A COMPARATIVE STUDY OF MOVING AVERAGE METHODS AND ARIMA IN FORECASTING GOLD PRICE

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CONTENTS

Introduction

➢ Gold is commonly traded in the commodity market due to its sustainability and high liquidity value

➢ Traders and researchers utilize **moving average methods** as one of forecasting tools to predict the gold price

➢ In a volatile market like gold market, moving average methods might underperform.

➢ Hence, this study aims to evaluate the performance of moving average methods in gold market.

Objectives

➢ To determine the accuracy rate of moving averages in forecasting the gold price.

➢ To forecast the gold price using Simple Moving Average (SMA), moving average convergence divergence (MACD), and autoregressive integrated moving average (ARIMA).

➢ To compare the accuracy rate and forecasting error measurement between moving average methods and ARIMA.

RESEARCH OVERVIEW

1

Literature review on gold price

2

Forecast the gold price data with simple moving average (SMA), moving average convergence divergence (MACD), and autoregressive integrated moving average (ARIMA)

3

Test and compare the accuracy rate and forecast error measurements

4

Finding/conclusion

METHODOLOGY -DETAILED FRAMEWORK

Autoregressive Integrated Moving Average (ARIMA)

- Test the stationarity of the model
- Differentiation and power transformation to the data
- Check the model assumptions about the errors

Moving Average Convergence Divergence (MACD)

- Calculate the exponential moving average of 9, 12, and 26 days
- Construct the MACD histogram and graph based on exponential moving average

Simple Moving Average (SMA)

- Evaluate and identify the best period of SMA for the daily data of gold price
- Determine the forecast error measurement and accuracy rate for comparison with MACD and ARIMA

DATA COLLECTION

➤ The dataset for gold price was collected from the World Gold Council website (World Gold Council, 2021).

➤ The daily close price of gold in the financial market from 1st January 2020 to 26th February 2021 is observed due to the result of economic uncertainty caused by the COVID-19 pandemic outbreak

➤ To investigate the gold price movement with effects of the global COVID-19 pandemic

# RESULTS & DISCUSSION

SMA, MACD, and ARIMA

Simple Moving Average (SMA) Analysis

MAPE and RMSE for four different SMA period

	MAPE	RMSE
SMA (10-day period)	1.3619	33.2418
SMA (21-day period)	1.9633	46.7193
SMA (50-day period)	3.1439	69.4630
SMA (200-day period)	7.9491	165.8375

Comparison of SMAs using four different periods

Legend:
- Close Price
- SMA (10-Day Period)
- SMA (21-day Period)
- SMA (50-day Period)
- SMA (200-day Period)
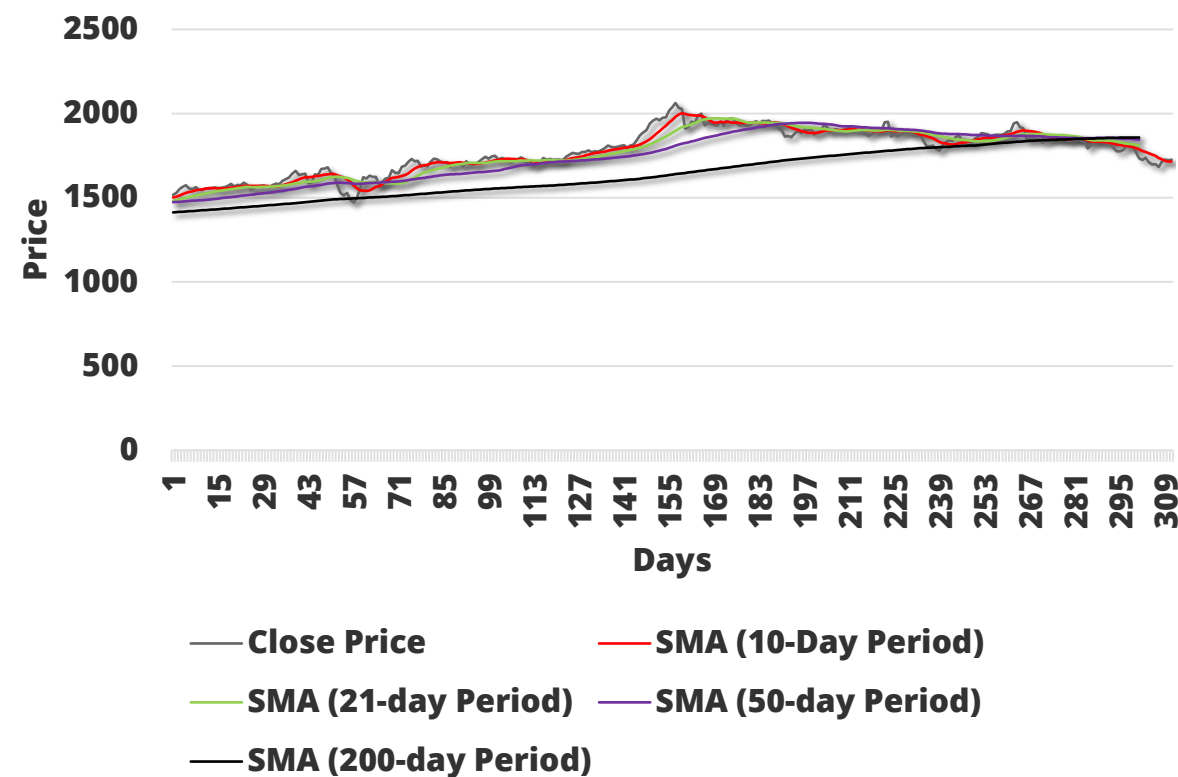
Simple Moving Average (SMA) Analysis

