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FORECAST AND TREND ANALYSIS OF GOLD PRICES IN INDIA USING AUTO REGRESSIVE INTEGRATED MOVING AVERAGE MODEL

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Abstract: Autoregressive Integrated Moving Average (ARIMA) is one of the powerful statistical method to forecast the timeseries data. Forecasting plays a key role in estimating the future prices. Keeping in view that we have selected the prices of Gold in India from 1964 to 2019 through different secondary sources. Many factors are responsible for rise of gold price in India such as traditional demand, no liability on the investors, inflation proof, low interest rate on most of the saving schemes, safe investment tool. In the present study we mainly focused on estimating the prices of Gold from the year 2020 to 2029, observed the sudden increase of gold price in 2020 due to various reasons and its impact on forecasting prices of gold using ARIMA model. Identifying the suitable ARIMA model (0,2,3) by conducting the analysis of Autocorrelation function (ACF) and Partial autocorrelation function (PACF) to the selected differenced series and present the forecasting prices of gold. The selected secondary source data exhibits the positive trends for the quantitative analysis.

Keywords: autoregressive integrated moving average; prices of gold; auto correlation function; trend analysis;

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1. INTRODUCTION

Gold is identified as a unique commodity because of its usefulness is derived from a diversity of special properties. Historically man has been identified that Gold is more useful mineral that 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 medium of exchange. Gold is highly efficient conductor which can pass tiny currents and remain free of corrosion. Electrical components which are made by Gold are reliable. It is used in computers to transfer the 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., Many authors have presented the results of trends in showing the variation of gold prices for non-seasonal and seasonal data over a period of time. Aarti and Saina (2015) forecast gold prices using ARIMA modelling. Guha and Bandyopadhyay (2016) considered the data from November 2003 to January 2014 and applied the ARIMA time series model to forecast and mitigate the prices of gold. Farah and Zahid (2016) suggested Box Jenkins methodology to forecast the gold prices. Akaike (1974) suggested a method to determine the best order of a non-seasonal model. Fuller has proposed augmented fuller test for checking the stationarity of data. If Nonstationary exists in the data ARIMA models can be solved by using integrated model one or more times. This integrated model will help us to eliminate the non-stationarity. Brockwell and Davies (1996) has suggested several methods to forecast time series data. Rajyalakshmi and Victorbabu (2018 ,2019) followed different statistical approaches to determine the optimal responses. Rajyalakshmi and Nageswara Rao (2019a, 2019b) suggested modified taguchi designs to forecast the future by applying various statistical procedures. Sandhyarani et al (2017) used ARIMA model to predict the life cycle of batteries.

In the present study, following the works of Aarti and Saina (2015) and Guha and

Bandyopadhyay (2016) we estimate the prices of gold from the year 2020 to 2029 using ARIMA model. Dukey fuller test provides the clear idea about the stationarity of our selected data. Identify the suitable ARIMA model (0,2,3) by conducting the analysis of Autocorrelation function (ACF) and Partial autocorrelation function (PACF) to the selected differenced series and present the forecasting the prices of gold from 2020 to 2029. We noted the price of gold has increased with rapid growth in the year 2020 due to Covid 19 and the impact of Global economy. In this study, we present the forecasts and rate of growth of gold prices from 2020 to 2028 by considering the data from 1964-2019 as well as the data of 1964-2020. According to world council, the demand has decreased 36% due to lock down, volatile prices and economic uncertainties in the first quarter of the year 2020. Many factors are responsible for rise of gold price in India such as traditional demand, no liability on the investors, inflation proof, low interest rate on most of the saving schemes, safe investment tool.

The selected secondary source data exhibits the positive trends through graphical representation and the quantitative analysis of gold prices.

2. DATA

To carry out this work, the researcher has taken data from the website https://www.bankbazaar.com/gold-rate/gold-rate-trend-in-india.html

3. METHODOLOGY

ARIMA model is one of the powerful statistical method to forecast the timeseries data. It is a combination of Autoregressive (AR), Integrated model and Moving average (MA). It exists from a generalization of Autoregressive moving average method (ARMA). Box and Jenkin (1976) proposed a nonseasonal ARIMA model with parameters (p,d,q). Nonseasonal ARIMA model have selected for better understand the data as well as to estimate the prices of Gold in India changes over a period of time. Dukey fuller test gives us an idea about the stationarity of data.

