

FORECASTING TECHNIQUE OF TIME SERIES ANALYSIS

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Science Degree in Mathematics

BY

SNEHA.B (38060011)



**DEPARTMENT OF MATHEMATICS
SCHOOL OF SCIENCE AND HUMANITIES**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

APRIL– 2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
SNEHA.B(38060011) who carried out the project entitled "**FORECASTING
TECHNIQUE OF TIME SERIES ANALYSIS**" under our supervision from
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DECLARATION

I **SNEHA.B** hereby declare that the Project Report entitled “**FORECASTING TECHNIQUE OF TIME SERIES ANALYSIS**” done by me under the guidance of **Dr.M.Mallika**(Internal) at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfillment of the requirements for the award of Bachelor of Science Degree in Mathematics.

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr.M.Nirmala**, Head of the Department, Department of Mathematics for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr.M.Mallika** for her valuable guidance, suggestions, and constant encouragement that paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Mathematics who were helpful in many ways for the completion of the project.

ABSTRACT

Historically, gold has been identified as a unique commodity because of its ability to act as a hedge against inflation and its stability during periods of financial volatility and crises. Tracing the trends in Gold prices and conducting a price forecast is relevant from the point of view of Gold producers, investors, and various central banks in the world. Time series analysis is a popular forecasting method for predicting the future value of variables. Time series forecasting techniques attempt to account for changes in the variable over time by examining trends. This technique also uses historical data to predict the future value of a variable. The objective of this study was to develop a suitable forecasting model for the price of gold. MA (Moving Average) model has been used in this project for Gold price forecasting. Data on yearly average gold prices for the period 1964 – 2019 were used to develop a suitable forecasting model.

KEYWORDS

Gold prices, Time Series, Forecasting model, Moving Average, MAPE.

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LIST OF ABBREVIATIONS

MA - Moving Average

MLR - Multiple Linear Regression

ARIMA - Autoregressive Integrated Moving Average

MAPE - Mean Absolute Percentage Error

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CHAPTER 1

INTRODUCTION

Gold is much more than a precious metal for Indians and we purchase it for festivals, weddings, and several other important life events. Gold is identified as a unique commodity because its usefulness is derived from a diversity of special properties. Historically man has identified that Gold is a more useful mineral out of all minerals that are mined from the Earth. Alloying gold with other metals can change the colour of the finished product. Based on the value of gold and limited supply it has been used as a medium of exchange. Gold is a highly efficient conductor which can pass tiny currents and remain free of corrosion. Electrical components which are made of Gold are reliable. It is used in computers to transfer digital information from one component to another component with high speed and accuracy. Gold is used in some surgical treatments, as a drug to treat a small number of medical conditions, diagnosis of health conditions, etc. The prices of gold were predicted using the Moving Average model. The price of gold has increased with rapid growth in the year 2020 due to Covid 19 and the impact on the global economy. In this project, gold prices were forecasted by considering the data from 1964 - 2019. According to the world council, the demand has decreased 36% due to lockdown, volatile prices, and economic uncertainties in the first quarter of the year 2020. Many factors are responsible for the rise of gold prices in India such as traditional demand, no liability on the investors, inflation-proof, low-interest rate on most of the saving schemes, safe investment tools.

1.1 TIME SERIES

Time series is a sequence taken at successive equally spaced points in time. A time series is a series of data points indexed in time order. Most time-series data are composed of four components – Trend, Seasonality, Cyclical, and Irregular components. The trend is defined as the long-term general movement of data. Cycles are patterns of highs and lows through which data move. Seasonal effects are shorter cycles measured over months or quarters. They are generally measured over a year. Irregular fluctuations are rapid changes that are unexplained e.g. Changes in trend due to riots or other unforeseen circumstances. Time series data that contain no trend, cyclical, or seasonality effects are said to be stationary. It allows management to understand timely patterns in data and analyze trends in business metrics. By tracking past data, the forecaster hopes to get a better than average view of the future. Time series data have a natural temporal ordering. A stochastic model for a time series will generally reflect the fact that observations close together in time will be more closely related than observations further apart. Also, time series models will often make use of the natural one-way ordering of time so that values for a given period will be expressed as deriving in some way from past values, rather than from future values. Examples: Heartbeat of a person, daily stock exchange index, monthly rainfall data, yearly sales of a commodity, etc.,

