International Journal on Emerging Technologies **4**(1): 26-31(2013)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Comparative analysis for measures of forecast accuracy 'A Case Study'

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(Received 05 November, 2012, Accepted 02 January, 2013)

ABSTRACT: Forecasting is defined as technique of translating past experience into prediction of things to come in future. It tries to evaluate the magnitude and significance of forces and efforts that will affect future operating conditions in an enterprise. So, the estimation of type, quantity and quality of future work is termed as Forecasting [6]. In this paper, an attempt has been made to study the various forecasting methods used in Indian Industries and find the best method by analyze the comparison between three methods. The paper consisting three forecasting methods, which are applied one by one on same data & the results are calculated. The data is collected from Finance and P&A Department of the XYZ Company. For each specific method of forecasting, different calculations are done. One thing is suggested in the paper based on result that is the best method of Forecasting is Moving Average Method that can considerably decrease the loss to the industry by forecasting at App. 92% accuracy in terms of both money and time. Suggestions can easily help to improve the efficiency of the industry and can also increase the productivity and profitability (in terms of sales revenue) of the industry.

Keywords: Forecasting, Moving Average Method, Least Square Method, Semi Average Method. Forecast accuracy, Forecast evaluation etc.

I. INTRODUCTION

The Journey of future forecasting process for any organization is duly culture oriented and requires an attitude of intention, perfection and devotion. The recent technological changes in the field of communication have made the market most competitive through all around the world. In such an environment existence is based on adopting forecasting techniques that will possess the 100% accuracy to stay within the required conditions.

Many measures of forecast accuracy have been proposed in the past, and several authors have made recommendations about what should be used when comparing the accuracy of forecast methods.

Forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. A commonplace example might be estimation for some variable of interest at some specified future date. Prediction is a similar, but more general term. Both might refer to formal statistical methods employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgemental methods. Usage can differ between areas of application: for example in hydrology, the terms "forecast" and "forecasting" are sometimes reserved for estimates of values at certain specific future times, while the term "prediction" is used for more general estimates, such as the number of times floods will occur over a long period.

The field of forecasting is concerned with approaches to determining what the future holds. It is also concerned with the proper presentation and use of forecasts. Alternatively, forecasts can be of one-off events such as the outcome of a union-management dispute or the performance of a new recruit. Forecasts can also be of distributions such as the locations of terrorist attacks or the occurrence of heart attacks among different age cohorts. The field of forecasting includes the study and application of judgment as well as of quantitative or statistical methods.

Risk and uncertainty are central to forecasting and prediction; it is generally considered good practice to indicate the degree of uncertainty attaching to forecasts.

II. METHODS OF FORECASTING

The three methods of forecasting i.e. Semi average method, Method of moving averages, Method of least squares are of interest here. The description about them as follows.

A. Semi Average Method

This is a graphical method to forecast the sales. According to this method, the original data is divided into two equal parts and the values of the parts are summed and then averaged. The average of each part is cantered in the period of the time of the part from which it has been calculated and then plotted on the graph.

A straight line may be drawn to pass through the plotted points and this line is known as the semi average trend line. On further extending this line on the graph, anyone can forecast the sales of the future years. The limitation of this method of forecasting is that is assumes straight line between the two fixed points and after that. But its advantage is that it is a simple method and free from prejudice and biasness.

B. Method of Moving Averages

A moving average may be defined as an average of some fixed or predetermined number of observations in a time series which moves through the series by dropping the top item of the previous averaged group and adding the next item below in each successive average.

The calculations depend upon the period to be odd or even. In case of odd periods generally 3 years, 5 years, 7 years and 9 years periods are taken to compute moving averages. In this method, when we calculate 3 yearly moving averages, the first three years values are added and their total and average will be recorded against the second year. Now eliminate the first year value and next three years value and note the total and mean against the third year. There will be no average against the first and the last period. Similarly, the five or seven year moving average will be calculated. The calculated values of the moving averages become the basis for determining the expected future sales. Graph is plotted between the sales and the time in the years and curve is drawn according to the data available and also the moving average curve is drawn and from this moving average curve the future sales are estimated.

The advantage of this method is that equal weight-age is assigned to all period's chosen for averaging and this method reduces the influence of fluctuations and is free from prejudice. Still, it cannot be applied if observations are missing.

C. Method of Least Squares

This is the most common method, which is used to fit a straight line to a given scatter, which suggests a linear trend. By this method straight line is defined in such a way that the sum of the squares of the differences between the ordinates of the suggested line and those of the given points is at minimum. The line is known as "line of best fit".

