

Analysis of Gold Price Forecasting at Different Frequencies Based on ARIMA

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Abstract. Gold is referred to as a critical safe-haven asset, which is significant to the international financial markets and risk management. As such, it is significant to the investors and financial institutions to predict the prices of gold and the stocks concerned with gold. The paper aims at comparing the gold price forecasting of the data at various data frequencies (daily, weekly, and monthly) using Autoregressive Integrated Moving Average (ARIMA) model. This paper will initially preprocess the data based on historical gold prices data in a representative international market between the years February 1, 2006 and January 1, 2026, by using stationarity tests and differencing operations. This paper, therefore, builds ARIMA models and optimizes them at each frequency to determine how well they predict using measures like MAE and RMSE. The empirical findings indicate that the long-term forecasts provided by lower-frequency data such as monthly yield are more stable and accurate and the short-term forecasts by higher-frequency data are more accurate and volatile in forecasting errors. This paper is not only adding to the existing empirical body of knowledge on the forecasting of gold prices at various data frequencies, but also offers a practical decision support to the market participants to develop specific trading and risk management strategies according to the various forecasting horizons.

Keywords: Gold price, Data Frequencies, ARIMA Model, Stock Price

1. Introduction

Nowadays, the world economic environment is constantly changing, the financial markets are subjected to constant changes, and a number of sources of uncertainties are constantly on the rise. The role of gold in the global financial market remains a major one by virtue of its safe haven and value preserving properties [1]. Over the last few years, the international price of gold has been very volatile and on an increasing trend. Gold prices have been rocketing high time and again due to the forces of global inflation and geopolitical threats, which have made them a subject of massive speculation among international investors. The changes in the international gold prices not only impact on the entire commodity market, but also significantly on the stock prices of the listed companies in the gold industry [2]. This paper will discuss the international gold prices and the stock prices of two gold companies, Newmont and Shandong Gold, and analyze the issue of price forecasting at various data frequencies. In the background of increasing needs of investment

decision-making and market stability, the enhancement of the precision of the gold price forecasting with the use of the scientific model becomes a very topical and useful research topic.

Currently, researchers both at home and in other parts of the world have conducted comprehensive research on the forecasting of gold prices. The ARIMA model is one of the most popular time series tools that are applied to forecast the price of gold because of its clear structure and predictive consistency. The ARIMA model was applied by Smith et al. to provide the short-term predictions of the gold prices in the international market and confirmed the feasibility of the model. Empirical studies by domestic researchers have also shown that ARIMA model can more suitably model the fluctuation trend of gold prices [3, 4].

This paper is a systematic study, based on historical data, February 1, 2006 to January 1, 2026, on the forecasting performance of ARIMA model on the price of the gold-related assets on weekly and monthly data frequencies, using international gold prices and the stock price of Newmont and Shandong Gold as the research objects. Specifically, this paper develops and maximizes the ARIMA models of different frequency data following the stationarity test and difference processing of the initial time series data. It then critically evaluates the effects of model fitting and predicting by the use of RMSE, MAE, and R^2 as the main assessment measures [5]. On this basis, the author analyses the forecasting differences in the model with two frequencies and the underlying reasons of the better predicting performance of low frequency monthly data of gold prices.

This study has serious theoretical and practical implications. Theoretically, it expands the study of the dynamic linkage mechanism between the international gold price and the stock price of the gold mining companies at different data frequencies, which enriches the empirical research on the application of ARIMA model in the study of the gold price forecasting area, and strengthens the research evidence of the effect of data frequency on the forecasting effect of time series model [6]. Practically, the findings of the research can be used to make specific decisions by investors, gold mining companies and market regulators.

