1. Introduction

Welcome to the series of E-learning modules on time series analysis.

By the end of this session, you will be able to:

- Explain the concept of business forecasting
- Explain the time series analysis technique
- Explain the role of time series analysis
- Explain the adjustments in time series analysis
- Explain the problems in time series analysis

Time series analysis:
The growing competition, rapidity of change in circumstances and the trend towards automation demand that decisions in business cannot be a pure guess and haunches. However, it should be based on a careful analysis of data concerning the future course of events.

When estimates of future conditions are made on a scientific basis the process is referred to as ‘forecasting’ and the figure or statement obtained is known as ‘forecast’. Forecasting aims at reducing the area of uncertainty that surrounds, management decision making with respect to costs, profits, sales, production, pricing, capital investment, and so on.

Forecasting is concerned with two tasks:
First, the determination of the best basis available for the formation of intelligent managerial expectation.
Second the handling of uncertainty about the future, so that implications of decisions become explicit.

Forecasting of business fluctuations is carried out by understanding why changes in the past occurred, determine which phase of business activity must be measured, selecting and compiling data used as measuring devices and analysis of data.

The basis of scientific forecasting is statistics that is the numerical data on business trends. However, along with the trends we need to consider the economic changes. Therefore, the forecasting involves more than an analysis of the data.

To handle this increasing variety of managerial forecasting, various techniques have been developed. Each has its special use and care must be taken to select the correct techniques for particular application.

2. Some Methods of Forecasting

Following are some of the methods of forecasting:

- Historical Analogy method
- Field survey and opinion poll
- Business barometer
- Extrapolation
- Regression analysis
- Econometric analysis
- Lead-lag analysis
- Exponential smoothing
- Input-output or end-use method
- Forecasting through time series analysis

Historical Analogy is a method used for forecasting a particular phenomenon based on some analogues conditions elsewhere in the past. Analogies very much help a country in determining the various stages of growth through which a country is passing before it reaches the 'take off stage'. This method of forecasting is considered to be a qualitative one because it is difficult to quantify most phenomena in respect to which analogies are being made.

Field survey and opinion Poll-field surveys may be conducted to obtain the necessary information, which may constitute the basis for forecasting. The survey methods are used widely for forecasting demand for both the existing and new products marketed within and outside the country. Survey can help in obtaining both quantitative and qualitative information.

Business Barometer:
This method is of great assistance in practical forecasting. It is used as an 'index' or indicator of the basic condition related to the industry. The trends indicated by the barometers will guide the businessperson as to whether the stocks of goods should be increased or released or whether to increase investment or not, etc.

Extrapolation is the simplest yet often a useful method of forecasting. In many forecasting situations the most reasonable expectation is that, the variable will follow its established path. Extrapolation relies on the relative constancy in the pattern of past movements in some time series.

Regression analysis:
The regression approach offers many valuable contributions to the solutions of the forecasting problem. The means by which we select among the many possible or theoretically suggested relationships between variable in a complex economy those will be useful for forecasting.

Econometric analysis:
The term econometrics refers to an application of mathematical economic theory and statistical procedures to economic data in order to verify economic theorems and to establish quantitative results in economics.

Lead-lag analysis:

The lead lag approach attempts to determine the approximate lapse of time between the movement of one series and the movements of general business conditions. If one or more series can be found such that their turning points lead by a number of months with substantial regularity, the turning points of general business in the past, it is quite logical to use these leading series to predict what is going to happen to general business activity.

Exponential smoothing:
The method of exponential smoothing for forecasting is an outgrowth of the recent attempts to maintain the smoothing function of moving averages. It operates in a manner analogous to moving averages by smoothing historical observations to eliminate randomness.

Input-output or end use method:
Professor Leontief developed the input output technique. Input – output analysis gets its name from the type of data on which it is based. That is the material requirements and the product of every economic activity in an I-O model is the raw data. The most widely familiar model is the pioneer work for the united states.

Here a detailed description of the last method time series analysis, which is very popularly used in business forecasting is made. The first step in making estimates for the future consists of gathering information from the past. In this connection, one usually deals with statistical data, which are collected, observed or recorded at successive intervals of time. Such data are generally referred to as 'time series'.