In this method, a mathematical relationship is established between the time factor "X" and the variable "Y". Where Y denotes the demand and the X denotes the period for the certain product. Then the linear relationship between X and Y can be represented as straight line equation.

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

Where, a = Y-intercept

b = slope of trend line

Normal equation of straight line is given by:

$$\Sigma Y = Na + b\,\Sigma X$$

$$\Sigma XY = a\,\Sigma X + b\,\Sigma X2$$

Where, N = number of items in series

From the above two equations the value of a and b can be calculated

$$a = \Sigma Y/N \;\&\; b = \Sigma XY/(\Sigma X2)$$

The estimates of trend computed in this manner are such that the sum of the squared deviations of the squared data from the estimated value is minimum.

III. LITERATURE REVIEW

Forecasting is critical to successful execution of an organization's operational and strategic functions such as for delivery of a cost effective and efficient supply chain. The complex and dynamic organizational environment that defines much of today's forecasting function is often supported by a range of technology solutions, or forecasting decision support systems (FDSS) [3].

Forecasters often have useful knowledge about a particular problem, which is referred to as domain knowledge. One approach to making effective use of domain knowledge consists of providing graphical decision support for judgmental forecasting. The reason for avoiding judgmental forecasts is it is more expensive than quantitative methods. If it is necessary to make inventory control forecasts every week each of 50,000 items, judgment cannot be used. Another reason for avoiding judgmental forecasts is that they are usually less accurate than formal methods [4].

Forecasting task complexity can negatively impact forecast reliability, accuracy, and performance [1,5]. Specifically, it can influence two elements of forecaster behavior that deriving forecasts and judgmental adjustment of these forecasts [7].

Most of the researches have shown that judgmental forecasts are subject to many biases such as optimism and overconfidence and described how to overcome many of these biases.

IV. PROBLEM FORMULATION

An attempt has been made for finding the accurate method by implementing the above mentioned forecasting methods on same data collected from P&FA Deptt. of an XYZ Company. Table 1 shows the sale and profit for past ten years.

Table 1: Financial Data for year 2002-03 to 2011-12.

Sr. No.	Financial Year	Profit Excluding Tax (Millions)	Sales (Nos.)
1	2002-03	184	31547
2	2003-04	204	29741
3	2004-05	785	37859
4	2005-06	917	32475
5	2006-07	923	29673
6	2007-08	1202	36444
7	2008-09	1936	48654
8	2009-10	2714	54740
9	2010-11	3273	61655
10	2011-12	4413	83094

The data given in Table 1 is collected from F&PA Deptt. The Line Diagram for this data is made and shown in Fig.1 (a) & (b) below:

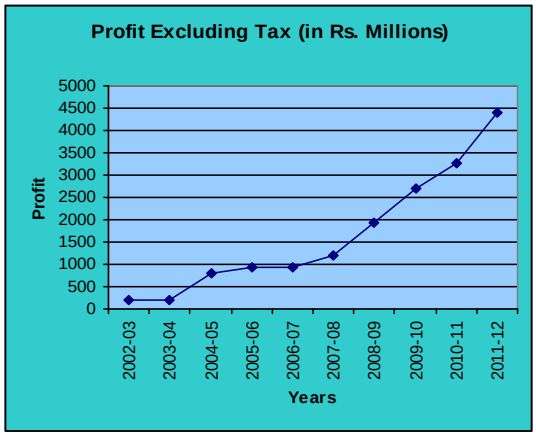

Fig. 1 (a) Line Diagram for Profit Data.

V. ANALYSIS

For the analysis purpose, the data collected (from financial year 2002-03 to 2011-12) is analysed through applying the above mentioned methods of forecasting individually one by one as follows:

Method 1: Semi average Method: The data for profit analysis by this method is calculated and shown in Table 2. In Table 2 the data collected is divided in two equal halves and finds their average.

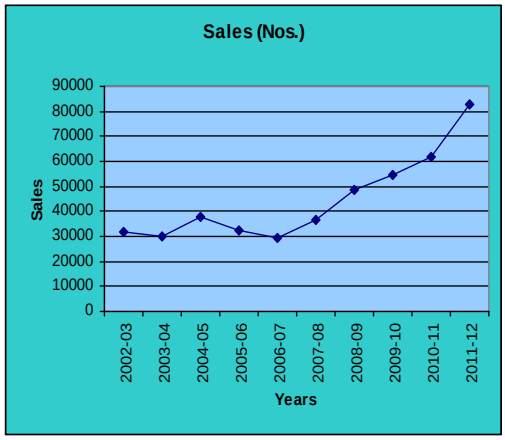

Fig.1 (b) Line Diagram for Sales Data.

