MATHEMATICS FOR FORECASTING GOLD PRICE

Abstract

This work concentrates on forecasting model and highlights the role and importance of forecasting in current business environment. Forecasting allows the organizations to plan their activities as per the resources available. The research mainly highlights the quantitative technique exponential smoothing analysis of forecasting which is more accurate than qualitative techniques. This technique used in this research helped the researcher to forecast the price of gold for forthcoming years. Thus, the readers will have a concrete idea about the price of Gold in coming years. Our model suggested for year 2023 estimated gold price is Rs. 47695.60. The investor has clear opportunity to invest in gold market as the price of the Gold may reduce.

Keywords: Forecasting; quantitative techniques; qualitative techniques; Exponential Smoothing Analysis

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I. INTRODUCTION

Forecasting is the process of predicting the future values and trends. It allows organizations to be more proactive than receptive. The process of forecasting affects every area or department of organization in numerous ways [1]. A major purpose of forecasting is to give us choice of alternative plan, design, and backup resources so that strategic decisions can be taken for the growth of an organization. It tries to find out how much the service or the products the customers will buy. To forecast different products or service, it involves different tools, techniques and methods which may be quantitative or qualitative in nature. Organization may use forecasting to make decisions regarding price, or should the company enter a new market zone or not [2]. Predicting how much of a product the customer will purchase is the essential to demand management. Forecasting is dedicated to short term production scheduling, thus helping logistics to coordinates product demand with production input availability and timing in order to meet customer delight. Following are the reasons of use of forecasting techniques by the companies:

- Increasing the delight of customer.
- Taking steps to decrease stock outs.
- Decreasing the levels of Buffer stock which organization may need.
- Proper Scheduling operations efficiency.
- Decreasing service or product cost of obsolescence.
- To Manage the policy of pricing as well as promotion in an optimum way
- Improving logistics and other activities of the firm.

Many researchers used forecasting models for predicting the future values in many areas [3-10].

II. METHODOLOGY

1. **Research problem:** The research problem considered for the research was the price fluctuations which occurs in the market. So, to overcome these fluctuations an attempt is made by the author to apply exploratory research which has proved a vital role in understanding the concept of forecasting and applications of Mathematical techniques in the business and Management. Also, the approach undertaken was descriptive as well as analytical in nature so that the result of application is understood in an appropriate way.

2. **Objectives of studies**
   - To study the forecasting methodology for prices of gold in commodity market India
   - Apply quantitative techniques of forecasting to the gold prices
   - Analysis of the results achieved

3. **Scope of study:** The scope of study is restricted to only one commodity namely gold. Also, the scope of research is restricted to one technique of forecasting.

4. **Research design:** The Research design formulated by the researcher was Exploratory and Descriptive in nature.

5. **Method of data collection:** For the intension to complete the research on the said domain, the method used for data collection was Secondary method of data collection. The data collected was secondary published data from the internet source namely, bankbazaar where gold-rate, the trend of published prices from 2000 to 2022 except 2006 in india was collected as on july 2022. Also, the one year 2006 data was collected from times of india, indiatimes, for gold-price. This authetic data was formed the base for futher analysis.

6. **Statistical and mathematical mode:** For the purpose of completing the research an attempt is made by the researcher to use one of the prominent quantitative techniques of forecasting which is popularly known as exponential smoothing analysis. This is some other time collection forecasting method the place the forecast for the subsequent length is calculated as 'weighted average method' of all preceding values. A forecasting technique for univariate time series data is exponential smoothing. With this strategy, forecasts are weighted averages of historical observations, with the weights of older observations decreasing exponentially. For each observation, this procedure updates the level component. It only requires one weighting parameter, alpha (α), because it only models one component. The amount of smoothing is controlled by this variable by altering how quickly the level component catches up with the most recent data.

The range of possible alpha values is 0 to 1, inclusive. Because they average out changes over time, lower values give greater weight to historical observations and generate smoother fitted lines. Higher values limit the degree of averaging by the earlier data, which results in a more jagged line since they place a higher emphasis on the current data. Analysts can choose the value of alpha using their discretion. Typically, we want to smooth the data in order to capture the underlying pattern and lessen the erratic fluctuations (noise). We don't want to smooth things out too much because we can miss important details. However, while selecting alpha, consider subject-area expertise and industry norms. Usually, a default value is set at 0.2.