The accuracy rate of SMA in 301 observations is 45.16%

	Test date	Price (Test date)	Price (Test date + 5 days)	Predicted trend	Actual trend
	Jan 14	1546.37	1558.02	-	+
	Feb 04	1552.56	1567.71	-	+
	Feb 28	1585.13	1674.23	-	+
	Apr 17	1684.69	1729.43	-	+
	Apr 30	1685.05	1717.94	-	+
	May 25	1729.57	1740.33	-	+
SMA	Jun 01	1740.33	1697.96	+	-
	Jun 03	1698.64	1737.10	-	+
	Aug 11	1911.25	2000.95	-	+
	Aug 26	1953.45	1942.62	+	-
	Sep 02	1946.66	1959.32	-	+
	Oct 01	1905.05	1893.09	+	-
	Oct 16	1898.97	1900.79	-	+
	Oct 19	1904.27	1901.69	+	-
	Nov 03	1909.18	1876.76	+	-
	Nov 09	1862.71	1888.34	-	+
	Jan 20	1870.93	1836.77	+	-

Moving Average Convergence Divergence (MACD) Analysis

The accuracy rate of MACD in 301 observations is 60.00%

	Test date	Price (Test date)	Price (Test date + 5 days)	Predicted trend	Actual trend
	Feb 12	**1565.63**	**1611.64**	**-**	**+**
	Mar 12	**1577.08**	**1471.00**	**+**	**-**
	Mar 23	**1553.81**	**1623.30**	**-**	**+**
	Apr 15	**1716.60**	**1714.82**	**+**	**-**
	May 08	**1702.65**	**1743.00**	**-**	**+**
	Jun 09	**1714.57**	**1727.46**	**-**	**+**
SMA	**Jul 22**	**1872.07**	**1970.73**	**-**	**+**
	Aug 21	**1939.40**	**1964.49**	**-**	**+**
	Sep 22	**1899.28**	**1897.69**	**+**	**-**
	Sep 30	**1885.44**	**1887.22**	**-**	**+**
	Dec 1	**1814.77**	**1870.04**	**-**	**+**
	Jan 07	**1912.95**	**1845.65**	**+**	**-**

Comparison Between The Accuracy Rate of SMA and MACD

|	No. of buy/sell signals	Accuracy rate (%)
Simple Moving Average (SMA)	31	45.16
Moving Average Convergence Divergence (MACD)	30	60.00

The accuracy rate for MACD is 60% which is higher than SMA which is 45.16%

In other research papers involving the accuracy rate of MACD, the results obtained usually score around 60% to 80%.