Table 2: Forecasting by Semi Average Method for Profit.

Sr. No.	Financial Year	Profit	Semi. Avg. Method
1	2002-03	184	
2	2003-04	204	
3	2004-05	785	602.6
4	2005-06	917	
5	2006-07	923	
6	2007-08	1202	
7	2008-09	1936	2707.6
8	2009-10	2714	
9	2010-11	3273	
10	2011-12	4413	

Average Formula: $\mathbf{\Sigma X_i / n}$
Where, i = 1,2,3,……..,n
& n is the number of values.
i.e. In Table 2, the value of profit from financial year 2001-02 to 2005-06 is taken for finding the average profit. This group consisting 5 Financial Years i.e. n = 5.
Then average of Group 1:
(184+204+785+917+923)/5 = 602.6
Similarly for group 2:
(1202+1936+2714+3273+4413) / 5 =2707.6
Similarly, the sales data is used for calculating the Semi Average Forecast method calculations. In Table 3, the data calculated is shown.

Table 3: Forecasting by Semi Average Method for Sales.

Sr. No.	Financial Year	Sales (Nos.)	Semi Avg.
1	2002-03	31547	
2	2003-04	29741	
3	2004-05	37859	32259
4	2005-06	32475	
5	2006-07	29673	
6	2007-08	36444	
7	2008-09	48654	56917.4
8	2009-10	54740	
9	2010-11	61655	
10	2011-12	83094	

Method 2: Now the data is further analysed by Moving Average Forecasting Method. In this Method, basically 3 years data is taken for calculation. The calculation for average is same as in Semi average Method. In Table 4, the Moving Average Method Calculation is shown.

Table 4: Forecasting by Moving Average Method for Profit.

Sr. No.	Financial Year	Profit	Moving Avg.
1	2002-03	184	
2	2003-04	204	391
3	2004-05	785	635.3
4	2005-06	917	875
5	2006-07	923	1014
6	2007-08	1202	1353.7
7	2008-09	1936	1950.7
8	2009-10	2714	2641
9	2010-11	3273	3466.7
10	2011-12	4413	

Calculations:

$A = \Sigma Y/N = 1655.1$

$B = \Sigma XY/\Sigma X^2 = 377.5$

$Y = a + bX$

$Y = 1655.1 + 377.5X$

Table 5: Forecasting by Moving Average Method for Sales.

Sr. No.	Financial Year	Sales	Moving Avg.
1	2002-03	31547	
2	2003-04	29741	33049
3	2004-05	37859	33358.3
4	2005-06	32475	33335.7
5	2006-07	29673	32864
6	2007-08	36444	38257
7	2008-09	48654	46612.7
8	2009-10	54740	55016.3
9	2010-11	61655	66496.3
10	2011-12	83094	

Method 3: The next process which is mentioned earlier is Straight Line Method or Method of Least Square for Forecasting. In this, the data is analysed through mathematical calculations. Table 6 shows all the calculated data for Least Square Method.

Table 6: Forecasting by Straight Line Method for Profit.

Financial Year	Profit Excluding Tax	X	XY	X^2
2002-03	184	-5	-920	25
2003-04	204	-4	-816	16
2004-05	785	-3	-2355	9
2005-06	917	-2	-1834	4
2006-07	923	-1	-923	1
2007-08	1202	1	1202	1
2008-09	1936	2	3872	4
2009-10	2714	3	8142	9
2010-11	3273	4	13092	16
2011-12	4413	5	22065	25
	$\Sigma Y=16551$	$\Sigma X=0$	$\Sigma XY=41525$	$\Sigma X^2=110$

Table 7: Forecasting by Straight Line Method for Sales.

Financial Year	Sale	X	XY	X^2
2002-03	31547	-5	-157735	25
2003-04	29741	-4	-118964	16
2004-05	37859	-3	-113577	9
2005-06	32475	-2	-64950	4
2006-07	29673	-1	-29673	1
2007-08	36444	1	36444	1
2008-09	48654	2	97308	4
2009-10	54740	3	164220	9
2010-11	61655	4	246620	16
2011-12	83094	5	415470	25
	$\Sigma Y=$ 445882	$\Sigma X=0$	$\Sigma XY=$ 475163	$\Sigma X^2=$ 110

$A = \Sigma Y/N = 44588.2$
$B = \Sigma XY/\Sigma X^2 = 4319.66$
$Y = a + bX$
$Y = 44588.2 + 4319.66X.$

b) Now for comparison purpose the data is further analysis from financial year 2002-03 to 2010-11 instead of 2002-03 to 2011-12. It means leaving the data of year 2011-12. The same procedure is applied one by one. In Table 8, the data for 9 financial years is given instead of 10 as in Table 1.

