreting index numbers. We have to ask whether the weights assigned to different items are appropriate.

Some Important Price Indexes

- Consumer Price Index (CPI)
  - Primary measure of the cost of living .
  - Based on 985 items including food, housing, clothing, transportation, and medical items.
  - Weighted aggregate price index with fixed weights derived from a usage survey.
  - Published monthly by the Bureau of Statistics.
  - Its base period is 2001-02 with an index of 100.

Methods of Constructing Consumer Price index

- Aggregate Expenditure method
- Family budget method
- Aggregate expenditure method is a weighted aggregated price index where weights are the base period quantities. (Laspyre's Index number)

$$CPI = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100$$

- Family budget method is a weighted aggregated of price relatives method where index is obtained by taking the average of weighted price relatives and the value weights are (P0q0) are used

$$CPI = \frac{\sum PV}{\sum V}$$

$$\frac{P_1}{P_0} \times 100$$

$$V = P_0 . Q_0$$

Some Important Price Indexes

- **Producer Price Index (PPI)**
  - Measures the monthly changes in prices in primary markets .
  - Used as a leading indicator of the future trend of consumer prices and the cost of living.
  - Covers raw, manufactured, and processed goods at each level of processing.

- Includes the output of manufacturing, agriculture, forestry, fishing, mining, gas and electricity, and public utilities.
- Weighted average of price relatives using the Laspeyres method.

Problem

- From the following data compute the Fisher's Price index number.

Commodity	Base Year		Current Year	
	Price	Quantity	Price	Quantity
A	1	6	5	8
B	2	7	4	7
C	3	8	3	6
D	4	9	2	5

Fisher's Index number is calculated by

$$P_{01} = \sqrt{L \times P}$$

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

$$= \sqrt{\frac{100}{80} \times \frac{96}{60}} \times 100$$

$$= \sqrt{\frac{9600}{4800}} \times 100$$

$$= \sqrt{2} \times 100$$

$$= 141.42$$

Problem

- Calculate chain indices and fixed base indices with 2000 as base from the following data

Year	2000	2001	2002	2003	2004
Price of item Per .Kg	20	25	30	45	63

Year	Price of Rice (Rs. per Kg)	FBIN
2000	20	100
2001	25	(25/20)*100=125
2002	30	(30/20)*100=150
2003	45	(45/20)*100=225
2004	63	(63/20)*100=315

Problem

- **Convert the following Link relatives in to price relatives taking 2000 as base**

Year	2000	2001	2002	2003	2004
Link Relative	80	125	120	150	140

Year	Link relatives (LR's)	Price Relatives (PR's)
2000	80	100
2001	125	(125/100)*100=125
2002	120	(120/100)*125=150
2003	150	(150/100)*150=225
2004	140	(140/100)*225=315

Problem

- From the following data compute the Consumers Price index number. (Aggregate Expenditure method

Commodity	Base Year		Current Year	
	Price	Quantity	Price	Quantity
A	1	6	5	8
B	2	7	4	7
C	3	8	3	6
D	4	9	2	5

$V = p_0 q_0$	Price Relative= $\frac{P_1}{P_0} \times 100$	PV
6	500	3000
14	200	2800
24	100	2400
36	50	1800
80		10000

$$CPI = \frac{\sum PV}{\sum V}$$

$$= \frac{1000}{80}$$

$$= 125$$

Problem

- From the following data compute the Consumers Price index number. (Family budget method

Commodity	Base Year		Current Year	
	Price	Quantity	Price	Quantity
A	1	6	5	8
B	2	7	4	7
C	3	8	3	6
D	4	9	2	5

$$CPI = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100$$

$$= \frac{100}{80} \times 100$$

$$= 125$$

1. The best average in the construction of index number is

(a) median

(b) geometric mean

(c) mode

(d) arithmetic mean

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(b) geometric mean

(c) mode

(d) arithmetic mean

2. The paaschee's index number is based on

(a) base year quantities

(b) current year quantities

(c) average of current and base years

(d) none of these

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(a) base year quantities

(b) current year quantities

(c) average of current and base years

(d) none of these

3. Fisher's ideal index is the

(a) arithmetic mean of Laspyre's and Paasche's index

(b) median of Laspyre's and Paasche's index

(c) geometric mean of Laspyre's and Paasche's index

(d) none of these

3.Fisher's ideal index is the

(a) arithmetic mean of Laspyre's and Paasche's index

(b) median of Laspyre's and Paasche's index

(c) geometric mean of Laspyre's and Paasche's index

(d) none of these

4.The circular test is satisfied by

(a) simple aggregate index
(b) Paasche's index
(c) Laspyre's index
(d) Fisher's index

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(a) simple aggregate index
(b) Paasche's index
(c) Laspyre's index
(d) Fisher's index

5. The index used to measure changes in total money value called

(a) price index

(b) quantity index

(c) value index

(d) none of these

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(a) price index

(b) quantity index

(c) value index

(d) none of these

6.Fisher's ideal index number satisfied by

(a) circular test
(b) time reversal
(c) factor reversal test
(d) both (b) and (c)

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(a) circular test
(b) time reversal
(c) factor reversal test
(d) both (b) and (c)

7.The weights used in quantity index are

(a) percentage of total quantity
(b) average quantity
(c) prices
(d) none of these

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(a) percentage of total quantity
(b) average quantity
(c) prices
(d) none of these

8.Symbolically Pon x P no = 1 stands for

(a) circular test
(b) factor reversal test
(c) time reversal test
(d) none of these

