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## **Business Statistics**

### **Unit 4**

**Q: Define Time Series. Mention the significance of time series.**

**Or**

**Explain the utility of Time Series.**

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**Ans.:**

A time series is an arrangement of statistical data in accordance to the time of occurrence in a chronological order. Any sequence of measurement taken on a response, i.e. variable over time is called a time series.

**According to Prof. Croxton and Cowden, "A time series consists of data arranged chronologically."**

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**According to Prof. Wessel and Wallet**, “when quantitative data are arranged in the order of their occurrence, the resulting series is called the time series.”

**According to Prof. Spiggel**, “A time series is a set of observation taken at specified times, usually at equal intervals.”

From the above analysis, we can say that a time series represents collection of data according to occurrence of different time periods. For example: number of deaths taking place during a certain period or we can say that number of road accidents taking place during a certain period.

*Time series analysis is done for the purpose of making forecast for future and also for evaluating past performance. The figures of national income, population, wages and prices, etc, in future may be estimated by analyzing the past behaviour of the variable under study. The time series analysis plays an important role in the study of various aspects of economy, business as well as natural and social sciences. Thus, we can say that the time series analysis is helpful in studying any phenomenon whose values are or can be arranged chronologically over successive period of time.*

### **ESSENTIAL REQUIREMENTS OF A TIME SERIES**

- A time series must consist of a homogeneous set of values
- Time elapsed between various observations must be, as far as possible, equal
- Time series must consist of data for a sufficiently long period
- The gaps, if any, in the data should be made up by interpretation.

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### **UTILITY / SIGNIFICANCE / IMPORTANCE OF TIME SERIES**

The importance of time series are:-

1. **Analysis:-** Time series helps in the analysis of past behaviour of a variable. Analysis of past data discloses the effect of various factors on the variable under study. With the help of such analysis the future behaviour of the variable under study can be predicted.
2. **Forecasting:-** It helps in forecasting. The analysis of past conditions is the basis of forecasting the future behaviour of the variable under study. These helps in making future plans of action. Various 5-years plans of our country are based on the analysis of past data.
3. **Evaluation:-** It helps in the evaluation of current achievements. The review and evaluation of progress made by the plan are done on the basis time series data. The progress of plans is judged by the annual rate of growth in Gross National Product (GNP).
4. **Comparison:-** It helps in making comparative studies. Once the data is arranged chronologically, the comparison between one time period and another is facilitated. It provides a scientific basis for making comparison by studying and isolating the effects of various components of a time series.
5. **Approximation:-** It gives approximate indicator which helps in the further analysis.

### **APPLICATION OF TIME SERIES**

The time series analysis has the following uses:

- It enables studying the past behaviour of a phenomenon under consideration
- It helps in studying the components which are of utmost importance to a businessman in the planning of future operations and in taking policy decisions.

- It helps us to compare the changes in value of different phenomenon at different places
- It helps to compare the actual current performance or accomplishment with the expected ones and analyse the causes of such variations.
- It helps in obtaining an understanding of the underlying process and structure that produced the observed data.
- It helps in fitting a model and process for forecasting, monitoring and feedback

Thus, we see that times series analysis is used in inventory studies; sales forecasting; economic forecasting; budgetary analysis; stock market analysis; quality control; work load projection, etc.

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**Q: Explain the components of time series.** ([www.prepNext.com](http://www.prepNext.com))

**Ans.:**

The components of time series are the various elements that can be segregated from the observed data. Time series consist of four components as follows:

1. **Secular trend or trend (T)**
2. **Seasonal variation (S)**
3. **Cyclical variation (C)**
4. **Irregular variation (I)**

**1) SECULAR TREND (T):** This refers to the basic tendency of STEADY movement in a set of observations to move in an upward or downward or constant direction over a fairly long period of time. It does not include short term variations like seasonality, etc.

Secular trend is the long term tendency of the time series to move in an upward or downward direction. This is the result of long term processes that gradually operate on the time series variables. A few examples of this long term process are the long term changes in per capital income, technological improvements, population growth, etc.

Trend of a time series characterizes the gradual and consistent pattern of its changes. Some series of data recorded over a given period of time show an upward trend, some show a downward trend while others remain more or less at constant level. Also, some series increase slowly and some increase fast, some decrease at varying rates. Again some series after a long period of growth or decline reverse themselves and enter a period of decline or growth.

