Forecasting

Forecasting is the art and science of predicting future events

Institute of business forecasting (www.ibforecast.com)

Why Forecast?

- Lead times require that decisions be made in advance of uncertain events.
- Forecasting is an important for all strategic and planning decisions in a supply chain.
- Forecasts of product demand, materials, labor, financing are an important inputs to scheduling, acquiring resources, and determining resource requirements.

Demand Forecasting

- Forecasting is a prediction/estimation of a future situation.
- Forecasting helps managers to predict the demand and to come up with a proper production mix.
- Forecasting future demand requires relevant information gathered at the right time.
- Demand forecasting can be termed as a process of prediction/estimation of the future demand of the product.
- Since the future is uncertain, no forecast can be cent percent correct.
- Demand forecasting has various benefits both at macro and micro levels

Aim of the Demand Forecasting

- Aim of the Demand Forecasting is to reduce the risk or uncertainty that the firm face in its short-term operational decision making and planning for its long term growth.

Types of Demand Forecasting

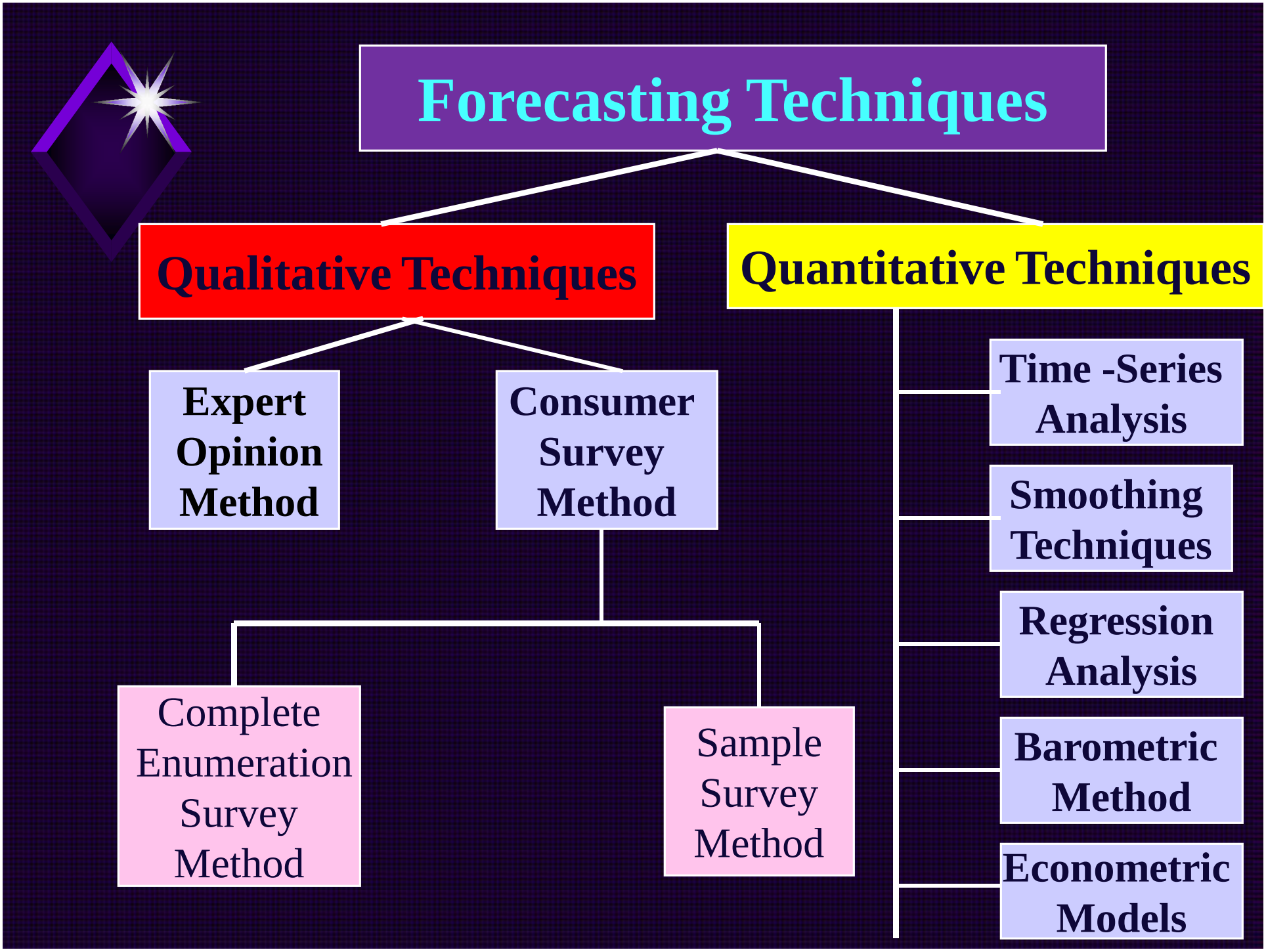
- Short, medium and long term forecasting
- Firm, industry and economy level forecasting