2. Methodology

2.1. ARIMA model

ARIMA model is a traditional time series forecasting model, it is a combination of Autoregressive (AR), Integration (I) and Moving Average (MA). The key concept of this model is to apply historical data to determine future values having transformed non-stationary data into stationary data through the integration process. This paper applies the ARIMA time series model to identify the correlation between the price of gold and the share price of gold mining companies, as proposed by Gohar and Bandyopadhyay [7]. This paper has demonstrated that the ARIMA model framework is relevant in modeling and evaluating the relationship between gold prices and the returns of the shares of gold mining companies since it is an effective way of capturing the trend and the volatility characteristics of the financial time series data.

2.2. Data selection and source

This study will focus primarily on the share prices of two gold mining companies, Newmont Mining and Shandong Gold and the world gold prices. These indicators have been selected since it gives a comprehensive representation of the volatility or characteristics of the gold-related assets and is very representative of the global gold market. The data is publicly available in financial databases such as

Yahoo Finance and covers the timeframe between February 1, 2006 and January 1, 2026 and is at weekly and monthly frequencies.

2.3. Data processing

The pre-processing stage in this study involves removing the missing values in the raw data first. The first step in the single-variable model is to test the gold price to establish whether it is stationary with the Augmented Dickey-Fuller (ADF) unit root test [8]. When the data is not stationary, first-order differencing is applied [9]. Automatic constructions of ARIMA models are then created on the basis of the processed data at different frequencies and performance of different models in predicting the data is compared with the help of error metrics.

3. Results

Table 1 presents the results of ADF unit root test, which provides a sufficient demonstration of the stationary aspect of the both the time series of gold prices, Newmont Mining share prices and Shandong Gold share prices. The null hypothesis that the series were non-stationary was rejected successfully following first-order differencing since all the p-values of the variables were below 0.05. This indicates that although the original data were not stationary and they did not pass the significance test, they can be transformed into stationary series following the differencing process and meet the modeling criteria of the ARIMA model.

The null hypothesis of non-stationarity, conversely, could not be rejected since the t-statistic of the original series was less than the critical value in terms of its absolute value. However, the absolute value of t-statistic after differencing was much bigger and proves that the first order differencing was effective in removing the trend and seasonal factors of the original data. This transformation is necessary because of the ARIMA model relies on stationary time series in order to come up with precise parameter estimates and consistent forecasts. The paper ensures that the model below is able to capture the relationships in the data as a function of time with high precision by ensuring the establishment of a stationary point through first-order differencing, offering a solid foundation upon which reliable predictive analysis of the prices of gold and returns on related equities can be made.

Table 1. ADF unit root test results

Variable	Frequency	t-statistic	p-value	1st-Diff t-stat	1st-Diff p-value
Gold Price	Weekly	-2.2265	0.4843	-3.5821	0.0464
Gold Price	Monthly	-2.7195	0.2733	-1.7399	0.0100
Newmont	Weekly	-0.6754	0.9717	-5.4436	0.0100
Newmont	Monthly	-0.6754	0.9717	-5.4436	0.0100
Shandong Gold	Weekly	-1.9390	0.6015	-4.7035	0.0100
Shandong Gold	Monthly	-1.9390	0.6015	-4.7035	0.0100

After using three significant measures, which are the Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Coefficient of Determination (R^2), Table 2 provides a comprehensive comparison of the model performance of the weekly and monthly frequency data using three variables, which are gold prices, Newmont Mining share prices, and Shandong Gold share prices. The results suggest that, although both RMSE and MAE are smaller than that of one week data, the

monthly data of all three variables have higher values of R^2 . This indicates that the monthly frequency data models are better fitted and give more predictions.

Specifically, the model is able to explain the variations in the prices of gold almost 99 percent of the monthly changes and only about 87 percent of the changes in the prices of gold on weekly data. Meanwhile, the monthly RMSE and MAE were reduced to 74.2359 and 55.9167, respectively, which is much lower than the weekly values of 49.66626 and 37.47334, respectively, which means that the error in predictions is smaller. Both Newmont Mining and Shandong Gold showed a steady performance and monthly R^2 increased to 0.906464 and 0.94904 respectively, and both RMSE and MAE dropped to different extents, which proves the advantage of monthly data.

