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SELECTING APPROPRIATE FORECAST METHOD ON THE BASIS OF FORECAST ACCURACY - PHARMACEUTICAL COMPANY CASE STUDY

Abstract

Forecasting is an essential discipline in planning and running a business. Companies make forecast regarding sales, production cost and financial requirement of the business. Sales forecast is the most important since it is a foundation of all other forecasts. Companies' success depends, to a large extent, on the accuracy of this forecast. Therefore using the most appropriate forecast method is very important. The purpose of this paper is to provide an overview of three sales time-series forecasting methods: moving average, exponential smoothing and regression analysis and to present an approach for the most appropriate forecast method selection. The methods are presented using data of Alkaloid AD Skopje sales revenue for time period from 2001 to 2015. The most appropriate forecast method was determined on the basis of forecast accuracy which was measured through: Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE) and Mean Square Error (MSE).

Key words: sales forecasting, forecasting methods, time-series forecasting techniques.

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Introduction

One of the most important functions of managerial accounting is providing information for planning, control and performance measurement.¹ Planning, as the first management function, in today's complex and rapidly changing business climate is crucial for any organization's short-term and long-term success. Lack of planning or fundamental shortcuts in business planning is one of the seven top reasons why businesses fail.² Planning is closely related to forecasting and together they are considered to be the basis for rational decision-making.³ Forecast is a mere estimate of what is likely to happen. It is a statement of probable event which is likely to happen under anticipated conditions during specified period of time.⁴ Companies make forecast regarding sales, production cost and financial requirement of the business. Sales forecast is the most important because it is a foundation of all other forecasts, since all expenditure dependent on the volume of sales.⁵

Forecasting methods can be classified as qualitative or quantitative. Qualitative methods generally involve the use of expert judgment to develop forecasts. Such methods are appropriate when historical data on the variable being forecast are either not applicable or unavailable. Quantitative forecasting methods can be used when (1) past information about the variable being forecast is available, (2) the information can be quantified, and (3) it is reasonable to assume that the pattern of the past will continue into the future.⁶ Due to the existence of many factors that may influence the sales, each company has its own characteristics regarding forecasting. The decision as to what method to use depends on the available data, knowledge and experience of the decision maker.⁷

¹ Drury, C.: Management and Cost Accounting, 6th edition. Thomson Learning, London, Great Britain (2004), pg.19.

² Schaefer, P.: The Seven Pitfalls of Business Failure and How to Avoid Them. [Online]. Available at: <http://www.businessknowhow.com/startup/business-failure.htm>.

³ Kurzak, L.: Importance of Forecasting in Enterprise Management. Advanced Logistic Systems Vol. 6. No. 1. pp. 173-182. (2012).

⁴ The Institute of Company Secretaries of India: Cost and Management Accounting. New Delphi, India. (2013), pg. 422.

⁵ Drury, C.: Management and Cost Accounting, 6th edition. Thomson Learning, London, Great Britain (2004), pg. 598.

⁶ Anderson, D. R., Sweeny, D. J., Williams, T. A.: Modern Business Statistics with Microsoft Excel, 4th Edition – Cengage Learning (2012).

⁷ Oblak, L., Stirn, Z., Horvatin, M., Kuzman, K.: Choice of Quantitative Method for Forecasting of Parquet Sales. Drvna industrija, Vol. 63, No 4., Faculty of Forestry, Zagreb University, Zagreb, Hrvatska

In the ever-changing world of business being able to accurately forecast customer demand is of the utmost importance. Without accurate forecasts companies essentially waste resources by carrying either too much (i.e. overstocks) or too little (i.e. stock outs) inventory.⁸ Substantially understanding demand is likely to lead to many lost sales, unhappy customers, and perhaps allowing the competition to gain the upper hand in the marketplace. On the other hand, significantly overestimating demand also is very costly due to: excessive inventory costs, forced price reduction, unneeded production or storage capacity and lost opportunities to market more profitable goods.⁹ Inaccurate forecasting may lead to bad decisions that may lead, to ineffective management in overall.¹⁰ Therefore forecast error measurement is very important step in the forecasting process as well as in the forecast method selection process. Error measurement statistics play a critical role in tracking forecast accuracy, monitoring for exceptions, and benchmarking the forecasting process.

The purpose of this paper is to present forecast sales revenue for Alkaloid AD Skopje for year 2016 by using some of the time-series forecasting methods and to determine which of the used methods provide most accurate forecast.

