CHAPTER 4: DEMAND AND DEMAND FORECASTING

4.1 INTRODUCTION

Managers use forecasts for budgeting purposes. A forecast aids in determining volume of production, inventory needs, labor hours required, cash requirements, and financing needs. A variety of forecasting methods are available. However, consideration has to be given to cost, preparation time, accuracy, and time period. The manager must understand clearly the assumptions on which a particular forecast method is based to obtain maximum benefit.

Management in both private and public organizations typically operates under conditions of uncertainty or risk. Probably the most important function of business is forecasting, which is a starting point for planning and budgeting. The objective of forecasting is to reduce risk in decision making.

In business, forecasts form the basis for planning capacity, production and inventory, manpower, sales and market share, finances and budgeting, research and development, and top management's strategy. Sales forecasts are especially crucial aspects of many financial management activities, including budgets, profit planning, capital expenditure analysis, and acquisition and merger analysis.

Forecasting is done both for the long run as well as short run.

In a short run forecast, seasonal patterns are of prime importance such a forecast help in preparing suitable sales policy and proper scheduling of output in order to avoid over –stocking or cost delay in meeting the orders. Besides, given an idea of likely demand short run forecasts also help in arriving at suitable price for the product and in deciding about necessary modifications in advertising and sales techniques. Short run forecasts are needed to evolve suitable production policy, controlling inventory and cost of raw materials, determining suitable price policy, setting sales targets and planning future financial requirements.

Long run forecasts are helpful in proper capital planning. Long term help in saving the wastages in raw materials, man-hours, variables like population, age group pattern, consumption pattern etc. are included. Long run forecasting usually used for ―new planning, long run financial requirements etc.

4.2 Market Demand Analysis

Companies use market demand analysis to understand how much consumer demand exists for a product or service. This analysis helps management determine if the company can successfully enter a market and generate enough profits to advance its business operations. While several methods of demand analysis may be used, they usually contain a review of the basic components of an economic market.

Market Identification

The first step of market analysis is to define and identify the specific market to target with new products or services. Companies will use market surveys or consumer feedback to determine their satisfaction with current products and services. Comments indicating dissatisfaction will lead businesses to develop new products or services to meet this consumer demand. While companies will usually identify markets close to their current product line, new industries may be tested for business expansion possibilities.

Business Cycle

Once a potential market is identified, companies will assess what stage of the business cycle the market is in. Three stages exist in the business cycle: emerging, plateau and declining. Markets in the emerging stage indicate higher consumer demand and low supply of current products or services. The plateau stage is the break-even level of the market, where the supply of goods meets current market demand. Declining stages indicate lagging consumer demand for the goods or services supplied by businesses.

Product Niche

Once markets and business cycles are reviewed, companies will develop a product that meets a specific niche in the market. Products must be differentiated from others in the market so they meet a specific need of consumer demand, creating higher demand for their product or service. Many companies will conduct tests in sample markets to determine which of their potential product styles is most preferred by consumers. Companies will also develop their goods so that competitors cannot easily duplicate their product.

Growth Potential

While every market has an initial level of consumer demand, specialized products or goods can create a sense of usefulness, which will increase demand. Examples of specialized products are iPods or iPhones, which entered the personal electronics market and increased demand through their perceived usefulness by consumers. This type of demand quickly increases the demand for current markets, allowing companies to increase profits through new consumer demand.

Competition

An important factor of market analysis is determining the number of competitors and their current market share. Markets in the emerging stage of the business cycle tend to have fewer competitors, meaning a higher profit margin may be earned by companies. Once a market becomes saturated with competing companies and products, fewer profits are achieved and companies will begin to lose money. As markets enter the declining business cycle, companies will conduct a new market analysis to find more profitable markets.

4.3 DEMAND FUNCTION

A demand function that represents the behavior of buyers can be constructed for an individual or a group of buyers in a market. The market demand function is the horizontal summation of the individuals' demand functions. In models of firm behavior, the demand for a firm's product can be constructed.

The nature of the "demand function" depends on the nature of the good considered and the relationship being modeled. In most cases the demand relationship is based on an inverse or negative relationship between the price and quantity of a good purchased. The demand for purely competitive firm's output is usually depicted as horizontal (or perfectly elastic). In rare cases, under extreme conditions, a "Giffen good" may result in a positively sloped demand function. These Giffen goods rarely occur.

