Module 3 Time Series

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Overview

➢ Definition

➢ Components of Time Series

➢Methods of measuring trend

➢ Simple average method of measuring seasonal variation.

➢ Definition

Time Series : It is defined as a set of values arranged according to time, say year, months, weeks, days etc.

e.g. i) The production of nut-bolts of a factory for different years.

ii) Rainfall of any state in different months etc.

➢ Components of Time Series : The factors which

affects the values of the variable in a time series are known as components of time series.

There are four components of time series.

 i) Secular Tend or Trend.   ii) Seasonal Variations

iii) Cyclical Variations.   iv) Irregular Variations.

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1) **Secular Trend:** The general Tendency of the variables to increase or to decrease its value is known as secular trend, e.g. production, prices, population are increasing where as Rainfall, death rate, illiteracy etc. are decreasing.

The increase or decrease in the values will not mean that it is always increasing or decreasing, but over all they are increasing or decreasing. For this we have to take the observations over a sufficiently longer period of time.

2) **Seasonal Variation:** If the variations in the values of the variable are due to the seasons of the year, festivals and practical needs of the people, then such variations are called as seasonal variations, e.g.

i) There is increase in sale of cold drinks, sunglasses, fans etc. in the summer seasons, whereas in winter season there is increase in a sale of warm cloths, Hot drinks etc and in rainy season there is increase in the sale of Umbrellas, Rain coats, rainy shoes.

ii) There is increase in the sale of costly cloths, Gold, sweets etc. in the festivals like Diwali, Id, Christmas etc.

iii) There is more demand for electricity in certain hours of a day. There is more demand for books in the month of June and July etc.

3) **Cyclical Variations:** The series relating to prices, production, stock, sales etc. show cyclical variations. They show up and down moments in the form of waves called cycles.

When any business is started then we get a profit which slowly increasing up to certain stage, this path is known as improvement. Then we get a maximum profit which is known as prosperity. Again the profit may decrease slowly up to certain stage, this path is known as decline, and lastly we get a minimum profit or loss which is known as depression. These ups and downs in the business is known as cyclical variations. The time required to complete one cycle is called as period of a cycle and its lies between 3 to 1 0 years.

4) Irregular Variations: The variations in the values of the variable of time series are due to irregular or chance factors like strike, floods, fire, lay-out, earth quacks, wars etc. is known as irregular variations.

Methods of Measuring Trend:

There are three methods of measur-ing the trend.

1) Moving average method

2) Progressive average method.

3) Least squares method

1) **Moving average method :** In this method, first we calculate the moving totals of the given values by taking groups of 3 or 5 or 4 years according to the period and write them in front of the middle year grouped together. Then obtain the corresponding moving averages by dividing these moving totals by 3 or 5 respectively according to the period, which gives the required trend values by moving average method.

If the period of moving averages is an even number like 4 years then one more column of centered moving totals is to be obtained by adding two 4 yearly moving total values together & write them in front of middle of two moving total values & Name the column as centered moving total. Then divide these centered moving total values by '8' which will give us the required trend values by moving average method.

2) Progressive average method : The method of moving averages cannot give trend values for all the years. It requires the data over long period. Hence it is not reliable method, thus method of progressive averages can be used.

In this method first we obtain the progressive totals using less than cumulative frequency method, i.e. to obtain 1st progressive total value, keep the 1st value as it is, to get 2nd progressive total add second value to the 1st progressive total, to obtain the 3rd progres-sive total add *3rd* value to the 2nd progressive total… etc. and so on. Use the same procedure till the last value is added in the total. Then to obtain progressive averages divide these progressive total values by 1, 2, 3, ... etc. respectively which will give us the required trend values by Progressive Average Method.