1.2 TIME SERIES ANALYSIS

Time series analysis comprises methods for analyzing time-series data to extract meaningful statistics and other characteristics of the data. Time series forecasting is the use of a model to predict future values based on previously observed values. In Time series analysis, we collect and study past observations of time series data. The development of an appropriate model that describes the inherent structure of the series. This model is then used to generate future values for the series, that is, to make forecasts. Time series analysis can be termed as the act of predicting the future by understanding the past. Forecasting is a common need in business and economics. Besides forecasting, Time series analysis is also useful to see how a single event affects the time series. Time series analysis can also help towards quality control by pointing out data points that are deviating too much from the normal. Control and monitoring applications of Time series analysis are more common in science and industry. Time series analysis can be useful to see how a given asset, security, or economic variable changes over time. It can also be used to examine how the changes associated with the chosen data point compare to shifts in other variables over the same period. Time series forecasting uses information regarding historical values and associated patterns to predict future activity. Forecasting is used in many fields like meteorology, medicine, stock price, business...etc.

1.3 ADVANTAGES OF TIME SERIES ANALYSIS

Historical data used in time series tests represent conditions reporting along with a progressive, linear chart. The first benefit of time series analysis is that it can help to smoothen the data. This makes it possible to find the true "signal" in a data set, by filtering out the noise. This can mean removing outliers or applying various averages to gain an overall perspective of the meaning of the data. The time series method of forecasting is the most reliable when the data represents a broad period. Information about conditions can be extracted by measuring data at various time intervals such as hourly, daily, monthly, quarterly, annually, or at any other time interval. Quantitative and qualitative methodologies for forecasting help managers to develop business goals and objectives. The time series method is a useful tool to measure both financial and endogenous growth. The impact of policy variables, for instance, can be evidenced through time series tests. The time series method is useful to measure both endogenous and financial growth. Endogenous growth is the development from within an organization's internal human capital that leads to economic growth. For example, the impact of policy variables can be evidenced through time series analysis. This rudimentary model is powerful in smoothing out data sets to observe their overall trend, with little regard for outlying data points. However, it may smooth out the seasonality of some timeseries. The goal of the time series method is to identify meaningful characteristics in the data that can be used in making statements about future outcomes.

1.4 IMPORTANCE OF GOLD

Gold has a deep-rooted significance in Indian history, alluring people from different parts of the world with its beauty and charm. Many people think that Indians are gold crazy. Though this statement cannot be completely negative, the truth is that gold has always had a special significance for all ages. Traditionally, gold has been considered auspicious among Hindus and is regarded to be symbolic of the Goddess of Wealth. Gold is a symbol of perfection, immortality, and prosperity; it is the substance that myths and legends are made of. It is a favourite for making jewellery, for the reason that it is anti-rust and has an everlasting shine.

Kanchipuram in southern India and Varanasi in northern India has been the centre of gold jewellery making since historic times. Gold has been used in the making of brocades and weaving. Gold lends itself as a commemorative medium to various engagements like golden anniversaries, golden jubilee, gold medals, gold credit cards, etc. In India, people buy gold anytime and not only during special occasions like weddings, festivals, or special events. Gold is also offered to Indian deities. People buy gold for a variety of reasons such as for its auspicious sentiment as an investment (gold continues to command long term value, a tag for being a haven); hedge against inflation; asset allocation etc., Gold also carries a high perceived value and a high emotional quotient. It reinforces the closeness of relationships. Gold coins in smaller denominations are also considered apt for corporate gifting and rewards for contests or commemorative giveaways.

1.5 ADVANTAGES OF GOLD FORECASTING

Gold is not only valued as an ornament but metal is also a popular form of investment in India. Most of the families treasure gold for ages passing it on from one generation to another as a form of asset. Most investors use it as a hedging instrument rather than as an investment. The value of gold tends to rise in line with the cost of living. When inflation is high, prices, rise, stocks fall, and the value of currency declines. Most currencies have depreciated against gold over time. That's why people like to invest in gold. While most asset classes lose value during a geopolitical crisis, the price of gold tends to rise during such periods. Investors see gold as a safe investment at times when geopolitical risk is high. Forecasting is based on complex calculations; historical periods are used to determine future demands. This gives a planner a guide to future demand. It is impossible to attain an accurate forecast. Therefore, planner's knowledge of the future is important in determining the product's future demand. The usefulness of an accurate forecast is that it enables the supplier to plan its strategy tactfully. Also, it allows for the limited flexibility to reschedule resources. Hence, the inability to maintain an accurate forecast can result in a decrease in sales, customers, excess inventory which may result in loss of goods and other inefficiencies. Other than that, the benefit of maintaining an accurate forecast is that it helps in capacity planning and setting strategic initiatives. The most singular and valid reason that places gold in the upper region is the fact that in the market, gold's value never faces a drawback. The prices always go up on a rollercoaster that does not come down. This is the sole reason that has attracted millions of people into investing in it to procure higher returns in the distant future.