Individual Demand Function

The behavior of a buyer is influenced by many factors; the price of the good, the prices of related goods (compliments and substitutes), incomes of the buyer, the tastes and preferences of the buyer, the period of time and a variety of other possible variables. The quantity that a buyer is willing and able to purchase is a function of these variables.

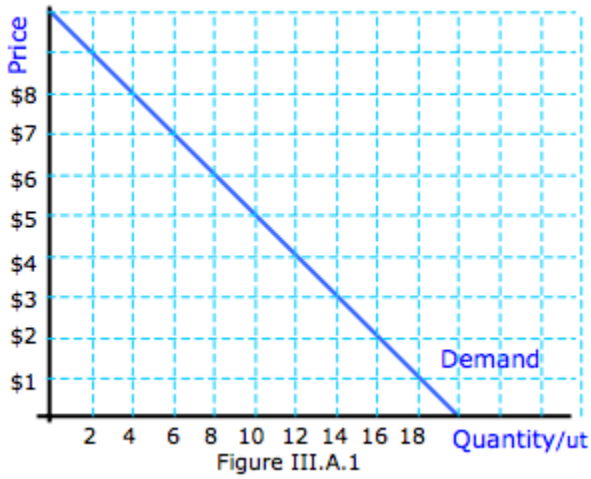

Figure III.A.1

Market Demand Function

When property rights are nonattenuated (exclusive, enforceable and transferable) the individual's demand functions can be summed horizontally to obtain the market demand function.

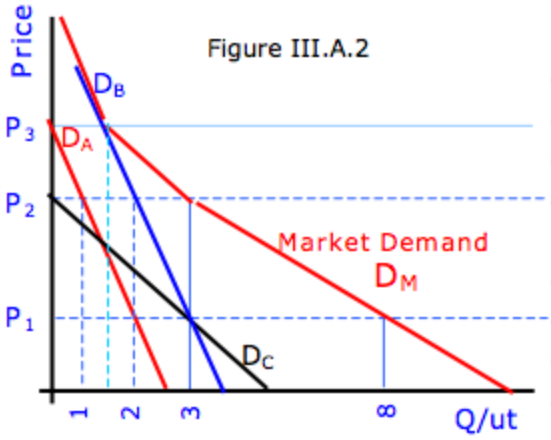

Figure III.A.2

Table III.A.2

Computation of Market Demand by Horizontal Summation of Individual Demand Functions.

Price	Ann's Demand	Bob's Demand	Cathy's Demand	Market Demand
P_1	2	3	3	8
P_2	1	0	2	3
P_3	0	0	1.5	1.5

4.4 DEMAND FORECASTING

Forecasts are needed for marketing, production, purchasing, manpower, and financial planning. Further, top management needs forecasts for planning and implementing long-term strategic objectives and planning for capital expenditures.

More specifically, here are who and why they need to forecast:

Marketing managers – They use sales forecasts to determine optimal sales force allocations, set sales goals, and plan promotions and advertising. Market share, prices, and trends in new product development are also required.

Production planners – They need forecasts in order to: schedule production activities, order materials, establish inventory levels and plan shipments. Other areas that need forecasts include material requirements (purchasing and procurement), labor scheduling, equipment purchases, maintenance requirements, and plant capacity planning.

The personnel department – It requires a number of forecasts in planning for human resources. Workers must be hired, trained, and provided with benefits that are competitive with those available in the firm's labor market. Also, trends that affect such variables as labor turnover, retirement age, absenteeism, and tardiness need to be forecast for planning and decision making.

The bank – Banks have to forecast too. Demands of various loans and deposits Money and credit conditions so that it can determine the cost of money it lends

4.4.1 Common Features and Assumptions Inherent in Forecasting

As pointed out, forecasting techniques are quite different from each other. But four features and assumptions underlie the business of forecasting. They are:

Forecasting techniques generally assume that the same underlying causal relationship that existed in the past will continue to prevail in the future. In other words, most of our techniques are based on historical data.

Forecasts are rarely perfect. Therefore, for planning purposes, allowances should be made for inaccuracies. For example, the company should always maintain a safety stock in anticipation of a sudden depletion of inventory.

