

Segment: Basics of Managerial Economics

Topic: Statistical Methods of Demand Forecasting

Statistical Methods of Demand Forecasting

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Statistical Methods of Demand Forecasting



Introduction

We know that there are two methods of demand forecasting namely, survey methods and statistical methods. We have discussed the survey methods in the previous topic.

In this topic, we will discuss the statistical method. It is the second most popular method of demand forecasting. It is the best available technique and most commonly used method in recent years. Under this method, statistical, mathematical models, equations, etc. are extensively used to estimate future demand of a particular product. They are used for estimating long term demand. They are highly complex and complicated in nature. Some of them require considerable mathematical background and competence.

They use historical data in estimating future demand. The analysis of the past demand serves as the basis for present trends and both of them become the basis for calculating the future demand of a commodity under consideration, after considering the changes that are likely to occur in future.



Learning Objectives

At the end of this topic, you will be able to:

- explain trend projection method of demand forecasting with illustration
- discuss economic indicators as a method of demand forecasting.

Statistical Methods of Demand Forecasting

1. Statistical Methods

There are several statistical methods and their application should be done by someone who is reasonably well versed in the methods of statistical analysis and the interpretation of the results of such analysis.

Trend projection method: An old firm operating in the market for a long period will have the accumulated previous data on either production or sales relating to different years. If we arrange them in chronological order, we get 'time series'. It is an ordered sequence of events over a period of time of certain variables. It shows a series of values of a dependent variable e.g., sales, as it changes from one point of time to another. In short, a time series is a set of observations taken at specified time, generally at equal intervals. It depicts the historical pattern under normal conditions. This method is not based on any particular theory, which explains the causes for the variables to change; it merely assumes that whatever forces contributed to the change in the recent past will continue to have the same effect. Based on time series, it is possible to project the future sales of a company.

Also, the statistics and information with regards to the sales call for further analysis. When we represent the time series in the form of a graph, we get a curve, the sales curve. It shows the trend in sales at different periods of time. Also, it indicates fluctuations and turning points in demand. If the turning points are few and their intervals are also widely spread, they yield acceptable results. Here, the time series show a persistent tendency to move in the same direction. Frequency in turning points indicates uncertain demand conditions and in this case, the trend projection breaks down.

The major task of a firm while estimating the future demand lies in the prediction of turning points in the business rather than in the projection of trends. When turning points occur more frequently, the firm has to make radical changes in its basic policy for future demand. It is for this reason that the experts give importance to identification of turning points while projecting the future demand for a product.

The heart of this method lies in the use of time series. Changes in time series arise on account of the following reasons:

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1. **Secular or long run movements** – Secular movements indicate the general conditions and direction in which graph of a time series move in relatively a long period of time.
2. **Seasonal movements** – Time series also change during seasonal sales of a company. During festival season, sales clearance season, etc., we come across most unexpected changes.
3. **Cyclical Movements** – It implies change in time series or fluctuations in the demand for a product during different phases of a business cycle like depression, revival, boom, etc.
4. **Random movements** – When changes take place at random, we call them irregular or random movements. These movements imply sporadic changes in time series occurring due to unforeseen events such as floods, strikes, elections, earth quakes, droughts and similar natural calamities. Such changes take place only in the short run. Still, they have their impact on the sales of a company.

An important question in this connection is how to ascertain the trend in time series? A statistician, in order to find out the pattern of change in time series, may make use of the following methods.

1. The least squares method
2. The free hand method
3. The moving average method
4. The method of semi-averages

The method of least squares is more scientific, popular and thus, more commonly used when compared to the other methods. It uses the straight line equation $Y = a + bx$, to fit the trend to the data.

Illustration: Under this method, the past data of the company is considered to assess the nature of present demand. Based on this information, future demand is projected. For example, a businessman collects the data of sales over the last 5 years. The statistics regarding the past sales of the company is given below.

The table 1 indicates that the sales fluctuate over a period of 5 years. However, there is an uptrend in the business. The same can be represented in a diagram.