Autoregressive Integrated Moving Average (ARIMA) Analysis

Time series plot for daily close price of gold from January 2020 to February 2021

- There is an outlier dated on 31st March 2020 which is contributed by the early phase of COVID-19 outbreak

- One of the limitations of ARIMA is the difficulty in forecasting when the outliers present in the dataset
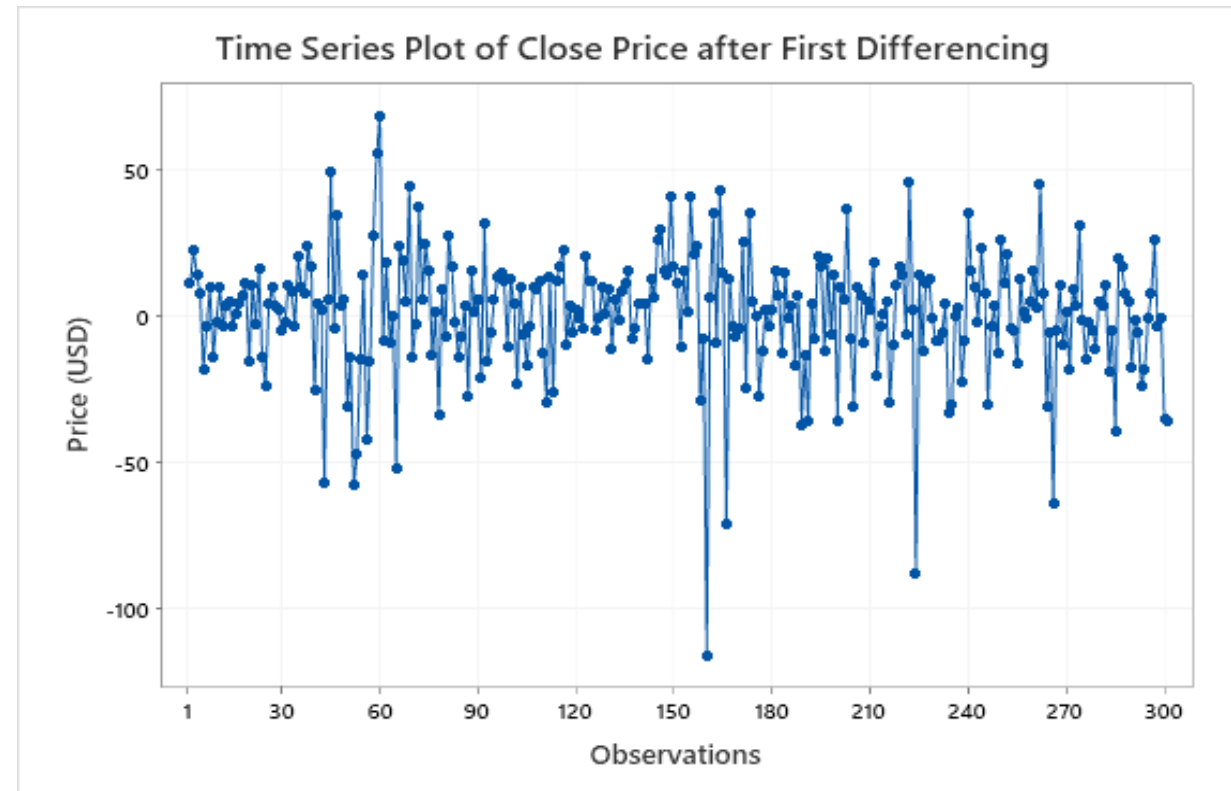