It is based totally on the precept that the latest values are the most vital for predicting the future value. Also, it presumes that values prior to the cutting-edge fee are additionally applicable however in a declining significance as we go again in time. The equation 1 is given as follows:

$$Y^1_{t+1} = \alpha\, y_t + (1 - \alpha)\, Y^1_t \quad \text{---(1)}$$

Were,

Y^1_{t+1} = Represents the new demand to be forecasted

Y^1_t = It represent the old demand which is based on weighted mean

y_t = Previous actual value

α = Smoothing value or constant, such that $0 < a < 1$

If the value of α is not given it is assumed to be 0.2

III. RESULT AND ANALYSIS

A statistical technique projection about the future which uses numerical facts is known as the quantitative method. There are many quantitative techniques but in this research the author has used analyses the data using Exponential Smoothing Analysis.

Table 1: Prices of Gold[11][12]

Year	Prices (Rs.)
2000	4400
2001	4300
2002	4990
2003	5600
2004	5850
2005	7000
2006	9870
2007	10800
2008	12500
2009	14500
2010	18500
2011	26400
2012	31050
2013	29600
2014	28006.50
2015	26343.50
2016	2862350
2017	29667.50
2018	31438
2019	35220
2020	48651
2021	48720
2022	52690
2023	?

The above data was analyzed using Exponential smoothing analysis, since we need to forecast for 23rd year as discussed below from equation 2 to equation 8.

$$t + 1 = 23 \quad \text{--(2)}$$

Therefore, $t = 22$

Substituting in the above formula we get,

$$Y^1_{t+1} = ay_t + (1 - a) Y^1_t \quad \text{--- (3)}$$

$$Y^1_{23} = 0.2 (52690) + (1 - 0.2) Y^1_{22} \quad \text{--(4)}$$

$$Y^1_{22} = \frac{1(35220) + 2(48651) + 3(48720)}{1 + 2 + 3} \quad \text{---(5)}$$

$Y^1_{22} = 46447$ --(6)

Thus, we have $Y^1_{23} = 0.2 (52690) + (1 - 0.2) 46447$ --------------------------(7)

$Y^1_{23} = 47695.60$ --(8)
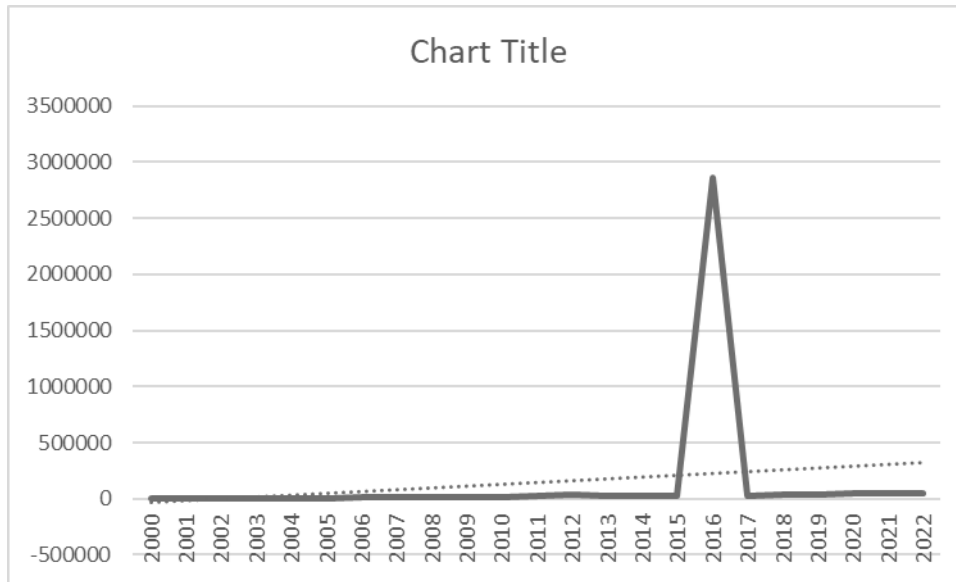

Figure 1*: Time series Plot of Prices of Gold*

The above graph depicts the trend of the gold prices in India from 2000 to 2022. The above Time Series plot highlights the stability of prices from 2000 to 2015. But from 2016 till 2017 there is a sharp increase of prices. After 2017 again the prices are almost stagnant within a particular range.