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Diagrammatic representation: Table 1 shows the sales fluctuation over 5 years and figure 1 depicts the sales curve based on that fluctuation.

a) Deriving sales Curve

Table 1: Sales Fluctuation

Year	Sales (Rs.)
1990	30
1991	40
1992	35
1993	50
1994	45

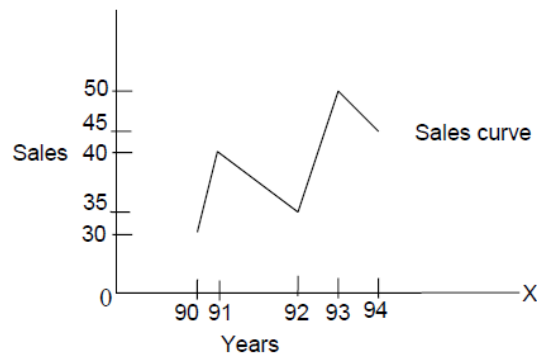


Fig. 1: Sales Curve

We can find out the trend values for each of the 5 years and also for the subsequent years making use of a statistical equation, the method of least squares. In a time series, x denotes time and y denotes variable. With time, we need to find out the value of the variable.

To calculate the trend values i.e., Y_c , the regression equation used is –

$$Y_c = a + bx.$$

As the values of 'a' and 'b' are unknown, we can solve the following two normal equations, simultaneously.

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i) $\sum Y = Na + b\sum x$

ii) $\sum XY = a\sum x + b\sum x^2$

Where,

$\sum Y$ = Total of the original value of sales (y)

N = Number of years,

$\sum X$ = Total of the deviations of the years taken from a central period.

$\sum XY$ = Total of the products of the deviations of years and corresponding sales (y)

$\sum X^2$ = total of the squared deviations of X values.

When the total values of X. i.e., $\sum X = 0$

Table 2 gives the values of x and y over a period of five years, in order to compute the trend value, Y_c .

Table 2: Trend Values Computation

Year = n	Sales in Lakhs Rs. Y	Deviation from assumed year X	Square of Deviation X^2	Product sales and time Deviation XY	Computed trend values Y_c
1990	30	-2	+4	-60	32
1991	40	-1	+1	-40	36
1992	35	0	0	0	40
1993	50	+1	+1	+50	44
1994	45	+2	+4	+90	48
N =5	$\sum Y=200$	$\sum X=0$	$\sum X^2=10$	$\sum XY=40$	

Regression equation = $Y_c = a + bx$

To find the value of a = $\sum Y/N = 200/5 = 40$

To find out the value of b = $\sum XY / \sum X^2 = 40/10 = 4$

For 1990 $Y = 40 + (4 \times -2)$

$Y = 40 - 8 = 32$

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For 1991 $Y = 40 + (4 \times -1)$

$$Y = 40 - 4 = 36$$

For 1992 $Y = 40 + (4 \times 0)$

$$Y = 40 + 0 = 40$$

For 1993 $Y = 40 + (4 \times 1)$

$$Y = 40 + 4 = 44$$

For 1994 $Y = 40 + (4 \times 2)$

$$Y = 40 + 8 = 48$$

For the next two years, the estimated sales would be:

For 1995 $Y = 40 + (4 \times 3)$

$$Y = 40 + 12 = 52$$

For 1996 $Y = 40 + (4 \times 4)$

$$Y = 40 + 16 = 56$$

Finding trend values when even years are given

Table 3 gives the values of x and y over a period of four (even) years, in order to compute the trend value, Y_c .

Table 3: Computation of Trend Values over Even No. of Years

Year = N	Sales in Rs. Lakhs = Y	Deviation From Assumed year = X	Square of Deviation = X^2	Product sales and time deviation = XY	Computed trend values Y_c
1990	55	-3	9	-165	44
1991	25	-1	1	-25	48
1992	65	+1	1	+65	52
1993	55	+3	9	+165	56
N = 4	$\Sigma Y = 200$	$\Sigma X = 0$	$\Sigma X^2 = 20$	$\Sigma XY = 40$	

Note:

When even years are given, the base year would be in between the two middle years. In this example, in between the two middle years is 1991.5 (one year = 1 whereas 6 months = .5).

For the purpose of simple calculation, we assume the value for each 6 months i.e. $0.5 = 1$

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To find out the value of $a = 200/4 = 50$

To find out the value of $b = 40/20 = 2$

$a=50, b=2$.

Calculation for each year

Finding trend values:

1991.5 = Base Year	For 1990	$Y = 50 + 2 \times -3$ $Y = 50 - 6 = 44$
90 = -3		
90.5 = -2	For 1991	$Y = 50 + 2 \times -1$ $Y = 50 - 2 = 48$
91 = -1		
91.5 = 0		
92 = +1	For 1992	$Y = 50 + 2 \times 1$ $Y = 50 + 2 = 52$
92.5 = +2		
93 = +3	For 1993	$Y = 50 + 2 \times 3$ $Y = 50 + 6 = 56$

Deriving trend line: Figure 2 depicts the trend projection for estimating future demand.