CHAPTER 2

LITERATURE SURVEY

Literature survey or review of literature shows various studies, analysis and research made in the field of the research topic of interest and the results already published, taking into account the various parameters. It also helps in the wider applicability of the models in the area of research. Various methodologies have been used by the researchers all over the world and some of the methods were discussed below.

Anand Ashesh and Piyush Dharnidharka (2012) in their paper carried out a study about forecasting gold prices using time series analysis. They have used Box - Jenkins methodology to forecast the monthly average gold prices. Monthly average gold price data for the period January 2012 to June 2012 was taken for analysis.

Aye, Godness et, al (2014) in their working paper titled "Forecasting the Price of Gold Using Dynamic Model Averaging" attempted to examine the possible factors influencing the price of Gold. Based on the study it was identified that the exchange rate factor and financial stress index have more impact on the gold prices than any other variables. It was also revealed that the exchange rate factor has the maximum impact on gold prices.

Abdulla, Lazim (2012), conducted a study using Autoregressive Integrated Moving Average (ARIMA) model to forecast gold prices. This study was done in the context of the Malaysian economy by taking daily selling Malaysian gold coin prices from 2002-2007. This study was mainly conducted to assess the investment potential of gold coins. Based on the study they concluded that the ARIMA model is not suitable for making gold price forecasting because of the influence of too many factors on gold prices.

Ismail (2009) carried out Gold price forecasting using the Multiple Linear Regression (MLR) method. MLR was done with London PM Fix Gold Prices as the dependant variable and Inflation Rate, Money supply, Dollar-Euro exchange Rate, New York Stock Exchange Index, Standard, and Poor Index, Reuters Commodity Research Bureau Future Index, Treasury Bill, and UD Dollar Index as independent variables.

Shafiee, Shahriar, and Erkan Topal (2010) developed a model for Gold price forecasting by using historical gold prices from January 1968 to December 2008. This model identified three components that were very important in influencing the gold price movements. The influence of these three components was validated with historical gold prices and the model was used to predict the gold price for the next 10 years.

Rebecca Davis, et.al (2014) in their paper “Modeling and Forecasting of Gold Prices on Financial Markets” has conducted a study on Gold price forecasting using the ARIMA model. The monthly adjusted price of Gold during the period January 2003 to April 2012 was used for analysis. The fitted ARIMA model was used for a six-step ahead forecast. The forecasted values were compared with the actual to understand forecasting accuracy.

M.G Deepika, Gautam Nambiar, and Rajkumar M (2012) in their paper identified that the short run and long run gold prices exhibited diverging trends. Therefore, they used two different methods to forecast the price of gold in the short run and long run. Short-run gold price forecasting was done using time series modeling and long-run price forecast using multiple regression analysis. Their study was based on the gold price data for the period from 1980 to 2012. Based on their study they concluded that ARIMA is not a suitable model for predicting gold prices. Therefore, they have to use the multiple regression model to analyze the influence of various factors in deciding gold prices.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

The main objective of this project was to develop a suitable forecasting model for the price of gold. Gold price data of India for a period of 55 years from 1964-2019 is considered as a dataset. The major hypothesis in analyzing the price oscillations in different markets (goods, stocks, financial markets, etc.) is the accidental nature of the market. We know that one of the reasons for gold price change is the external effects such as economic policies, environmental conditions, and cultural factors. One general assumption made in such cases is that the historical data incorporates all those behaviour. As a result, the historical data is the major input to the prediction process. There are several forecasting techniques available that are developed mainly based on different assumptions, mathematical foundations, and specific model parameters. However, for better results, it is important to find the appropriate technique for a given forecasting task. In this project work, the gold prices were forecasted using the Moving Average method and then calculated the forecasting error and come to a conclusion about the model which best fits the prediction of gold prices. There is scope for further research wherein the model can be applied using daily gold price data and this model can be used to estimate the prices of gold in the future.