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(a) circular test
(b) factor reversal test
(c) time reversal test
(d) none of these

9. Fixed base index numbers and chain indexes are

(a) same

(b) different

(c) equal to 100

(d) none of these

9. Fixed base index numbers and chain indexes are

(a) same

(b) different

(c) equal to 100

(d) none of these

10. Weighted average of price relatives index using base year value as weighted is called

(a) Laspyre's index

(b) Paasche's index

(c) Bowley's index

(d) Fisher's index

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(a) Laspyre's index

(b) Paasche's index

(c) Bowley's index

(d) Fisher's index

11. A time series is deflated by using the following formulae

(b) Deflated value = $\dfrac{\text{current value}}{\text{price index of base year}}$

(a) Deflated value = $\dfrac{\text{current value}}{\text{price index of current year}}$

(c) Deflated value = $\dfrac{\text{current value}}{\text{price index of previous year}}$

(d) none of these

11. A time series is deflated by using the following formulae

(a) Deflated value = $\frac{\text{current value}}{\text{price index of current year}}$

(b) Deflated value = $\frac{\text{current value}}{\text{price index of base year}}$

(c) Deflated value = $\frac{\text{current value}}{\text{price index of previous yea}}$

(d) none of these

12. Shifted price index is calculated as

(a) $\dfrac{original\ \ price\ index}{price\ index\ of\ \ year\ on\ which\ it\ is\ to\ obtain} * 100$

(b) $\dfrac{\text{price index of year on which it is to be shifted}}{\text{original price index}} \text{x}100$

(c) $\dfrac{\text{original price index} \times \text{chain index of current year}}{\text{price index of year on which it is to be obtained}} \text{x}100$

(d) none of these

12.S

(a) $$\frac{\text{original price index}}{\text{price index of year on which it is to obtain}} 100$$

(b) $$\frac{\text{price index of year on which it is to be shifted}}{\text{original price index}} \times 100$$

(c) $$\frac{\text{original price index} \times \text{chain index of current year}}{\text{price index of year on which it is to be obtained}} \times 100$$

(d) none of these

13.Atechnique to link two or more index number Series is known as

A) Splicing

B) Base shifting

C) Deflating

D) None of these

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A) Splicing

B) Base shifting

C) Deflating

D) None of these

14.The Cost of Living index always

A) Weighted index

B) Price index

C) Quantity index

D) None of these

14.The Cost of Living index always

A) Weighted index

B) Price index

C) Quantity index

D) None of these

15. Marshall -Edge worth Formula does satisfy ----test

a) Time reversal test
b) Factor reversal test
c) Circular test
d) none

15. Marshall -Edge worth Formula does satisfy ----test

a) Time reversal test
b) Factor reversal test
c) Circular test
d) none

16. If the old series is connected, with the new series of index numbers it is know as

A) Backward splicing

B) Base shifting

C) Forward splicing

D) None of the above

16. If the old series is connected, with the new series of index numbers it is know as

A) Backward splicing

B) Base shifting

C) Forward splicing

D) None of the above

- 17.If with a rise of 10% in prices the salaries are increased by 20%, the real salary increases by

A) 10%

B) More than 10%

C) 20%

D) Less than 10%

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A) 10%

B) More than 10%

C) 20%

D) Less than 10%

- 18. The _____ is satisfied when

  $P_{ab} \times P_{bc} \times P_{ca} = 1$
- A) Time reversal test
- B) Factor reversal test
- C) Circular test
- D) Unit test

- 18. The _____ is satisfied when

  $P_{ab} \times P_{bc} \times P_{ca} = 1$
- A) Time reversal test
- B) Factor reversal test
- C) Circular test
- D) Unit test

- 19. The total sum of the values of a given year divided by the sum of the values of the base year is
- A) Price index.
- B) Quantity index
- C) Value index.
- D) None of these.

- 19. The total sum of the values of a given year divided by the sum of the values of the base year is
- A) Price index.
- B) Quantity index
- C) Value index.
- D) None of these.

- 20. Fisher's Ideal formula does not satisfy_____ test.
- A) Circular test
- B) Unit test
- C) Time Reversal test
- D) None of these

- 20. Fisher's Ideal formula does not satisfy_____ test.
- A) Circular test
- B) Unit test
- C) Time Reversal test
- D) None of these

- 21. If with rise of 10% in prices the wages are increased by 20%. Find the percentage of real wage increase
- A) 109.29%
- B) 9.09%
- C) 9.29%
- D) None of these

- 21. If with rise of 10% in prices the wages are increased by 20%. Find the percentage of real wage increase
- A) 109.29%
- B) 9.09%
- C) 9.29%
- D) None of these

- 22. The price level of a country in a certain year has increased 20% over the base period. The Index number is

  _____

- A) 20
- B) 120
- C) 220
- D) None of these

- 22. The price level of a country in a certain year has increased 20% over the base period. The Index number is

  _____

- A) 20
- B) 120
- C) 220
- D) None of these

- 23. The consumer price index is an example of a
- A) Laspeyre's index
- B) Paasche's index
- C) Simple aggregate price index
- D) Base year price

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- A) Laspeyre's index
- B) Paasche's index
- C) Simple aggregate price index
- D) Base year price

- 24. The base year is
- A) Is the reference year from which changes in the index are measured
- B) Is always last year
- C) Is the first year the index is created
- D) Is the current year the index is created

- 24. The base year is
- A) Is the reference year from which changes in the index are measured
- B) Is always last year
- C) Is the first year the index is created
- D) Is the current year the index is created

Index Numbers

THE END