Time Series Plot of Close Price (Gold)
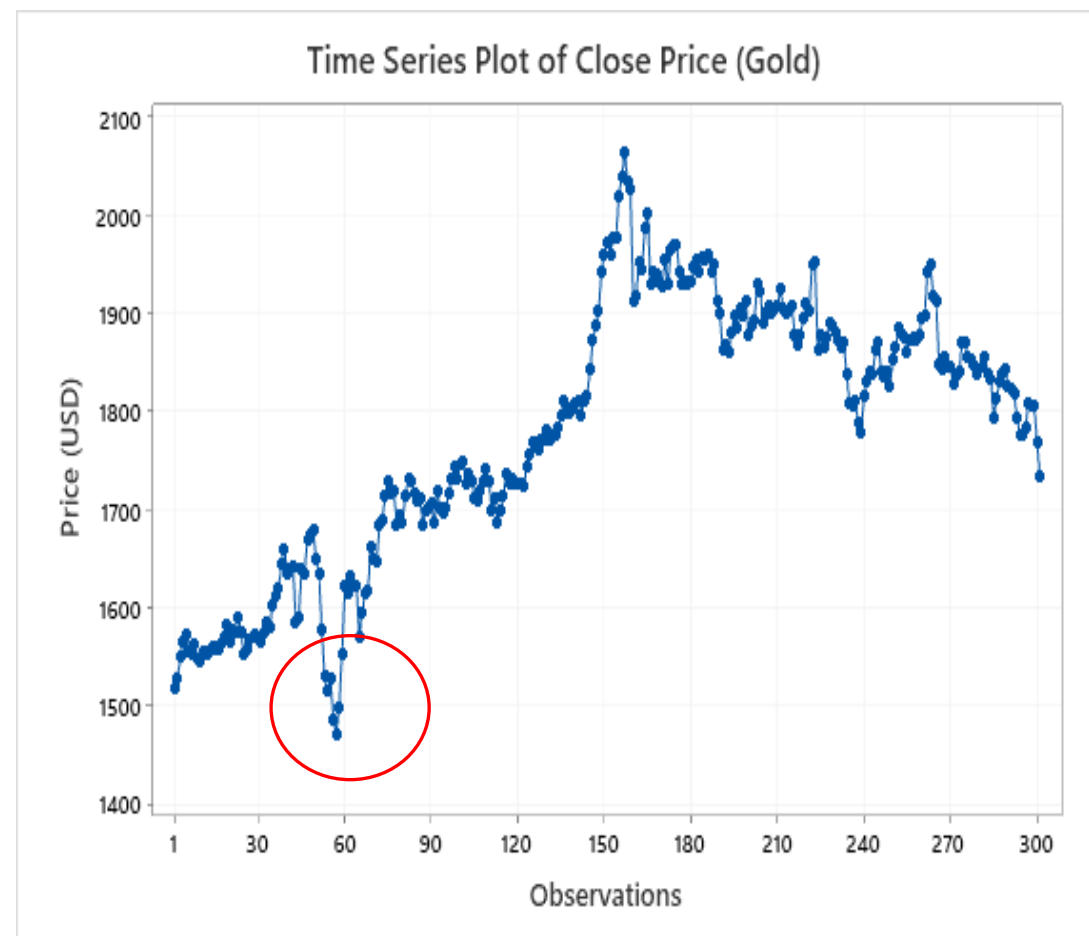
Autoregressive Integrated Moving Average (ARIMA) Analysis