CHAPTER 4

METHODOLOGY

4.1 MOVING AVERAGE

MOVING AVERAGE model is one of the powerful statistical methods to forecast the time series data. A moving average (MA) is a stock indicator that is commonly used in technical analysis. The reason for calculating the moving average of a stock is to help smooth out the price data over a specified period by creating a constantly updated average price. Calculating a moving average involves creating a new series where the values are comprised of the average of raw observations in the original time series. A moving average is defined as an average of a fixed number of items in the time series which move through the series by dropping the top items of the previous averaged group and adding the next in each successive average.

The forecast value is given by

$$F_t = \frac{A_{t-1} + A_{t-2} + \dots + A_{t-n}}{n}$$

where,

F_t = forecast for the period 't', n=number of terms to be averaged and

$A_{t-1}, A_{t-2}, A_{t-3}$ are the actual values for the periods t-1, t-2, t-3 and so on. 'n' is called the 'period of moving average'.

4.1.1 PERIOD OF MOVING AVERAGE

The number of terms to be considered to calculate the average has to be decided and that is called the period of the moving average. The length of a moving average period means how many bars are used for calculating the moving average. When you are selecting a moving average period length, you are deciding how far back to the history you want to look. It can be 2-yearly, 3-yearly, 4-yearly, 5-yearly moving average, and so on. For example, a moving average with a period of 10 will be calculated by adding up the closing prices of the last 10 bars and dividing the sum by 10. As the result, the value of the moving average represents the average closing price of the last 10 bars. The shorter the period used to create the average, the more sensitive it will be to price changes. The longer the time, the less sensitive the average will be. Investors may choose different periods of varying lengths to calculate moving averages based on their trading objectives. Shorter moving averages are typically used for short-term trading, while longer-term moving averages are more suited for long-term investors. There is no correct time frame to use when setting up your moving averages. The best way to figure out which one works best for you is to experiment with some different periods until you find one that fits your strategy.

4.1.2 IMPORTANCE OF MOVING AVERAGE

Moving averages are pervasive in the technical stock market analysis because they can smooth price data, form trend lines, and create an easily interpreted visual aid. Developed as a statistical tool for use in conjunction with data sets that span a specific period, moving averages have proven to be well-suited for price charts and other indicators. Simple moving averages (SMAs) are calculated by the sum of data points in a time interval divided by the number of periods therein. Their most basic function is to create a series of average values of different subsets of the full data set. A natural complement to any time series interpretation, a moving average can smooth out the noise of random outliers and emphasize long-term trends. Technical analysts and stock market traders use moving averages in an enormous number of tools, many of which would not be possible without their application. Few indicators have been as reliable. Moving averages provide important information regarding the direction of the market. In the current generation of high-speed computer calculations, its use has become much more relevant and simplified. Moving averages are used not only to identify the direction of the trend but also for trade entry. Moving average is used for forecasting goods or commodities with constant demand, where there is a slight trend or seasonality. Moving average is useful for separating random variations. A moving average can help you identify areas of support and resistance. Moving average gives constant forecasts. Moving average crossovers have subsequently become the focus of an entire subset of technical indicators.

4.2 ERROR MEASURE

The measurement error is defined as the difference between the true or actual value and the measured value. The true value is the average of the infinite number of measurements, and the measured value is the precise value. In statistics, an error is not a "mistake". The gross error occurs because of human mistakes. For example, consider the person using the instruments takes the wrong reading, or they can record the incorrect data. Such type of error comes under the gross error. The gross error can only be avoided by taking the reading carefully. Environmental errors are due to the external condition of the measuring devices. Such types of errors mainly occur due to the effect of temperature, pressure, humidity, dust, vibration, or because of the magnetic or electrostatic field. The measurement error is the result of the variation of measurement of the true value. Usually, Measurement error consists of a random error and systematic error. Theoretical errors are caused by the simplification of the model system. For example, a theory states that the temperature of the system surrounding will not change the readings taken when it does, then this factor will begin a source of error in measurement. The measured value can be defined as the estimated value of true value that can be found by taking several measured values during an experiment.

4.2.1 MEAN ABSOLUTE PERCENTAGE ERROR (MAPE)

MAPE is the most common measure used to forecast error.

$$MAPE = \frac{1}{N} \sum \left| \frac{A - F}{A} \right| * 100$$

Here A= Actual value, F= Forecast value, N= Number of observations.