1. DATA AND METHODOLOGY

This study uses data of annual sales of Alkaloid AD Skopje from 2001 to 2015. Alkaloid AD Skopje is the major pharmaceutical company in Republic of Macedonia. The data were collected from its income statements and used for sales forecast for year 2016. The study applies three sales forecasting methods: moving average, exponential smoothing and regression analysis. The most appropriate forecast method was determined on the basis of forecast accuracy which was measured through: Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE) and Mean Square Error (MSE). The forecast method and forecast accuracy determination methods are explained in the section below.

249–254 (2012).

⁸ Nadler, S., Kros, J, F.: Forecasting with Excel: Suggestions for Managers. Spreadsheets in Education (eJSiE), Volume 2, Issue 2, (2007).

⁹ Gor, R.M.: Industrial Statistics and Operational Management – Forecasting Techniques. (2009), e-book available at: <http://nsdl.niscair.res.in/jspui/handle/123456789/823>.

¹⁰ Sahu, P. K., Kumar, R.: The Evaluation of Forecasting Methods for Sales of Sterilized Flavoured Milk in Chhattisgarh. International Journal of Engineering Trends and Technology (IJETT) – Volume 8 Number 2 (2014).

1.1. Forecast methods

Moving average

This study applies three time-series forecasting methods: moving average, exponential smoothing and regression analysis.

Moving averages are considered to be the easiest method of quantitative forecasting to develop. This method involves calculating the average of observations and then employing that average as the predictor for the next period. The moving average method is highly dependent on n , the number of terms selected for constructing the average. The equation is as follows:

$$F_{t+1} = (Y_t + Y_{t-1} + Y_{t-2} + \dots + Y_{t-n+1})/n$$

Where:

F_{t+1} = the forecast value for the next period;

Y_t = the actual value at period t ;

n = the number of term in the moving average.

It is very important to select the best period for the moving average. In this study 3-years and 5-years moving average are applied.

Exponential smoothing

Exponential smoothing is another method of quantitative forecasting which use is slightly more complex than traditional moving average forecasts. Specifically, exponential smoothing combines a prior forecast with a weighted error measurement. This error measurement comes from the difference between the prior forecast and the actual observation at the time of the prior forecast. The equations for exponential smoothing follow this format:

$$F_{t+1} = F_t + \alpha (Y_t - F_t), \text{ or}$$
$$F_{t+1} = \alpha Y_t + (1 - \alpha)F_t$$

Where:

F_{t+1} = forecast value for period $t+1$;

Y_t = Actual value for period t ;

F_t = Forecast value for period t .

α = Alpha (a smoothing constant where $(0 \leq \alpha \leq 1)$)

The equation shows that the forecast for the next period will equal the forecast made for this period plus or minus an adjustment. The accuracy of the simple exponential smoothing method strongly depends on the optimal value of (α) . Alpha (α) should be a value between zero and one and it reflects how much weight is given to distant past values of y when making our forecast. A very low value of α (0.1 to 0.3) means that more weight is given to past values, whereas a high value of α (0.6 or higher) means that more weight is given to recent values and the forecast reacts more quickly to changes in the series. When estimating Alkaloid AD Skopje sales for 2014 we use three different values of α ($\alpha = 0,2$; $\alpha = 0,5$; $\alpha = 0,8$).

Regression analysis

A popularly used method to forecast sales and earnings is regression analysis, which is a statistical procedure for estimating mathematically the average relationship between the dependent variable y and the independent variable or variables x . Simple regression involves one independent variable, and can be presented with the following equation:

$$Y = a + bX$$

Where,

Y = Dependent variable;

X = Independent variable;

a = Y intercept;

b = Slope.

The regression method attempts to find a line of best fit through a technique called method of least squares.

When using least squares method for sales forecasting the dependent variable Y refers to sales and the independent variable X refers to time period i.e. the sales are observed as a function of time. In the least squares method the equations for a and b are as follows:

$$a = \bar{y} - b\bar{X}, \text{ and}$$
$$b = \frac{\sum Xy - n\bar{X}\bar{y}}{\sum X^2 - n\bar{X}^2}$$

1.2. Measuring Forecasting Error

Mean Absolute Deviation

This study uses three statistical error measures in order of determining forecast accuracy:

Mean Absolute Deviation (MAD) is the mean of the deviation of the forecast demands from the actual demands.

$$MAD = \frac{\sum_{t=1}^n (Y_t - F_t)}{n}$$

Where:

Y_t = the actual value in time period t ;

F_t = the forecast value in time period t ;

n = the number of periods.

Mean Absolute Percentage Error

A common method for measuring overall forecast error is the Mean Absolute Percentage Error (MAPE). The equation is:

$$MAPE = \frac{1}{n} \sum_{t=1}^n \frac{Y_t - F_t}{Y_t}$$

Where:

Y_t = the actual value in time period t ;

F_t = the forecast value in time period t ;

n = the number of periods.