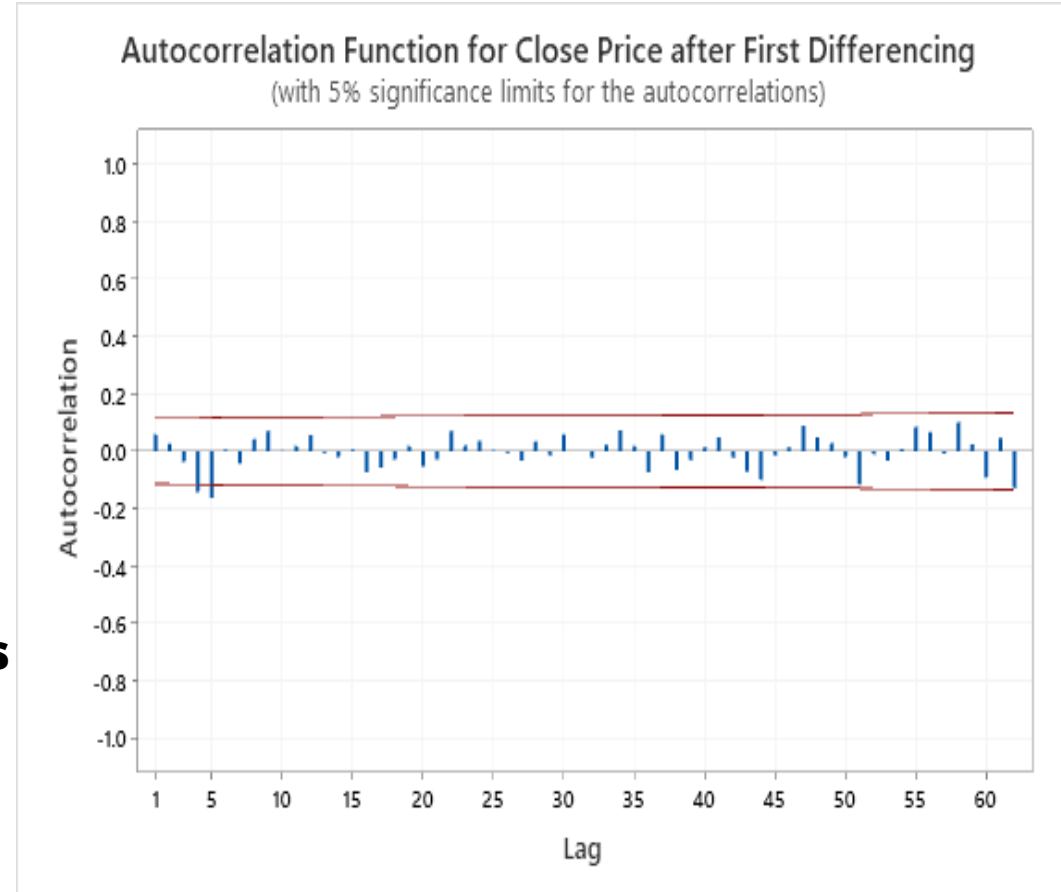**Model identification determines the value of d in the ARIMA model (p, d, q)**

Model Identification

- **Differencing the dataset is needed to transform the non-stationary data into stationary data.**

- A stationary time series has the property that its statistical characteristics such as the autocorrelation structure are constant over time.

- **The value of _d_ is obtained by the number of differencing.**

- **After differencing the dataset, the value for _d_ is obtained which is 1.**

Time Series Plot of Close Price after First Differencing

Autoregressive Integrated Moving Average (ARIMA) Analysis

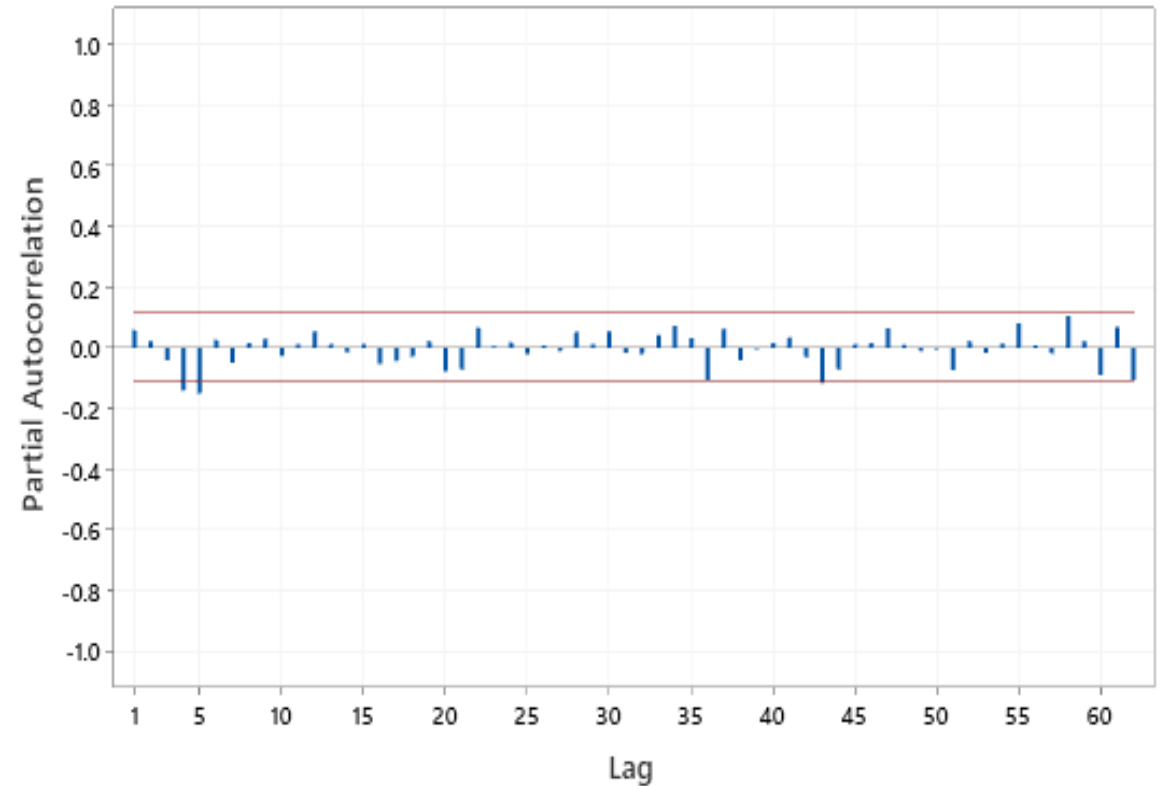**Parameter identification determines the value of p and q in the ARIMA model (p, d, q)**