Forecasting Horizons.

- Short Term (0 to 3 months): for inventory management and scheduling.
- Medium Term (3 months to 2 years): for production planning, purchasing, and distribution.
- Long Term (2 years and more): for capacity planning, facility location, and strategic planning.

Forecasting Methods

- ***Qualitative methods*** are subjective in nature since they rely on human judgment and opinion.
- ***Quantitative methods*** use mathematical or simulation models based on historical demand or relationships between variables.


Forecasting Techniques
Qualitative Techniques
Quantitative Techniques
Expert Opinion Method
Consumer Survey Method
Complete Enumeration Survey Method
Sample Survey Method
Time -Series Analysis
Smoothing Techniques
Regression Analysis
Barometric Method
Econometric Models

Determinants of Demand Forecasting Techniques

- **1. Data availability**
- **2. Time availability**
- **3. Cost of preparing the forecasting.**

Qualitative Forecasting Methods / techniques:

- Qualitative techniques are often used to make short term forecasts when, quantitative data are not available.
- Such methods are often required when historical data are not available. For instance, when a company is trying to introduce a new product, no historical data is available, therefore, it must rely on expert opinion to forecast sales of the new product.
- These qualitative techniques can also be useful for supplementing quantitative forecasts that anticipate change in consumer tests or business expectation about future economic condition.

Qualitative Forecasting Methods / techniques:

1. **Expert Opinion Survey:** In this method the experts on the particular product whose demand is under study are requested to give their 'Feel' about the likely sales in the future period.

   Experts can predict the likely sales in future period under different conditions based on their experience.

Advantage: Simple, Minimum statistical work, Less time & money consuming.

Limitation: Experts may be biased for forecasting

Qualitative Forecasting Methods / techniques:

- **1. Expert Opinion Survey:** Delphi Approach
  - A panel of experts, each of whom is physically separated from the others and is anonymous, is asked to respond to a sequential series of questionnaires.
  - After each questionnaire, the responses are tabulated and the information and opinions of the entire group are made known to each of the other panel members so that they may revise their previous forecast response.
  - The process continues until some degree of consensus is achieved.

Qualitative Forecasting Methods / techniques:

2. Consumer Survey Methods: This the most direct approach to demand forecasting is to ask the consumers themselves about their future consumption plans.

Three types of Consumer survey

a. Consumer survey by Complete Enumeration:

b. Consumer survey by Sampling Enumeration:

c. Consumer survey by End use Method:

Qualitative Forecasting Methods / techniques:

- **2. Consumer Survey Methods: Three types**
- **a. Consumer survey by Complete Enumeration:**

Under this method, the forecaster undertakes a complete survey of all consumers of the commodity whose demand he wish to forecast.

He ask every consumer the amount of that commodity he would like to buy in the forecast period.

Qualitative Forecasting Methods / techniques:

- **2. Consumer Survey Methods: Three types**
- **b. Consumer survey by Sampling Enumeration:**

Under the sample survey method, the forecaster select a few consuming units out of the relevant population and then obtain probable demand of each of the selected units in the forecast period.