Mean Square Error

Mean Square Error (MSE) measures the average of the squares of the “errors”, and is calculated by the following formula:

$$MSE = \frac{1}{n} \sum_{t=1}^n (Y_t - F_t)^2$$

Where:

Y_t = the actual value in time period t ;

F_t = the forecast value in time period t ;

n = the number of periods.

2. RESULTS AND DISCUSSION

Table 1 presents Alkaloid AD Skopje sales forecast as a result of 6 forecast models: 3-years moving average, 5-years moving average, exponential smoothing with $\alpha=0,8$, exponential smoothing with $\alpha=0,2$, exponential smoothing with $\alpha=0,5$ and linear regression model. Exponential smoothing model with α value of $0,8$ estimates lowest value for 2016 sales (5.986 millions) and linear regression model estimates highest sales value (8.117 millions).

Table 1: Prediction of sales for Alkaloid AD Skopje (in million denars)

Year	Sales	Prediction					
		3-years MA	5-years MA	ES-0,2	ES-0,5	ES-0,8	LR
2001	3,183						2,372
2002	3,431	#N/A	#N/A	#N/A	#N/A	#N/A	2,755
2003	3,196	#N/A	#N/A	3,183	3,183	3,183	3,138
2004	3,167	3,270	#N/A	3,381	3,307	3,233	3,521
2005	3,250	3,265	#N/A	3,233	3,252	3,225	3,904
2006	3,536	3,204	3,245	3,180	3,209	3,214	4,287
2007	4,023	3,318	3,316	3,236	3,230	3,221	4,670
2008	4,726	3,603	3,434	3,476	3,383	3,284	5,053
2009	5,466	4,095	3,740	3,914	3,703	3,432	5,436
2010	5,934	4,738	4,200	4,564	4,214	3,691	5,819
2011	6,738	5,375	4,737	5,286	4,840	4,046	6,202
2012	6,789	6,046	5,377	5,804	5,387	4,423	6,585
2013	7,098	6,487	5,931	6,551	6,063	4,886	6,968
2014	7,398	6,875	6,405	6,741	6,426	5,267	7,351
2015	7,860	7,095	6,791	7,027	6,762	5,633	7,734
2016		7,452	7,177	7,324	7,080	5,986	8,117

Source: Author's calculations

The most appropriate forecast method in this study was selected on the basis of forecast accuracy. The accuracy of the forecast method was assessed using Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE) and Mean Square Error (MSE). The values of MAD, MAPE and MSE for the methods applied in this study are presented in Table 2. The mean errors are computed only for the last seven time periods, from 2009 to 2015, as recommended by Gor (2009).¹¹ Gor recommends dividing the data into two parts when evaluating forecasting models. The first part is used to fit the forecasting model and it is referred as warm-up sample. The second part of the data is used to test the model and is called forecasting sample. Accuracy in the warm-up sample is really irrelevant. Accuracy in the forecasting sample

¹¹ Gor, R.M.: Industrial Statistics and Operational Management – Forecasting Techniques. (2009), e-book available at: <http://nsdl.niscair.res.in/jspui/handle/123456789/823>, pg. 161.

is more important because the pattern of the data often changes over time. The forecasting sample is used to evaluate how well the model tracks such changes.

Table 2: Forecast error measurement

Method	MAD	MAPE	MSE
0,2 ES	743	10.96%	724,372
5 years MA	1,196	17.60%	1,784,779
3 years MA	835	12.33%	911,711
0,5 ES	1,161	17.07%	1,678,125
0,8 ES	1,982	28.70%	4,610,128
LR	165	2.42%	53,865

Source: Author's calculations

Table 2 show highest values of the mean forecast errors of exponential smoothing model with alpha value 0,8. The lowest values of the mean forecast errors are detected in the linear regression model. The model with the lowest forecast error is considered as the most accurate.

Conclusion

Forecasting is an essential discipline in planning and running a business. Companies make forecast regarding sales, production cost and financial requirement of the business. Sales forecast is the most important because it is a foundation of all other forecasts, since all expenditure dependent on the volume of sales. In the ever-changing world of business being able to accurately forecast customer demand is of the utmost importance. Companies' success depends, to a large extent, on getting that forecast right.

In this study six methods were used for forecasting Alkaloid AD Skopje sales. The most appropriate forecast method was identified on the basis of its accuracy. The results show that linear regression model obtained the best accuracy and it is selected as the most appropriate for Alkaloid AD Skopje sales forecasting. The actual sales of Alkaloid AD Skopje of 8,293 million denars for 2016 confirm our findings.

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