A time series is a set of observations taken at specified times, usually at equal intervals. Mathematically, a time series is defined by the values $Y_1, Y_2 \ldots$ of a variable Y at times $t_1, t_2 \ldots$ Thus, Y is a function of t, symbolized Y is equal to F of t. Thus, when we observe numerical data at different points of time, the set of observations is known as time series.

For example, if we observe production, sales, imports, exports, etc. at different points of time, say, over the last 5 or 10 years, the set of observations formed shall constitute time series.

Thus, in the analysis of time series, time is the most important factor because the variable is related to time, which may be year, month, week, day, hour or even minute or a second.

The problem of time series analysis can best be appreciated with the help of the following example:
In this example, we have collected the data of sales of a firm for a period of 8 years as represented in this table.

Figure 1

Sales (thousand units)			
Year	Firm A	Year	Firm A
2003	40	2007	43
2004	42	2008	48
2005	47	2009	65
2006	41	2010	42

If we observe the above series, we find that generally the sale have increased but for two years that is 2006 and 2010 a decline is noticed. There may be several causes for increase or decrease from one period to another such as changes in tastes and habits of people, growth of population, availability of alternative products, etc.

It may be very difficult to study the effect of various factors that either have led to an increase or decrease in sales. The statistician, therefore analyze the effect of the various factors under the following broad heads:

- Changes that have occurred as a result of general tendency of the data to increase or decrease, known as ‘secular movements’
- Changes that have taken place during a period of 12 months as a result of change in climate, weather conditions, festivals, etc. Such changes are called as ‘seasonal changes’
- Changes that have taken place as a result of booms and depressions. Such changes are classified under the head ‘cyclical variations’
- Changes that have taken place as a result of such forces that could not be predicted like floods, earthquake, famines, etc. Such changes are classified under the head ‘irregular or erratic variations’

3. Role of Time Series Analysis

Role of time series analysis:
Time series analysis is of great significance in business decision making for the following reasons:

1. It helps in the understanding of past behavior- by observing data over period of time one can easily understand what changes have taken place in the past. Such analysis will be extremely helpful in predicting the future behavior.
2. It helps in planning future operations- statistical techniques have been evolved, which enables time series to be analyzed in such a way that the influence, which has determined the form of that series, may be ascertained. If the regularity of occurrence of any feature over a sufficient long period could be clearly established then, within limits, prediction of probable future variations would become possible.
3. In fact, the greatest potential of a time series lies in predicting an unknown value of the series. From this information, intelligent choices can be made concerning capital investment decisions, decisions concerning production and inventory, etc.
4. It facilitates comparison. Different time series are often compared and important conclusions drawn.
5. It helps in evaluating current accomplishments. The actual performance can be compared with the expected performance and the cause of variation analyzed. For example, if an expected sale for the year 2000 was 20,000 colored TV sets and the actual sales are only 19,000, one can investigate the cause for the shortfall in achievement. Time series analysis will enable us to apply the scientific procedure of "holding other things constant" as we examine one variable at a time.

For example, if we know how much is the effect of seasonality on business, then we may devise ways and means of ironing out the seasonal influence or decreasing it by producing commodities with complementary seasons.
However, one should not be led to believe that by time series analysis one could foretell with 100 percent accuracy the course of future events. After all, statisticians are not fortune-tellers.

This could be possible only if the influence of the various forces, which affect these series. Such as climate, customs and traditions, growth and decline factors, and the complex forces, which produce business cycle, would have been regular in their operation.

However, the facts of life reveal that this type of regularity does not exist. Then this does not mean that time series analysis is of no value. When such analysis is coupled with a careful examination of current business indicators one can undoubtedly improve substantially upon guestimates (that is estimates based upon pure guesswork) in forecasting the future business conditions.

4. Preliminary Adjustments before Analyzing the Time Series

Preliminary adjustments before analyzing the time series:
Before beginning the actual work of analyzing a time series, it is necessary to make certain adjustments in the raw data. The adjustments are:

- Adjustments for calendar variations
- adjustments for population changes
- adjustments for price changes and
- adjustments for comparability

Calendar variation:
A vast proportion of the important time series is available in a monthly form and it is necessary to recognize that the month is a variable unit. The actual length of the shortest month is about 10 percent less than that of the longest, and if we take into account holidays and weekends, the variation may be even greater.