Qualitative Forecasting Methods / techniques:

- **2. Consumer Survey Methods: Three types**
- **c. Consumer survey by End use Method:** Under end use method, the sales of a commodity X are projected through a survey of its end users.
- The demand for commodity is for two purpose (Final consumption, and Intermediate goods)
- The demand for the final consumption estimated through some forecasting methods.
- Demand for intermediate use is estimated through a survey of its user industries regarding their production plans and input-output coefficients.

Quantitative Forecasting Methods / techniques:

- Quantitative methods are based on an analysis of historical data concerning one or more time series.
- In this section, we will explain statistical method which utilize historical (time- series) data analysis for estimating long term demand.
- Statistical methods are considered to be superior techniques of demand estimation for the following reasons.
- 1. The element of subjectivity is minimum
- 2. Method of estimation is scientific
- 3. Estimates are relatively more reliable.
- 4. Estimation involve smaller cost.

Quantitative Forecasting Methods / techniques:

- **Quantitative/Statistical Techniques of demand projection include the following techniques:**
- **1. Time-Series Analysis**
- **2. Smoothing Techniques**
- **3. Barometric Method of Forecasting:**
- **4. Econometric Model**
- **5. Input Output Forecasting**

Quantitative Forecasting Methods / techniques: Time-Series Analysis

- **1. Time-Series Analysis: is one of the most frequent used method**
- **Time-Series data refers to the values of a variable arranged chronological by days, weeks, months, quarters, or years.**
- **Time-Series Analysis attempt to forecast future values of the time series by examining past observation of the data only . The assumption is that the time series will continue to move as in the past.**

Quantitative Forecasting Methods / techniques:

- **1. Time-Series Analysis:**
- **Reasons for fluctuation in Time-Series Data:** **If we plot economic time-series data, we discover that they fluctuate over time, this variation is usually caused by secular trend, cyclical fluctuation, seasonal fluctuation, and random fluctuation.**
- Secular Trend refers to long-run increase or decrease in the data series
- Cyclical Fluctuations refers to major expansion and contraction in most economic time-series that seem to recur every several years.
- Seasonal Variations refers to the regular recurring fluctuation in economic activity during each year.
- Random Fluctuation are the variations in the data series resulting from war, natural disasters, strikes or other unique events.
- We can forecast the values of time-series data by using only secular trend seasonal variation

Quantitative Forecasting Methods / techniques:

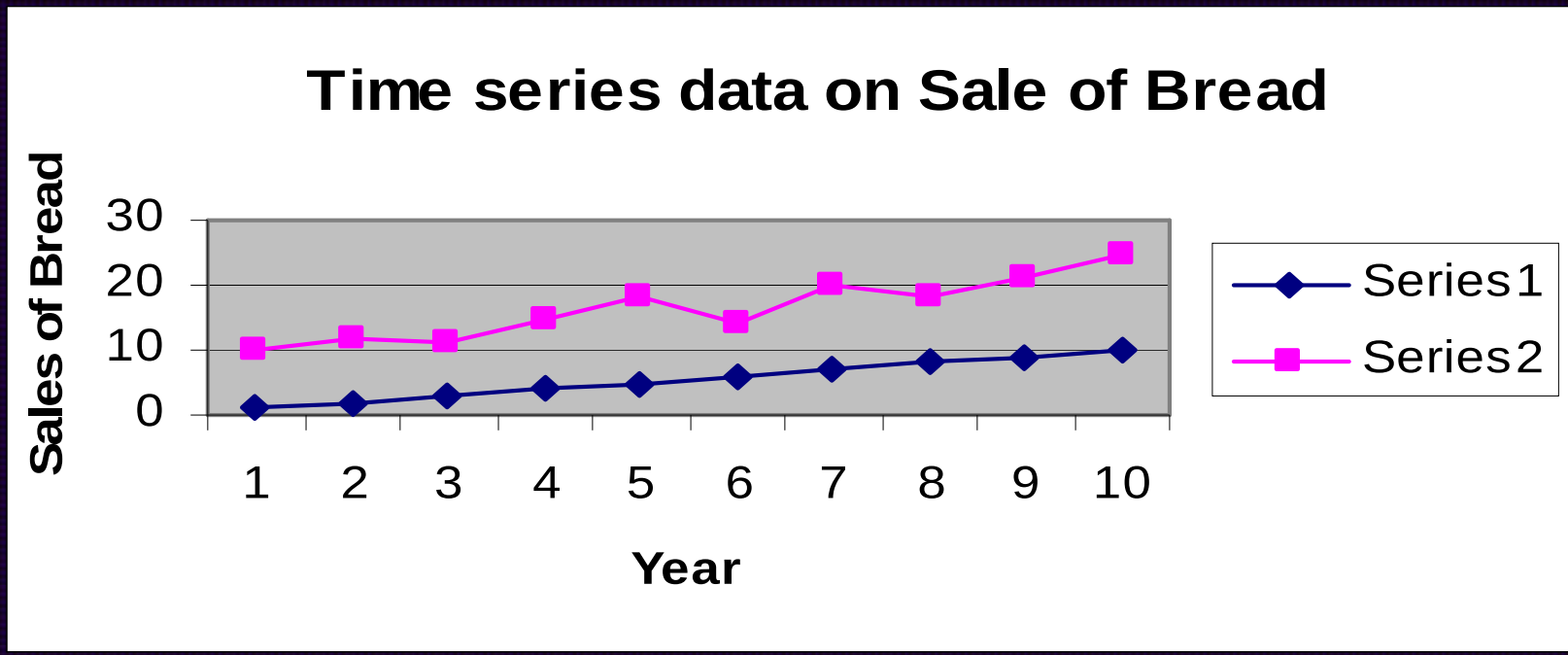
- **1. Time-Series Analysis: *Trend Projection:***
- If a time series exhibits a linear trend, the method of **least squares** may be used to determine a trend line (projection) for future forecasts, which minimizes the mean square error between the trend line forecasts and the actual observed values for the time series.
- The independent variable is the time period and the dependent variable is the actual observed value in the time series.

Assumption: Factors responsible for the past trends in the variable to be projected will continue to play their part in future in the same manner and the same extent as they did in the past in determining the magnitude and direction of the variable.

Quantitative Forecasting Methods / techniques:

1. Time-Series Analysis: a. *Trend Projection:*

Sr	1	2	3	4	5	6	7	8	9	10
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Sales of Bread	10	12	11	15	18	14	20	18	21	25



1. Time-Series Analysis:
a. Trend Projection:

- Using the method of least squares, the formula for the trend projection is: $T_t = b_0 + b_1 t$.

  where T_t = trend forecast for time period t

  b_1 = slope of the trend line

  b_0 = trend line projection for time 0

$$b_1 = \frac{n\Sigma tY_t - \Sigma t \Sigma Y_t}{n\Sigma t^2 - (\Sigma t)^2} \qquad b_0 = \bar{Y} - b_1\bar{t}$$

where

Y_t = observed value of the time series at time period t

$\bar{Y}$ = average of the observed values for Y_t

$\bar{t}$ = average time period for the n observations

1. Time-Series Analysis:
a. Trend Projection: Example:

The number of plumbing repair jobs performed by Auger's Plumbing Service in each of the last nine months are listed below.

Month	Jobs	Month	Jobs	Month	Jobs
March	353	June	374	September	399
April	387	July	396	October	412
May	342	August	409	November	408

Forecast the number of repair jobs Auger's will perform in December using the least squares method. Also, forecast for December using a three-period weighted moving average with weights of .6, .3, and .1. Then, compare the two forecasts.