Forecast accuracy decreases as the time period covered by the forecast (i.e., the time horizon) increases. Generally speaking, a long-term forecast tends to be more inaccurate than a short-term forecast because of the greater uncertainty.

Forecasts for groups of items tend to be more accurate than forecasts for individual items, because forecasting errors among items in a group tend to cancel each other out. For example, industry forecasting is more accurate than individual firm forecasting.

4.4.2 Forecasting Techniques

There are two types of forecasting technique. They are:

1. Qualitative forecasting techniques
2. Quantitative forecasting techniques

4.4.2.1 QUALITATIVE FORECASTING METHODS

The qualitative (or judgmental) approach can be useful in formulating short-term forecasts and can also supplement the projections based on the use of any of the quantitative methods.

Forecasts based on judgment, experience or opinions are appropriate when:

a) Forecasts must be prepared quickly in a short period of time,
b) Available data may be obsolete or up to date information might not be available because of rapid and continuous changes in the external environment such as economic and political conditions,
c) Historical data cannot be available like demand for a newly introduced product, and
d) The forecasting period is long range that past events will not repeat themselves in a similar fashion.

Four of the better-known qualitative forecasting methods are executive opinions, the Delphi method, sales-force polling, and consumer surveys:

1. Executive Opinions

The subjective views of executives or experts from sales, production, finance, purchasing, and administration are averaged to generate a forecast about future sales. Usually this method is used in conjunction with some quantitative method, such as trend extrapolation. The management team modifies the resulting forecast, based on their expectations.

The advantage of this approach: The forecasting is done quickly and easily, without need of elaborate statistics. Also, the jury of executive opinions may be the only means of forecasting feasible in the absence of adequate data.

The disadvantage: This, however, is that of group-think. This is a set of problems inherent to those who meet as a group. Foremost among these are high cohesiveness, strong leadership, and insulation of the group. With high cohesiveness, the group becomes increasingly conforming through group pressure that helps stifle dissension and critical thought. Strong leadership fosters group pressure for unanimous opinion. Insulation of the group tends to separate the group from outside opinions, if given.

2. Delphi Method

This is a group technique in which a panel of experts is questioned individually about their perceptions of future events to get the views of expertise that are located at different geographic areas to generate the forecast. The experts do not meet as a group, in order to reduce the possibility that consensus is reached because of dominant personality factors. Instead, the forecasts and accompanying arguments are summarized by an outside party and returned to the experts along with further questions. This continues until a consensus is reached.

Advantages: This type of method is useful and quite effective for long-range forecasting. The technique is done by questionnaire format and eliminates the disadvantages of group think. There is no committee or debate. The experts are not influenced by peer pressure to forecast a certain way, as the answer is not intended to be reached by consensus or unanimity.

Disadvantages: Low reliability is cited as the main disadvantage of the Delphi method, as well as lack of consensus from the returns.

3. Sales Force Polling

Some companies use as a forecast source salespeople who have continual contacts with customers. They believe that the salespeople who are closest to the ultimate customers may have significant insights regarding the state of the future market. Forecasts based on sales force polling may be averaged to develop a future forecast. Or they may be used to modify other quantitative and/or qualitative forecasts that have been generated internally in the company.

The advantages of this forecast are:

- It is simple to use and understand.
- It uses the specialized knowledge of those closest to the action.
- It can place responsibility for attaining the forecast in the hands of those who most affect the actual results.
- The information can be broken down easily by territory, product, customer, or salesperson.

The disadvantages include: salespeople's being overly optimistic or pessimistic regarding their predictions and inaccuracies due to broader economic events that are largely beyond their control.

4. Consumer Surveys

Some companies conduct their own market surveys regarding specific consumer purchases. Surveys may consist of telephone contacts, personal interviews, or questionnaires as a means of obtaining data. Extensive statistical analysis usually is applied to survey results in order to test hypotheses regarding consumer behavior.

4.4.2.2 QUANTITATIVE FORECASTING METHODS

Quantitative forecasting models are used to forecast future data as a function of past data. They are appropriate to use when past numerical data is available and when it is reasonable to assume that some of the patterns in the data are expected to continue into the future.