Table 8.

Sr. No.	Financial Year	Profit Excluding Tax (in Rs. Millions)	Sales (Nos.)
1	2002-03	184	31547
2	2003-04	204	29741
3	2004-05	785	37859
4	2005-06	917	32475
5	2006-07	923	29673
6	2007-08	1202	36444
7	2008-09	1936	48654
8	2009-10	2714	54740
9	2010-11	3273	61655

Method 1: Applying Semi Average Method

Table 9: Forecasting by Semi Average Method for Profit and Sale.

Financial Year	Profit Excluding Tax	Semi Avg.	Sales	Semi Avg.
	(in Rs. Millions)		(Nos.)	Semi Avg.
2002-03	184		31547	
2003-04	204		29741	
2004-05	785	522.5	37859	32905.5
2005-06	917		32475	
2006-07	923		29673	
2007-08	1202		36444	
2008-09	1936	2281.25	48654	50373.25
2009-10	2714		54740	
2010-11	3273		61655	

Method 2: Applying Moving Average Method

Table 10: Forecasting by Moving Average Method for Sales and Profit.

Financial Year	Profit Excluding Tax	Moving Avg.	Sales	Moving Avg.
2002-03	184		31547	
2003-04	204	391	29741	33049
2004-05	785	635.3	37859	33358.3
2005-06	917	875	32475	33335.7
2006-07	923	1014	29673	32864
2007-08	1202	1353.7	36444	38257
2008-09	1936	1950.7	48654	46612.7
2009-10	2714	2641	54740	55016.3
2010-11	3273		61655	

Method 3: Least Square Method

Table 11: Forecasting by Least Square Method for Profit.

Financial Year	Profit Excluding Tax	X	XY	X^2
2002-03	184	-4	-736	16
2003-04	204	-3	-612	9
2004-05	785	-2	-1570	4
2005-06	917	-1	-917	1
2006-07	923	0	0	0
2007-08	1202	1	1202	1
2008-09	1936	2	3872	4
2009-10	2714	3	8142	9
2010-11	3273	4	13092	16
	$\Sigma Y=$ 12138	$\Sigma X=$ 0	$\Sigma XY=$ 22473	$\Sigma X^2=$ 60

$a = \Sigma Y/N = 1348.7$
$b = \Sigma XY/\Sigma X^2 = 374.55$
$Y = a + bX$
$Y = 1348.7 + 374.55X$

Table 12: Forecasting by Least Square Method for Profit.

Financial Year	Sale	X	XY	X^2
2002-03	31547	-4	-126188	16
2003-04	29741	-3	-89223	9
2004-05	37859	-2	-75718	4
2005-06	32475	-1	-32475	1
2006-07	29673	0	0	0
2007-08	36444	1	36444	1
2008-09	48654	2	97308	4
2009-10	54740	3	164220	9
2010-11	61655	4	246620	16
	$\Sigma Y=$ 362788	$\Sigma X=0$	$\Sigma XY=$ 220988	$\Sigma X^2=$ 60

$a = \Sigma Y/N = 40309$
$b = \Sigma XY/\Sigma X^2 = 3683.13$
$Y = a + bX$
$Y = 40309+3683.13X$

Now, finally after calculating the Profit after Taxes and sales the data is summarized in Table 13. The deviation for the forecasting is also calculated and given in Table 13.

Table 13: Summarize data for profit & sales forecast for the year 2011-12.

Forecast for Year 2011-12	**Profit**	**Sales**
Semi Avg.	2720.93	54740.2
Moving Avg.	4021.6	71823.5
Straight Line	3221.45	58724.6
Actual value	**Profit**	**Sales**
Financial Year 2011-12	**4413**	**83094**
Deviation in Percentage		
Semi Avg.	38.34	34.12
Moving Avg.	8.87	13.56
Straight Line	27	29.3

VI. RESULT AND DISCUSSION

As it is clear from the Table 13 that the forecast made using the moving average method is more accurate as compared to the other two techniques.
Reason for this conclusion is that the moving avg. method takes into consideration the latest trends of the data, whereas the other two methods consider the whole range of the data and the effect of previous trends do also matter in the forecast made by these methods and also these are statistical methods only and they cannot be 100% accurate.

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