MAPE is the mean or average of the absolute percentage errors of forecasts. Error is defined as actual or observed value minus the forecasted value. Percentage errors are summed without regard to sign to compute MAPE. This measure is easy to understand because it provides the error in terms of percentages. Also, because absolute percentage errors are used, the problem of positive and negative errors cancelling each other out is avoided. Consequently, MAPE has managerial appeal and is a measure commonly used in forecasting. The smaller the MAPE the better the forecast.

CHAPTER 5

RESULTS AND DISCUSSIONS

The first and the most important step in any time series analysis is to plot the observation against time. This graph is called a time series plot. It will show important features of the series such as trend, seasonality, outliers, and discontinuities. The plot is vital both to describe the data and to help in formulating a sensible model. The time series plot of the given dataset is shown in figure 5.1

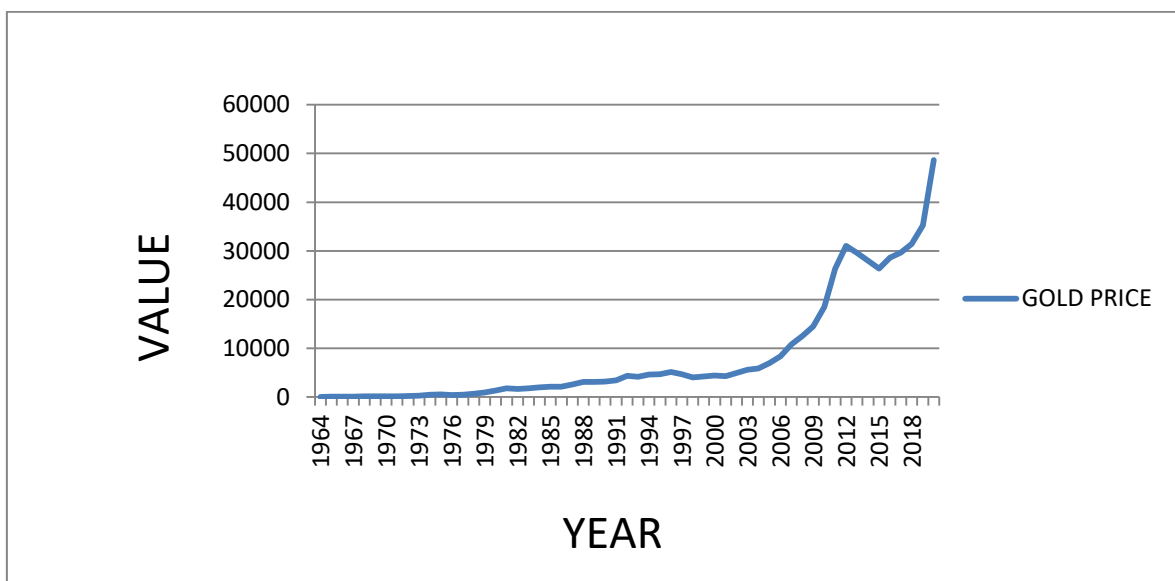


FIGURE 5.1: TIME SERIES PLOT OF ANNUAL GOLD PRICES OF INDIA

In this project work, the period of the moving average is taken from 2 to 10. The prices of Gold in India are increased over some time. It has increased from Rs.

63.25 per 10 grams of 24-carat gold to Rs. 35,220 per 10 grams for the period 1964 to 2019. Using the Moving Average technique, the gold prices for the period 1964 to 2019 are estimated and using these values forecasting errors were calculated by using error measure MAPE. Using error measure MAPE, 2 – yearly is considered as best. The results of the research show that the primary data are not stationary. The initial data graph shows that the average price of gold is changing. This trend can be explained as a result of the sensitivity of other investment instruments to the fluctuations of the price of gold. Nevertheless, the investment in gold stock is considered to be the riskiest since the prices of the gold stock rise and fall faster than the price of gold. The investment in gold funds and mutual funds is usually considered more effective than the investment in any physical form of gold because investors do not face the problems of gold storage.