1. Time-Series Analysis:

a. Trend Projection: Example:

- Trend Projection

(month) t	Y_t	tY_t	t^2
(Mar.) 1	353	353	1
(Apr.) 2	387	774	4
(May) 3	342	1026	9
(June) 4	374	1496	16
(July) 5	396	1980	25
(Aug.) 6	409	2454	36
(Sep.) 7	399	2793	49
(Oct.) 8	412	3296	64
(Nov.) 9	408	3672	81
Sum 45	3480	17844	285

1. Time-Series Analysis:
a. Trend Projection: Example:

- Trend Projection (continued)

$$\bar{t} = 45/9 = 5 \qquad \bar{Y} = 3480/9 = 386.667$$

$$b_1 = \frac{n\Sigma tY_t - \Sigma t\Sigma Y_t}{n\Sigma t^2 - (\Sigma t)^2} = \frac{(9)(17844) - (45)(3480)}{(9)(285) - (45)^2} = 7.4$$

$$b_0 = \bar{Y} - b_1\bar{t} = 386.667 - 7.4(5) = 349.667$$

$$T_{10} = 349.667 + (7.4)(10) = \boxed{423.667}$$

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

- **2. Smoothing Techniques:**
- This techniques predicts values of a times series on basis of some average of its past value only.
- In cases in which the time series is fairly stable and has no significant trend, seasonal, or cyclical effects, one can use ***smoothing techniques*** to average out the irregular components of the time series.
- Four common smoothing methods are:
  - a. Moving averages
  - b. Exponential smoothing

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

- a. Moving Average Method

The ***moving average method*** consists of computing an average of the **most recent *n* data** values for the series and using this average for ***forecasting the value of the time series for the next period.***

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques :

- a. **Moving Average Method:** During the past ten weeks, sales of cases of Comfort brand headache medicine at Robert's Drugs have been as follows:

Week	Sales	Week	Sales
1	110	6	120
2	115	7	130
3	125	8	115
4	120	9	110
5	125	10	130

Use a three week moving average to forecast the 11th period.

	A	B	C		
1	Robert's Drugs				
2					
3	*Week (t)*	*Sales$_t$*	*Forec$_{t+1}$*	*Error*	*Error^2*
4	**1**	110			
5	**2**	115			
6	**3**	125			
7	4	120	116.7	3.3	11.11
8	5	125	120.0	5.0	25.00
9	6	120	123.3	-3.3	11.11
10	7	130	121.7	8.3	69.44
11	8	115	125.0	-10.0	100.00
12	9	110	121.7	-11.7	136.11
13	10	130	118.3	11.7	136.11
	11		118.3		
				SUM	488.89
				MSE	69.84

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

- **b. Exponential Smoothing:**

Using ***exponential smoothing***, the forecast for the next period is equal to the forecast for the current period plus a proportion **(α)** of the forecast error in the current period.

- Using exponential smoothing, the forecast is calculated by:

α[the actual value for the current period] +

(1- α)[the forecasted value for the current period],

where the smoothing constant, α , is a number between 0 and 1.

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

b. Exponential Smoothing

During the past ten weeks, sales of cases of Comfort brand headache medicine at Robert's Drugs have been as follows:

Week	Sales	Week	Sales
1	110	6	120
2	115	7	130
3	125	8	115
4	120	9	110
5	125	10	130

If Robert's uses exponential smoothing to forecast sales, which value for the smoothing constant α, $\alpha = .1$ or $\alpha = .8$, gives better forecasts?

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

- b. Exponential Smoothing

To evaluate the two smoothing constants, determine how the forecasted values would compare with the actual historical values in each case.