The various methods that can be use for measurement of trend are:

- (i) Free hand or rapid method
- (ii) Semi average method
- (iii) Moving average method
- (iv) Least square method

Thus, trend is either upward or downward, but it is not necessary that the increase or decrease should be in a same direction throughout the given period.

**2) SEASONAL VARIATION (S):** By seasonal variation in a time series, we mean those variations which occur regularly and periodically, with period less than ONE year. Seasonal movements affect most of the economic and business phenomena and unless a business decision maker knows about the nature of such variations, he cannot take any policy decision. The purpose of studying Seasonal Variation is:

- To isolate the effect of seasonal factors
- To eliminate their effects from the time series so that the values in a time series, without the effect of seasonal factors, may be computed. These values are useful for making forecasts for a long period of time.

Seasonal variation refers to such movement in a time series which are due to factors which are rhythmic in nature and which repeat themselves periodically in every season. These variations repeat themselves in less than one year. Seasonal variations are usually measured in an interval.

For example, sale of umbrellas may go up during the rainy season and go down during the dry season. Coal consumption may increase in winter. Sale of woollen garments may increase during winter season. A study of pattern is extremely useful for the business decision makers.

**3) CYCLICAL VARIATIONS (C):** Cyclical variations are the OSCILLATORY movement in a time series with period of oscillation greater than one year. These variations in a time series are due to ups and downs recurring after a period greater than one year. These are not necessarily uniformly periodic. They may or may not follow exactly similar patterns after equal interval of time.

Cyclical variations which are also generally termed as business cycles, are the periodic movements in a time series around the trend line. These are up swings and down swings in the time series that are observable over extended periods of time. All economic activities get a boost during the upward swing of business cycle and dip during the down ward swings. The study of business cycle helps us to take anti-cyclical measures. Business cycle represents interventions of (i) Prosperity (ii) Recession (iii) Depression (iv) Recovery.

**4) IRREGULAR VARIATION (I):** Irregular variations do not exhibit any definite pattern and there is no regular period of time of their occurrence. These are accidental changes which are purely random, unforeseen and unpredictable. There is no regularity of occurrence. For examples, wars, earthquake, floods, etc. Normally they are short term variations but sometimes their effect is so intense that they may give rise to new cyclical or other movements.

The variations either go very deep downward or too high upward to attain peak abruptly. It occurs on account of random external event.

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**Q: Differentiate between seasonal variations and cyclical variations.** *(www.prepNext.com)*

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**Ans.:**

<b>Seasonal variation</b>	<b>Cyclical variation</b>
The causes of seasonal variations are seasons, festivals and customs needs.	The causes of cyclical variations are disparity between demand and supply, working of economic system
It occurs during less than a year	It occurs during different periods between 3-4 years or 7-9 years
These variations occur in every economy	These variations usually occur in capitalist economy
These variations are less powerful	These variations are more powerful

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**Q: Write a short note on Models of time Series.**

*(www.prepNext.com)*

**Ans.:**

**Popular Mathematical Models of Analysis of Time Series:**

Most commonly used models of time Series are Additive model and Multiplicative Model:

**1) ADDITIVE MODEL:**

This model assumes the four components of the time series to be independent of each other. The components are assumed to be additive in nature, and it is believed that S, C and I are not affected by the Trend.

Here,  $Y = T + S + C + I$

Where, Y=observed value in a given time series

T=Trend

S=Seasonal variations

C=Cyclical variations

I=Irregular variations

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## **2) MULTIPLICATIVE MODEL:**

It assumes that all the 4 components are due to different causes but they are not necessarily independent and they can affect one another. It describes only the trend as an absolute value while other components (that C, S & I) are expressed as percentage. The original data (Y) is expressed as a product of 4 components as follows:

$$Y = T \times S \times C \times I$$

## **3) MIXED MODEL:**

Many other models have been developed by combining additive and multiplicative models in many ways. Important among them are:

- (i)  $Y = TC + SI$
- (ii)  $Y = TCS + I$
- (iii)  $Y = T + SCI$
- (iv)  $Y = T + S + CI$

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**Q. Differentiate between additive and multiplicative model.**