Thus, the production of sales for the month of February may be less not because of any real drop in activity but because of the fact that February has fewer days. Thus, the purpose of adjusting for calendar variation is to eliminate certain spurious differences, which are caused by difference in number of days in various months.

The adjustments for calendar variation are made by dividing each monthly total by the number of days in the month (sometimes by the number of working days in the month) thus, arriving at daily average for each month. Comparable (adjusted), monthly data may then be obtained by multiplying each of these values by 3 lakh 4 thousand 1 hundred and 67, the average number of days in a month (in a leap year this factor is 30.5).

Population changes:
Certain types of data call for adjustment for population changes. Changes in the size of the population can easily distort comparisons of income, production and consumption figures. For example, national income may be increasing year after year, but per capita income may be declining because of greater pressure of population.

Similarly, the production of a commodity may be going up but the per capita income may be declining because of greater pressure of population. Similarly, the production of a commodity may be going up but the per capita consumption may be declining.

In such cases, where it is necessary to adjust data for population changes, a very simple procedure is followed, that is the data are expressed on a per capita basis by dividing the original figures by the appropriate population totals.

Price changes:
An adjustment for price changes is necessary whenever we have a value series and are interested in quantity changes alone. Because of rising prices, the total sale proceeds may go

up even when there is a fall in the number of units sold.

For example, if in 2 crore and 41 thousand units of a commodity that is priced Rs.10 are sold, the total sale proceeds would be 1,000 into 10 is equal Rs.10 thousand. Assume that in 2005 the price of the commodity increases from Rs.10 to Rs.11. If the sales do not decline, the total sale proceeds will be 1,000 into 11 is equal to 11 thousand. This increase in sale proceeds, which is 1,000 is not due to increase in the demand of the commodity but purely because of the rise in price from Rs.10 to Rs.11.

Since value is equal to price per unit multiplied by the number of units sold, the effect of price changes can be eliminated by dividing each item in a value series by an approximate price index.

Comparability:
For any meaningful analysis of time series, it is necessary to see that the data are strictly comparable throughout the time period under investigation. Quite often, it is difficult or even impossible to get strictly comparable data.

For example, if we are observing a phenomenon over the last 25 years, the comparability may be observed by difference in definition, difference in geographical coverage, difference in the method adopted, change in the method of reporting, etc.

For example, a safe figure for January 2005 may give the average for that month. Some years later, the corresponding sales figure may give the total for the month or perhaps sales on the 15^{th} or the last day of the month. If such type of changes is not taken into account, the data cannot strictly be compared and its analysis would lead to fallacious conclusions.

5. Problems of Classification

Problems of classification:
Although it is a simple matter to classify the factors affecting time series into four groups for analytical purposes, the actual application of the classification frequently present serious problems.

Seasonal variations are by no means always so uniform is amplitude and timing that their identification can be made with certainty. Consequently, the investigator is often put to hardship to distinguish the seasonal influence from cyclical or random factors.

Long and severe cycles may appear to some observers as changes in the direction of the regular trend. For example, during the great depression of the 1930's, many leading economist interpreted the existing conditions not as a cyclical depression but as "secular stagnation".

Another difficulty arises because of four components of time series data, which are not mutually independent of one another. An exceedingly severe seasonal influence may aggravate or even precipitate a change in the cyclical movement. Conversely, cyclical influence may seriously affect the seasonal. A very rapidly rising trend virtually eliminates seasonal and cyclical variations.

Finally, the four fold breakdown of time series data when applied to general business conditions has frequently been challenged on analytical grounds. Bratt says he has seen that there are two trends, the primary trend representing the long-term growth of productive capacity and the drift away from it, which is called the secondary trend.

Schumpeter developed an even more detailed breakdown by identifying three cyclical components, the 3-year kitchin cycle, the 10-year juglar cycle and the 50-year Kondratieff cycle. The divergence of opinion among the eminent scholars indicates clearly that the four-fold break down is mere approximation, convenient to employ but frequently subject to modification.

Here's a summary of our learning in this session, where we have understood:

- The concept of business forecasting
- The time series analysis technique
- The role of time series analysis
- The adjustments in time series analysis
- The problems in time series analysis