There are two types of quantitative forecasting techniques: Time Series Analysis and Causal Methods

1. **Time Series Analysis:** A time series is a set of some variable (demand) overtime (e.g. hourly, daily, weekly, quarterly, annually). Time series analyses are based on time and do not take specific account of outside or related factors.

Time series analysis is a time-ordered series of values of some variables. The variables value in any specific time period is a function of four factors:

a) Trend c) Cycles
b) Seasonality d) Randomness

A) Trend – is a general pattern of change overtime. It represents a long time secular movement, characteristic of many economic series.

B) Seasonality- refers to any regular pattern recurring with in a time period of no more than one year. These effects are often related to seasons of the year.

C) Cycle – are long-term swings about the trend line and are usually associated with a business cycle (phases of growth and decline in a business cycle).

D) Randomness – are sporadic effects due to chance and unusual occurrences.

A. **Types of Time Series Analysis:**

- Naive methods/approach

Naïve forecasts are the most cost-effective forecasting model, and provide a benchmark against which more sophisticated models can be compared. In time series data, using naive approach would produce forecasts that are equal to the last observed value. This method works quite well for economic and financial time series, which often have patterns that are difficult to reliably and accurately predict. If the time series is believed to have seasonality, seasonal naive approach may be more appropriate where the forecasts are equal to the value from last season.

- **Simple Moving Average**

A simple moving average is obtained by summing and averaging values from a given number of periods repetitively, each time deleting the oldest value and adding the new value. Each of the observations used to compute the forecasted value is weighted equally.

Simple moving average is preferable if the demand for a product is neither growing nor declining rapidly and also does not have any seasonal characteristics.

$$SMA = F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + ... + A_{t-n}}{n}$$

$$= \frac{\sum_{i=1}^{n} A_{t-i}}{n}$$

Where

SMA – simple moving average

F_t - Forecast for period t

A_{t-i} - Actual demand in period t-i

n - Number of periods (data points) in the moving average

Example: A food processor uses a moving average to forecast next month's demand. Past actual demand (in units) is shown in the following table

Month	1	2	3	4	5	6	7	8
Actual demand	105	106	110	110	114	121	130	128

a. Compute a simple 5 month moving average to forecast demand for month 9

b. Find a simple 5 month moving average to forecast the demand for month 10 if the actual demand for month 9 is 123.

Solution

a) $SMA_9 = F_9 = \frac{128+130+121+114+110}{5}$

$= 120.6$

Therefore, the forecasted demand for month 9 is 120.6.

b) $SMA_{10} = F_{10} = \frac{123+128+130+121+114}{5}$

$=616/5 = 123.2$

Therefore, the 5 month moving average forecasted demand for month 10 is 123.2.

Note: In moving average, as each new actual value becomes available, the forecast is updated by adding the newest value and dropping the oldest value and computing the average. Consequently the 'forecast' moves by reflecting only the most recent values.

- Weighted moving average

In certain cases, it might be beneficial to put more weight on the observations that are closer to the time period being forecast. When this is done, this is known as a weighted moving average technique. The weights in a weighted Moving average must sum to 1.

$$F_t = WMA = W_1A_{t-1}+W_2.A_{t-2}+\dots +W_n.A_{t-n}$$

$$= \sum_{i=1}^{n} A_{t-1}.W_i$$

Where

F_t =forecast in time t

WMA = weighted moving average

W = weight

A = Actual demand value

The demand for defense machinery for a certain project is given each month as follows:

Month	1	2	3	4	5	6	7	8	9	10
Demand	120	110	90	115	125	117	121	126	132	128

The defense officer is asked to forecast the demand for the 11th month using three period moving average techniques.

The defense officer has decided to use a weighting scheme of 0.5, 0.3, and 0.2 and calculated the weighted moving average for the 11th month as follows.

WM A (3) = Ft+1 = Wt1(Dt0) + Wt2(Dt-1) + Wt3(Dt-2)

WMA (3): F11 = 0.5(128) + 0.3(132) + 0.2(126) = 64 + 39.6 + 25.2 = 128.2

- **Simple Exponential Smoothing**

The other type of time series forecasting method is simple exponential smoothing which weights past data in an exponential manner so that most recent data carry more weight in the moving average.