IV. CONCLUSION

The chapter has given a depth of understanding the concept of Exponential smoothing analysis as one of the prominent techniques of forecasting with applications. Since the market of Gold is volatile, it was imperative for the researcher to predict the price of Gold in India in relation to the prices prevailing in the previous years. Thus, the readers will have a concrete idea about the price of Gold in 2023 which is estimated to Rs. 47695.60. The investor has clear opportunity to invest in gold market as the price of the Gold will reduce. Thus, the mathematical modelling namely Exponential smoothing analysis may be used further also for other commodities to predict a specific parameter of the commodity. The following are the limitations of the proposed work. The future work direction suggests to concentrate on resolving the below limitations.

- This work is limited to small data.
- Time and certainly cost are the limitations.
- Only exponential smoothing analysis was used as a techniques and others techniques were not considered.

REFERENCES

[1] Arrow, Kenneth J., and William M. Capron 1959 " Dynamic shortages and price rises: The engineer-scientist case," Quarterly Journal of Economics (May): 292-308.

[2] Armstrong, J. Scott 2001. "Combining Forecasts." In Principles of Forecasting, edited by J Scott Armstrong, Kluwer Aca, 1–19. Norwell, MA: Kluwer.

[3] A. Pavate, A. Chaudhary, P. Nerurkar, P. Mishra and M. Shah, "Cuisine Recommendation, Classification and Review Analysis using Supervised Learning," 2020 International Conference on Convergence to Digital World - Quo Vadis (ICCDW), 2020, pp. 1-6, doi: 10.1109/ICCDW45521.2020.9318646.

[4] A. Pavate and N. Ansari, "Risk Prediction of Disease Complications in Type 2 Diabetes Patients Using Soft Computing Techniques," 2015 Fifth International Conference on Advances in Computing and Communications (ICACC), 2015, pp. 371-375, doi: 10.1109/ICACC.2015.61.

[5] Nerurkar, P., Pavate, A., Shah, M., Jacob, S. (2019). Analysis of Probabilistic Models for Influence Ranking in Social Networks. In: Iyer, B., Nalbalwar, S., Pathak, N. (eds) Computing, Communication and Signal Processing . Advances in Intelligent Systems and Computing, vol 810. Springer, Singapore. https://doi.org/10.1007/978-981-13-1513-8_23

[6] U. Rathod, A. Pavate and V. Patil, "Product Rank Based Search Engine for E-Commerce," 2018 3rd International Conference for Convergence in Technology (I2CT), 2018, pp. 1-5, doi: 10.1109/I2CT.2018.8529503.

[7] Aruna Pavate, Dr. Rajesh Bansode, Dr. A. Prasanth. (2021). Explore and Analysis of Methods to Train CNN in Machine Learning Environment. Annals of the Romanian Society for Cell Biology, 14750–14761.

[8] Brown, Robert G. (1956). Exponential Smoothing for Predicting Demand. Cambridge, Massachusetts: Arthur D. Little Inc. p. 15.

[9] Holt, Charles C. (1957). "Forecasting Trends and Seasonal by Exponentially Weighted Averages". Office of Naval Research Memorandum. 52. reprinted in Holt, Charles C. (January–March 2004). "Forecasting Trends and Seasonal by Exponentially Weighted Averages". International Journal of Forecasting. 20 (1): 5–10. doi:10.1016/j.ijforecast.2003.09.015

[10] Makridakis, Spyros & Wheelright, Steve & Hyndman, Rob. (2000). Manual of Forecasting: Methods and Applications. 10.13140/RG.2.1.2528.4880.

[11] https://www.bankbazaar.com/gold-rate/gold-rate-trend-in-india [accessed on dated july 2022]

[12] https://timesofindia.indiatimes.com/city/kanpur/gold-prices [accessed on dated july 2022]

[13] Winters, P. R. (April 1960). "Forecasting Sales by Exponentially Weighted Moving Averages". Management Science. 6 (3): 324–342.