*(www.prepNext.com)*

**Ans.:**

<b>Additive Model</b>	<b>Multiplicative Model</b>
It assumes that all the four component of time series are independent of each other	It assumes that all the 4 components of time series are due to different causes but they are not necessarily independent and they can affect one another.
It can be expressed as $Y = T + S + C + I$	It can be expressed as $Y = T \times S \times C \times I$
All components of time series are expressed as absolute value	Only trend is expressed as absolute value while other components are expressed as percentages

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**Q. Explain the different methods of measurement of trend.**

*(www.prepNext.com)*

**Ans.:**

The different methods for measuring trend are:-

- 1. Free hand or graphic method**
- 2. Method of semi averages**
- 3. Method of moving averages**
- 4. Method of least squares**

➤ **Free hand or graphic method:-** This method is the simplest and the most flexible method of estimating the secular trend and consists of first plotting the points on the graph paper for the time series values and then drawing a free hand smooth curve through this point so that it accurately reflects the long term tendency of the data.

➤ **Method of semi averages:-** Semi averages are the averages of 2 halves of a series that is the whole time series data is classified into 2 equal parts with respect to time.

If we have a time series data from 1982 to 1991, it would be divided two halves- 1 half from 1982 to 1986 and other half from 1987 to 1991. In case of odd number of years, 2 equal parts can be made simply by omitting the middle year. The averages of the values of these 2 halves would be calculated. This average value would be plotted against the mid value of each half. The 2 points are then joined by a straight line which can be extended on either side. This line would be the trend line by the method of semi averages.

➤ **Method of moving averages:-** This method is a simple device of reducing fluctuations and operating trend values with a fair degree of accuracy. This method consists of taking arithmetic mean of the values for a certain time span and placing it at the centre of a time span.

In this method the average value of a number of years is taken as the trend value for the middle point of the period of moving averages. For applying the method of moving averages, the period of the moving averages has to be first selected. This period can be 3 yearly, 5 yearly, 7 yearly, 4 yearly moving averages. The period of moving averages is to be decided in the light of the length of the series.

- **Method of least square:-** This is the **best method for obtaining the trend values**. It provides a convenient basis for obtaining the line of best fit in a series. Line of best fit is a line from which the sum of the deviations of various points on either side is zero. Further the sum of the squares of these deviations would be the least as compared to the sum of squares of the deviations obtained by using other lines.

We know that the sum of the deviations from the arithmetic mean is zero. Therefore the sum of the deviation from the line of the best fit is zero. For this reason the sum of the square of deviation of various points from the line of best fit is the least. That is why this method is known as the method of least square.

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**Q. Write a short note on method of least squares.**

*(www.prepNext.com)*

**Ans.:**

The method of least square is the best method for obtaining the trend values. It provides a convenient basis for obtaining the line of best fit in a series. Line of the best fit is a line from which the sum of the deviations of various points on its either side is zero. Further the sum of the squares of these deviations would be the least as compared to the sum of squares of the deviations obtained by using other lines.

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We know that sum of the deviations from the arithmetic mean is zero. Therefore, the sum of the deviation from the line of best fit is zero. For this reason the sum of the squares of the deviations of various points from the line of best fit is the least. That is why, this method is known as the method of least square.

This method satisfies the following conditions:

1.  $\sum(y - y_c) = 0$ , i.e. the sum of deviation of the actual values of Y and the computed values of y is zero.
2.  $\sum(y - y_c)^2$  is the least that the sum of the squares of deviations from the actual and the computed value of Y is least.

The straight line trend as an equation of  $y = a + bx$  where, y represents the estimated values of the trend, x represents the deviations in time period, a and b are constants. The values of 2 constants a and b are estimated by solving the following 2 normal equations.

$$\sum y = Na + b\sum x \quad \text{and,} \quad \sum xy = a\sum x + b\sum x^2.$$

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**Q: Mention the significance of studying trend.**

**Or**

**Mention the importance of trends.** *(www.prepNext.com)*

**Ans.:**

The study of trends is extremely useful because of the following reasons:

1. The study of secular trend allows us to **describe historical patterns**—We can use past trend to evaluate success of a previous policy.
2. The study of secular trend **permits us to project past patterns or trends into the future**—Knowledge of past can tell us a great deal about the future. Thus the world's population can help in estimating population for some future time period.

3. The **trend component can be estimated from the time series**—  
By eliminating trend it becomes easier to study the other three components like seasonal, cyclical and irregular variations.

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