With simple exponential smoothing, the forecast is made up of the last period forecast plus a portion of the difference between the last period actual demand and the last period forecast.

Mathematically

$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$

Where

F_t = Forecast for period t

F_{t-1} = Forecast for the previous period

α = Smoothing constant ($0<\alpha<1$)

A_{t-1} = Actual demand for the previous period

The difference between the actual demand and the previous forecast (i.e. $A_{t-1} - F_{t-1}$) represents the forecast error. As we observe from the equation, each forecast is simply the previous forecast plus some correction for demand in the last period. Thus,

- ➲ If actual demand was above the last period forecast, the correction will be positive, and
- ➲ If the actual demand was below the last period forecast, the correction will be negative.

The smoothing constant,α actually dictates how much corrections will be made. It is a number between 0 and 1, and it is used to compute the forecast.

Exponential smoothing is the most widely used of all forecasting techniques, because;

- ❖ Exponential forecasting models provide closer forecasts to actual demand.
- ❖ Formulating an exponential smoothing model is relatively easy.
- ❖ The user can easily understand the model
- ❖ It requires little computation
- ❖ It requires only three pieces of data

- The most recent forecast
- The actual demand of the previous period
- The smoothing constant, α

Example : The production supervisor at a fiber board plant uses a simple exponential smoothing technique ($\alpha = 0.2$) to forecast demand. In April, the forecast was 30 shipments, and the actual demand was for 25 shipments. The actual in May and June was 25 and 26 shipments. Forecast the value for May

Solution

$F_{may} = F_{April} + \alpha (A_{April} - F_{April})$

$= 30+0.2(25-30)$

$= 30 + 0.2(-5)$

$= 30 - 1 = 29$

2. Associative (Causal Methods)

- Simple linear regression

The linear trend is the most commonly used method of time series analysis. The following are various trend projections used under various circumstances.

Linear Trend Equation:

$Y = a + b X$, Y = demand

X = time period and a, b constant values representing intercept and slope of the line. To calculate Y for any value of X we have to solve the following equations,

(i) and (ii). We can derive the values of 'a' and 'b' through solving these equations and by substituting the same in the above given linear trend equation we can forecast demand for 'X' time period.

$\sum Y = na + b\sum X$ -----(i)

$\sum XY = a\sum X + b\sum X2$ -----(ii)

Example:

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Sales	22734	24731	31489	44685	55319	91021	146234	107887	127483	97275

Estimate the sales for 2012, 2015 and fit a linear regression equation and draw a trend line.

Year	X	Sales (Y)	XY	X2
2002	1	22734	22734	1
2003	2	24731	49462	4
2004	3	31489	94467	9
2005	4	44685	178740	16
2006	5	55319	276595	25
2007	6	91021	546126	36
2008	7	146234	1023638	49
2009	8	107887	863096	64
2010	9	127483	1147347	81
2011	10	97275	972750	100
	∑X = 55	∑Y= 748858	∑XY= 5174955	∑X2= 385

$\sum Y = na + b\sum X$ ----- (i)

$\sum XY = a\sum X + b\sum X2$ ----- (ii)

748858 = 10a + 55b ----- (i)

5174955 = 55a + 385 b ----- (ii)

Equation (i) x 7 5242006 = 70a + 385 b ----- (iii)

Equation (iii) – (ii) 67051 = 15a

4470.07 = a

Substitute value of ‘a’ in equation (i)

748858 = 44700 + 55 b

55b = 748858 – 44700

b =12802.8

Y = a + b X

Y = 4470.07 + 12802.8X

Sales for 2012 = 4470.07 + 12802.8(11) = 145300.87

Sales for 2015 = 4470.07 + 12802.8(14) = 183709.27

Correlation: - is concerned about evaluating the strength of the relationship and quantifying the closeness of such relationship.

The correlation coefficient r, can be obtained by using the following formula and coefficient of determination is r^2

$$\text{Coefficient of correlation (r)} = \frac{n.\Sigma xy - \Sigma x.\Sigma y}{\sqrt{\left[n.\Sigma x^2 - (\Sigma x)^2\right]\left[n\Sigma y^2 - (\Sigma y)^2\right]}}$$