Let Y_t = actual sales in week t

F_t = forecasted sales in week t

$F_1 = Y_1 = 110$. For other weeks, $F_{t+1} = .1Y_t + .9F_t$

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

b. Exponential Smoothing

For $\alpha = .1$, $1 - \alpha = .9$

F_1 = 110

$F_2 = .1Y_1 + .9F_1 = .1(110) + .9(110) = 110$

$F_3 = .1Y_2 + .9F_2 = .1(115) + .9(110) = 110.5$

$F_4 = .1Y_3 + .9F_3 = .1(125) + .9(110.5) = 111.95$

$F_5 = .1Y_4 + .9F_4 = .1(120) + .9(111.95) = 112.76$

$F_6 = .1Y_5 + .9F_5 = .1(125) + .9(112.76) = 113.98$

$F_7 = .1Y_6 + .9F_6 = .1(120) + .9(113.98) = 114.58$

$F_8 = .1Y_7 + .9F_7 = .1(130) + .9(114.58) = 116.12$

$F_9 = .1Y_8 + .9F_8 = .1(115) + .9(116.12) = 116.01$

$F_{10} = .1Y_9 + .9F_9 = .1(110) + .9(116.01) = 115.41$

Quantitative Forecasting Methods / techniques: 2. Smoothing Techniques

Exponential Smoothing

For $\alpha = .8$, $1 - \alpha = .2$

F_1 = 110

$F_2 = .8(110) + .2(110) = 110$

$F_3 = .8(115) + .2(110) = 114$

$F_4 = .8(125) + .2(114) = 122.80$

$F_5 = .8(120) + .2(122.80) = 120.56$

$F_6 = .8(125) + .2(120.56) = 124.11$

$F_7 = .8(120) + .2(124.11) = 120.82$

$F_8 = .8(130) + .2(120.82) = 128.16$

$F_9 = .8(115) + .2(128.16) = 117.63$

$F_{10} = .8(110) + .2(117.63) = 111.53$

Quantitative Forecasting Methods / techniques: 3.Regression Analysis:

- ***Regression analysis*** is a statistical technique that can be used to develop a mathematical equation showing how variables are related.
- The variable being predicted is called the dependent or ***response variable***.
- The variable(s) that predict the value of the dependent variable are called the ***independent or predictor variables***.
- ***Simple linear regression*** involves one independent variable and one dependent variable.
- ***Multiple regression analysis*** involves two or more independent variables.

Quantitative Forecasting Methods / techniques: 3.Regression Analysis:

- Estimated Simple Linear Regression Equation

$$\hat{y} = b_0 + b_1 x$$

where

$\hat{y}$ = estimated value of the dependent variable

b_0 = intercept of the estimated regression equation

b_1 = slope of the estimated regression equation

x = value of the independent variable

Quantitative Forecasting Methods / techniques: 3.Regression Analysis:

- The Least Squares Method
- Slope for the Estimated Regression Equation

$$b_1 = \frac{\sum x_i y_i - (\sum x_i \sum y_i)/n}{\sum x_i^2 - (\sum x_i)^2/n}$$

- *y*-Intercept for the Estimated Regression Equation

$$b_0 = \bar{y} - b_1 \bar{x}$$

where

x_i = value of independent variable for *i*th observation

y_i = value of dependent variable for *i*th observation

$\bar{x}$ = mean value for independent variable

$\bar{y}$ = mean value for dependent variable

n = total number of observations

Quantitative Forecasting Methods / techniques: 3.Regression Analysis:

Reed Auto periodically has a special week-long sale. As part of the advertising campaign Reed runs one or more television commercials during the weekend preceding the sale. Data from a sample of 5 previous sales showing the number of TV ads run and the number of cars sold in each sale are shown below.

Number of TV Ads	Number of Cars Sold
1	14
3	24
2	18
1	17
3	27

Quantitative Forecasting Methods / techniques: 3.Regression Analysis:

- Slope for the Estimated Regression Equation

$$b_1 = \frac{220 - (10)(100)/5}{24 - (10)^2/5} = 5$$

- *y*-Intercept for the Estimated Regression Equation

$$b_0 = 20 - 5(2) = 10$$

- Estimated Regression Equation

$$\hat{y} = 10 + 5x$$

If 3 TV ads are run prior to a sale, we expect the mean number of cars sold to be:

$$\hat{y} = 10 + 5(3) = 25 \text{ cars}$$

Quantitative Forecasting Methods / techniques: 4. Barometric Forecasting

- **4. Barometric forecasting** can be defined as "the prediction of turning points in one economic time series through the use of observations on another time series called the barometer or the indicator."
- **In barometric analysis, the economic time series are divided into three groups**
- leading indicators,
- coincident indicators
- lagging indicators.

Quantitative Forecasting Methods / techniques: 5. Econometric Models

- **5. Econometric Models**

Quantitative Forecasting Methods / techniques: 6. Input-Output Forecasting

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The End