Consider a Non seasonal ARIMA model of Box and Jenkin (1976) with the following notation:

ARIMA(p,d,q)

where p, d and q are non-negative integers

p: no. of autoregressive terms

d: no. of non-seasonal differences required for stationarity

q: order of the moving average model

Initial differences step can be applied one or more times to eliminate the non-stationarity. To cross check the stationarity of timeseries, use Augemented Duckey-Fuller test. Rejecting the null hypothesis suggests that a time series is stationary

ARIMA models are using any of the following models are as follows:

ARIMA (1,0,0); Autoregressive(1)

ARIMA (0,1,0): Integrated model (1)

ARIMA (0,1,0) without constant is called random walk => $Y_t=a+Y_{t-1}+e_t$

ARIMA 0,1,0) with constant is called random walk with drift => $Y_t=a+Y_{t-1}+e_t$

ARIMA(0,0,1): moving average (1)

ARIMA (0,0,0)-white noise model

ARIMA (0,1,2)-Damped Holt's model

ARIMA(0,1,1)-Basic experimental smoothing model (without constant)

ARIMA (0,2,2)-Double exponential smoothing model

Akaike information criteria (AIC) is used to determine the appropriate order of a non-seasonal ARIMA model. AIC criteria provides the approximate models towards the reality of the situation. For a good model we have to minimize the values of AIC, AIC_c, Bayesian information criteria (BIC). BIC used to find the perfect fit.

4. Result and Conclusions

The prices of Gold in India are increased over a period of time. It has increased 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. It has reached to Rs. 53,500 per 10 grams. The summary statistics are presented in the following table.

Table: 1 Summary Statistics of Prices of Gold rate in India from 1964-2019 and 1964-2020

	Prices of Gold from 1964 to 2019	**Prices of Gold from 1964-2020**
N	56	57
Min	63	63
Max	35220	52000
Average	7724	8501
Standard deviation	10369	11832
Standard error	1386	1567
Range	35157	51937
Skewness	0.319	0.316
Kurtosis	0.905	2.555

Now, we test the stationarity of data using Augmented Dickey fuller test and confirmed that the data is stationary by considering the integrated model with differences (2) (Ref. 10)

Figure (1) and figure (2) are indicating the results of non-stationarity and stationarity of the data for the period 1964-2019 as well as 1964-2020. Hence I was fixed as '2'. Now, we are searching for the values of AR and MR. The following values represent the different ARIMA models along with AIC values.

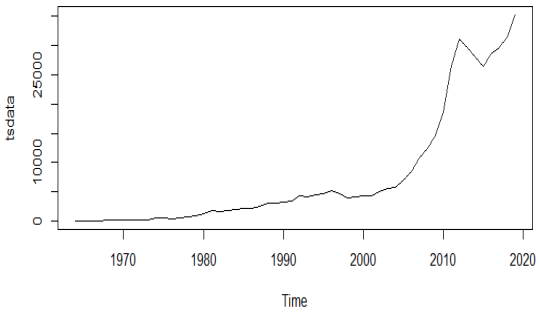

Figure 1 : Prices of Gold (original series)

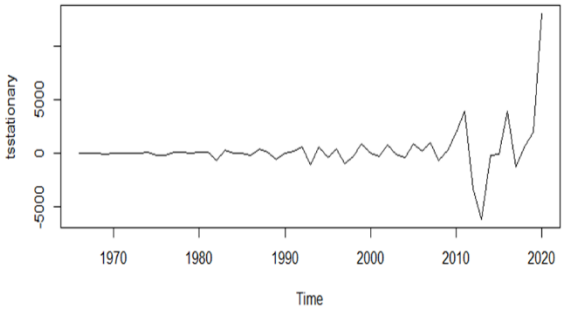

Figure 2: Prices of Gold (differenced series)

Table :2 Different ARIMA models with AIC Values

Model - prices of Gold from 1964-2020	**AIC Values**	**Model -prices of Gold From 1964-2019**	**AIC Values**
ARIMA(0,2,0)	1004.695	ARIMA(0,2,0)	933.0024
ARIMA(1,2,0)	1004.348	ARIMA(1,2,0)	934.7273
ARIMA(0,2,1)	1004.296	ARIMA(0,2,1)	934.2529
ARIMA(1,2,1)	1006.253	ARIMA(1,2,1)	926.2759
ARIMA(0,2,2)	1002.688	ARIMA(0,2,2)	925.8795
ARIMA(1,2,2)	996.1303	ARIMA(1,2,2)	926.2752
ARIMA(1,2,3)	996.1538	ARIMA(1,2,3)	927.0159
ARIMA(0,2,3)	**994.4764**	**ARIMA(0,2,3)**	**924.5966**

Based on the results of different ARIMA models represnted in table (2) are shows that the Best model with **ARIMA (0,2,3).**