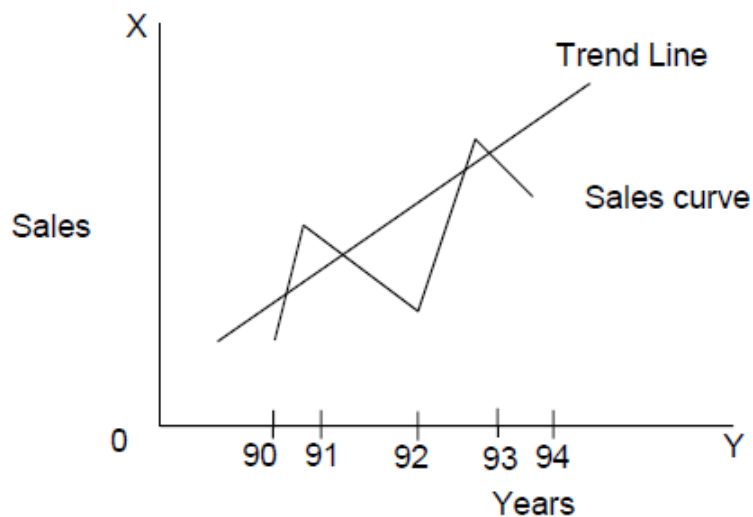


Fig. 2: Trend Projection

Trend projection method requires simple working knowledge of statistics, which is quite inexpensive and yields fairly reliable estimates of future course of demand.

While estimating future demand, we assume that the past rate of change in the dependent variable will continue to remain the same in future as well. Hence, the method yields result

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only for that period where we assume there are no changes. It does not explain the vital upturns and downturns in sales, thus, it is not very useful in formulating business policies.

Economic indicators: Economic indicators as a method of demand forecasting are developed recently. Under this method, a few economic indicators become the basis for forecasting the sales of a company. An economic indicator indicates change in the magnitude of an economic variable. It gives the signal about the direction of change in an economic variable. This helps in the decision-making process of a company. We can mention a few economic indicators in this context, as follows:

1. Construction contracts sanctioned for demand towards building materials like cement.
2. Personal income towards demand for consumer goods.
3. Agriculture income towards the demand for agricultural inputs, instruments, fertilizers, manure, etc.
4. Automobile registration towards demand for car spare-parts, petrol etc.
5. Personal income, consumer price index, money supply, etc., towards demand for consumption goods.

The above mentioned and other types of economic indicators are published by specialist organizations like the Central Statistical Office. The analyst should establish relationship between the sales of the product and the economic indicators to project the correct sales and to measure the extent to which these indicators affect sales. The job of establishing relationship is a highly difficult task, particularly in case of new products where there are no past records.

Under this method, demand forecasting involves the following steps:

- a. The forecaster has to ensure whether a relationship exists between the demand for a product and certain specified economic indicators.
- b. The forecaster has to establish the relationship through the method of least square and derive the regression equation. Assuming the relationship to be linear, the equation will be $y = a + bx$.

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After the regression equation is obtained by forecasting the value of x , economic indicator can be applied to forecast the values of Y , i.e., demand.

d. Past relationship between different factors may not be repeated. Therefore, the value judgment is required to forecast the value of future demand. In addition to it, many other new factors may also have to be taken into consideration.

When economic indicators are used to forecast the demand, a firm should know whether the forecasting is undertaken for a short period or long period. It should collect adequate and appropriate data and select the ideal method of demand forecasting. The next stage is to determine the most likely relationship between the dependent variables and finally interpret the results of the forecasting.

However, it is difficult to find out an appropriate economic indicator. This method is not useful in forecasting demand for new products.

2. Summary

Here is a quick recap of what we have learnt so far:

- There are several statistical methods and their application should be done by someone who is reasonably well versed in the methods of statistical analysis and in the interpretation of the results of such analysis.
- Trend projection method is not based on any particular theory, which explains the causes for the variables to change; it merely assumes that whatever forces contributed to the change in the recent past will continue to have the same effect. On the basis of time series, it is possible to project the future sales of a company.
- Economic indicators as a method of demand forecasting are developed recently. Under this method, a few economic indicators become the basis for forecasting the sales of a company. An economic indicator indicates change in the magnitude of an economic variable.
- When economic indicators are used to forecast the demand, a firm should know whether the forecasting is undertaken for a short period or long period. It should collect adequate and appropriate data and select the ideal method of demand forecasting. The next stage is

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to determine the most likely relationship between the dependent variables and finally interpret the results of the forecasting.