The Moving Average for the gold price data from 2 yearly to 10 yearly are calculated for these Moving Average values the MAPE value is calculated. These values are tabulated in the following table 5.1

TABLE 5.1: MAPE VALUES

MA (2 Yearly)	16.59407
MA (3 Yearly)	19.86405
MA(4 Yearly)	23.19049
MA(5 Yearly)	25.98376
MA(6 Yearly)	28.85235
MA(7 Yearly)	31.58517
MA(8 Yearly)	34.13456
MA(9 Yearly)	36.58497
MA(10Yearly)	38.7312

Among the yearly averages, 2 yearly is considered as the best based on the MAPE value which is obvious from the table. For this 2 yearly Moving Average, the graph of the actual and predicted value of the gold price is shown in figure 5.2

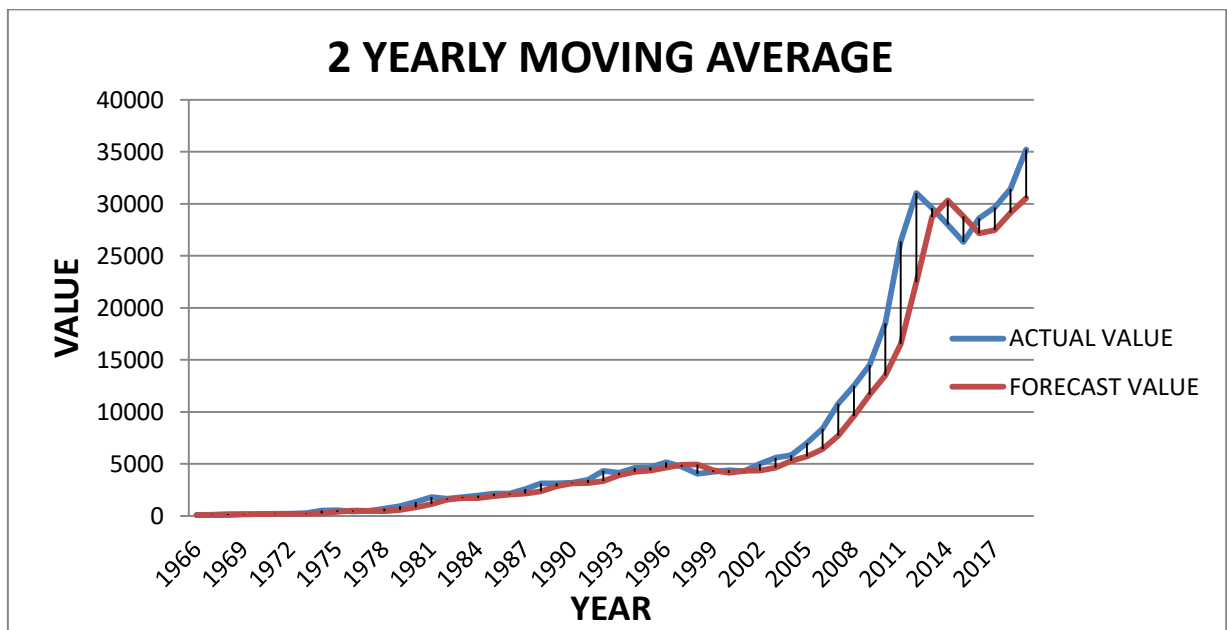


FIGURE 5.2: GRAPH OF ACTUAL AND PREDICTED VALUES OF ANNUAL GOLD PRICES OF INDIA USING MA (2 YEARLY)

SUMMARY AND CONCLUSIONS

This project mainly aims to investigate and carry out the prediction of the future international gold price to determine the most accurate and appropriate model for forecasting. The prices of Gold in India are increased over some time. It has increased from Rs. 63.25 per 10 grams of 24-carat gold to Rs. 35,220 per 10 grams from 1964 to 2019. But we observed the rapid growth in the year 2020 due to the influence of several factors. In this project, forecasts were achieved using the Moving Average model. Finally, in the short term, gold prices are negatively related to stock prices which again corroborates the hedging role of the yellow metal. Again, markets seem to take a longer horizon view while responding to stock market changes. The results show that the model used can reflect the true gold price trend to a certain extent and can provide consumers with a certain guiding role in gold investment. However, due to the limitations of the model itself and the complexity of the real world, there is still a certain gap between this model and the real data, which cannot be fully accurately reflected and forecasted. Therefore, in the future when we conduct related research on gold prices to more comprehensively consider various influencing factors and improve the prediction model. For the empirical analysis results of this study, several significant facts can be found. Initially, other uncertain factors especially policies do have a significant effect on the international gold price, which is quite difficult to forecast. Additionally, the tendencies of the international gold price of the in-sample data and out-of-sample data show different directions, which indicate different causal factors. The study demonstrates that incorporating high-frequency predictors without aggregation using mixed frequency models leads to substantial gains in forecast accuracy of gold prices over a short horizon. This model can be used to estimate the price of gold in the future.

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