The parameter estimates of Gold prices in India for the selected ARIMA (0,2,3) model are as follows

Table:3 Parameter estimates and AIC, AIC_c, BIC values

Model	Estimate		Standard Error		AIC		AIC_c		BIC	
	1964-2020	1964-2019	1964-2020	1964-2019	1964-2020	1964-2019	1964-2020	1964-2019	1964-2020	1964-2019
MA1	0.5342	-0.1159	0.1346	0.1273	993.68	923.78	994.48	924.6	1001.71	931.74
MA2	-0.2579	-0.3389	0.1562	0.1631						
MA3	-0.8075	-0.3666	0.1428	0.1610						

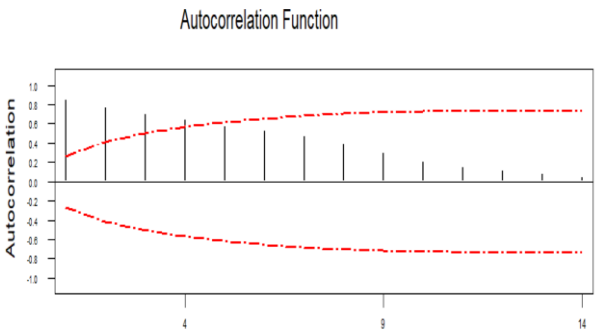

Figure 3

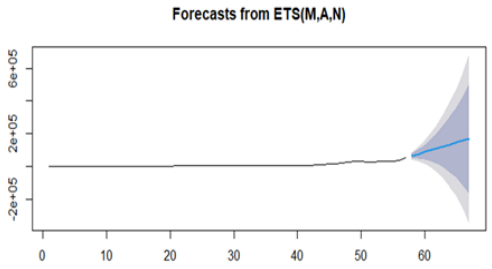

Figure 4

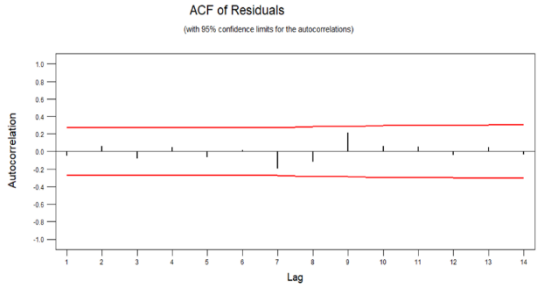

Figure 5

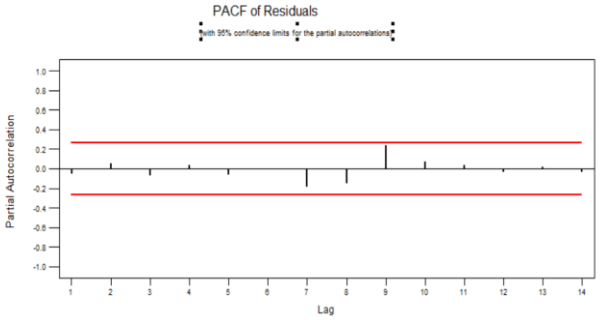

Figure 6

The forecast values of gold prices in India from 2020 to 2028 with model ARIMA(0,2,3) are presented in the following table (4)

Table:4 Forecast values of Gold prices from 2020 to 2029 in India

Period	Forecast (1964-2019)	95 Percent limits		Forecast (1964-2020)	95 percent limits	
		Lower	Upper		Lower	Upper
2020	39630.2	37394.4	41866	-	-	-
2021	43443.9	38844.4	48043.5	70690	67080	74301
2022	46504.7	39782.8	53226.7	83025	73607	92444
2023	49634.0	41379.7	57888.2	87757	72276	103239
2024	52831.6	43343.5	62319.8	92597	72599	112594
2025	56097.8	45567.5	66628	97543	73676	121411
2026	59432.3	47998.1	70866.6	102597	75225	129969
2027	62835.3	50603.5	75067.1	107759	77117	138400
2028	66306.8	53363.2	79250.3	113027	79279	146776
2029	69846.6	56262.8	83430.5	118403	81666	155141

The present paper deal with the modelling and forecasts of gold prices in India using ARIMA Model (0,2,3). The fitted model shows the increasing trend in gold prices for next 10 years from Rs. 35,220 per 10 grams of 24 carat in the year 2019 to Rs. 69846.6 per 10 grams of 24 carat in 2029 based on the data of 1964-2019. In the year 2020 due to various reasons the gold rate has exhibits rapid growth rate. If the same trend continues then the forecast prices will be Rs. 35,220 per 10 grams in the year 2019 to Rs. 118403 per 10 grams.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

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