Parameter Identification in ACF Graph

- The p value is determined by the vertical line that exceeds below the red line which is 4 and 5

Autoregressive Integrated Moving Average (ARIMA) Analysis

Parameter identification determines the value of p and q in the ARIMA model (p, d, q)

Partial Autocorrelation Function for Close Price after First Differencing
(with 5% significance limits for the partial autocorrelations)

Parameter Identification in PACF Graph

- The q value is determined by the vertical line that exceeds below the red line which is 4 and 5

Autoregressive Integrated Moving Average (ARIMA) Analysis

Test the adequacy of ARIMA (4, 1, 4) model

Diagnostic Checking

- To test the adequacy of ARIMA (4, 1, 4) model, an adequacy test is required which is Ljung-Box test.

- For a model to be determined as adequate, the p-values for all lags should be greater than 0.05

- Hence, the ARIMA (4, 1, 4) model is adequate based on the p-values in Ljung-Box test.

Lag	12	24	36	48
Chi-Square	2.67	8.44	16.09	28.90
DF	3	15	27	39
P-Value	0.445	0.905	0.951	0.882

Autoregressive Integrated Moving Average (ARIMA) Analysis

Since ARIMA (4, 1, 4) model is adequate, the next step is to calculate the forecasted values.

From the forecasted values, mean absolute percentage error (MAPE) and root mean square error (RMSE) can be determined.

The MAPE and RMSE for ARIMA (4, 1, 4) model obtained is 1.81% and 35.57732 respectively.

MAPE	0.018093
RMSE	35.57732

Comparison Between The Forecasting Error Measurement of SMA and ARIMA

	MAPE	RMSE
Simple Moving Average (SMA)	1.264%	27.64023
Autoregressive Integrated Moving Average (ARIMA)	1.8093%	35.57732

The values of both MAPE and RMSE for simple moving average (SMA) are lower than ARIMA.

Lower values of MAPE and RMSE indicate that there are only small deviations between the actual and predicted values.

The result favours to SMA as compared to ARIMA due to the outliers in the dataset.

One of the limitations of ARIMA is the difficulty in forecasting when the outliers present in the dataset.

The difficulty happens because the outliers lie outside of the trend captured by the model, (Grogan, 2020).

CONCLUSIONS

The overview performance of SMA, MACD, and ARIMA in forecasting the gold market

- Despite the popularity of moving average methods in stock market, this may not necessarily be the case in the gold market.

- The accuracy rate of both SMA and MACD is considered as low in predicting the gold price.

- Although ARIMA is an advanced method as compared to SMA, the MAPE and RMSE for SMA outperformed ARIMA.

- This is due to the timeframe of the dataset chose which takes place during the COVID-19 outbreak.

- The COVID-19 pandemic contributes to the uncertainty in the economy including the gold market.

THANK YOU