3) Method of Least Squares:

In this method a straight line is obtained by minimizing the sum of squares of deviation of actual value of y from the estimated values by a line. The equation of a straight line is $y = a + bx$ and the normal equation to obtain the constants a & b are

$$\sum y = na + b\sum x \qquad \text{and} \qquad \sum xy = a\sum x + b\sum x^2$$

Steps :

1) The point of time (x) are obtained by

$x = $ year- middle most year

2) Obtain Squares of x values & obtain its total $\sum x^2$

3) Obtain product of x & y & obtain its total $\sum xy$

4) Also obtain the totals of x as well as y, i.e. $\sum x$ & $\sum y$

5) Solve normal eqns & them simultaneously to find a & b
6) Put this values in equation $y = a + bx$
7) Obtain trend values (y_e) using above equation.
   Which gives the equation of trend line by least square method.

4) Seasonal variations by simple average method :

1) Obtain totals of each month for all the years (if the data is given in months).
2) Obtain average of each month by dividing totals by no. of years.
3) Obtain average of monthly average by dividing total of monthly averages by 12.
4) Obtain seasonal Index using formula
   Seasonal Index = (Monthly Ave/ Ave of monthly ave) x 100
   Which gives us the required seasonal indices by simple average method.

➢ **Time Series is also known as Historical Series :**

The time series is also called as a Historical series because in time series we study the past history or behavior of the variable under study and we estimate the future values of the variable on the basis of this past history and hence Time Series is called as a Historical series.

➢ **Analysis of time series :**

The Separation of Components of time series & their measurement or study is called as analysis of time series.

Ex. 1 Obtain three yearly moving average for the data given below.

Years: 1965 1966 1967 1968 1969 1970 1971 1972 1973

Sales: 23   21   26   34   30   35   41   47   51

Years	Sales197	3-yearly Moving Totals	3-yearly Moving Averages
1965	23	---	---
1966	21	70	23.3333
1967	26	81	27
1968	34	90	30
1969	30	99	33
1970	35	106	35.3333
1971	41	123	41
1972	47	139	46.3333
1973	51	---	---

Ex. 2. Obtain 4 yearly centered moving average for the data given below.

Years: 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Profits: 33   29   34   37   42   40   48   53   57   60

Years	profits	4-yearly Moving Totals	4-yearly Centered Moving Totals	4-yearly Centered Moving Totals
2001	33	---	---	---
2002	29	---	---	---
2003	34	133	275	34.375
2004	37	142	295	36.875
2005	42	153	320	40
2006	40	167	350	43.75
2007	48	183	381	47.625
2008	53	198	416	52
2009	57	218	---	---
2010	60	---	---	---

Ex. 3. obtain trend line using least square method.

Years : 1985   1986   1987   1988   1989

Productions: 32   30   34   35   38

Years	Produ. (Y)	X=year-1987	X^2	XY	Ye
1985	32	-2	4	-64	30.4
1986	30	-1	1	-30	32.1
1987	34	0	0	0	33.8
1988	35	1	1	35	35.5
1989	38	2	4	76	37.2
Totals	169	0	10	17	

$a = \sum Y/n = 169/5 = 33.8$, $b = \sum XY/\sum X^2 = 17/10 = 1.7$

Thus the equation of trend line is $Y = a + b X = 33.8 + 1.7X$

for X= -2, Y = 33.8+ 1.7(-2) = 30.4.

Similarly we can obtain other values of Y for different values of X as 32.1,   33.8,   35.5,   37.2.

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Ex. 4. obtain seasonal index by simple average method for the data given below.

		Quarters			
		I	II	III	IV
SALE (in Thousand Rs)	1993	8	9	11	12
	1994	9	11	12	13
	1995	10	12	14	15
	Quarterly Totals	27	32	37	40
	Quarterly Avg.	9	10.66	12.33	13.33
	Seasonal Index	**79.44**	**94.08**	**108.82**	**117.65**

Quarterly average ($\bar{X}$) = Quarterly Totals /3   and $\bar{\bar{X}} = \sum \bar{X} / N$

Seasonal Index = $[(\bar{X})/\bar{\bar{X}}] * 100$

Summary (Learning Outcomes)

At the end of this module student must be able to

➢ Define time series.

➢ Explain Components of time Series.

➢ Compute trend values using various methods of measuring trend.

➢ Compute Seasonal Index using simple average method.

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