These results imply that monthly data will be much more effective in capturing long-run trends in gold and mining stock prices and can be used effectively to filter short-run noise in financial markets. To have a more credible empirical foundation in the examination of the dynamic connection between gold prices and shares of mining stocks, this research has adopted monthly frequency information to be utilized in the out-of-sample prediction.

Table 2. Model performance comparison

Variable	Frequency	RMSE	MAE	R-squared
Gold Price	Weekly	49.6663	37.4733	0.8678
Gold Price	Monthly	74.2359	55.9167	0.9882
Newmont	Weekly	4.4800	3.3854	0.9080
Newmont	Monthly	4.5131	3.3818	0.9065
Shandong Gold	Weekly	1.8064	1.2356	0.9490

The ARIMA model was employed in this paper to perform out-of-sample prediction as per the superior performance of monthly data. The results of the predictions of the prices of gold, Newmont stock and the Shandong Gold stock are shown in Figures 1-3 respectively. The forecasting effect is excellent and the trend conforms to the real situation.

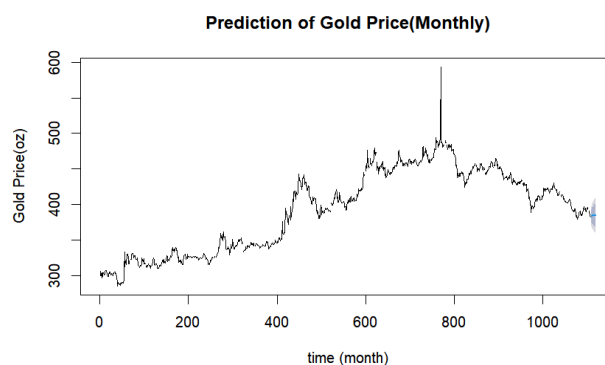


Figure 1. Prediction of gold price (monthly)

The Figure 1 monthly gold price predictions are sufficient to depict the extent to which the ARIMA model is able to capture the trends of the gold price. The model is effective in reflecting the dynamic changes in the price of gold over the sample period as the model prediction of trends closely matches the actual trends of the same as indicated by the values in the model and history. There was a steady positive trend in the initial stages of gold prices that the model was able to

forecast; during the intermediate stages, the model was able to forecast the fluctuation of gold prices which took the highest point of approximately 800 and then resumed a downward trend. This great turning point and the fluctuating market conditions that came with it were also met well by the model.

Regarding fit, the general forecast curve was a large follower of the fluctuations of the real price curve, although the model did exhibit small infractions at certain times of considerable volatility. This demonstrates that the ARIMA model, as a monthly model, is very reliable and successful in forecasting global gold prices since it is able to filter the short-term random market noise and adequately capture the long-term macro trend and the underlying fluctuation trends of gold prices.

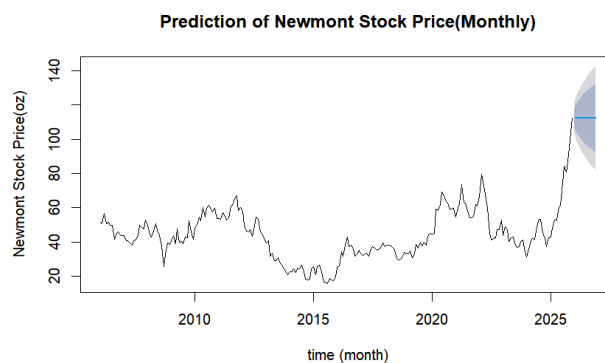


Figure 2. Prediction of newmont stock price (monthly)

The predicted results of the ARIMA model for the monthly share price of Newmont Mining are displayed in Figure 2. The share price is more volatile than gold prices; the model effectively captures both the rapid upward spike after 2020 and the fluctuating adjustment pattern seen between 2010 and 2020. The model's practical significance is demonstrated by its ability to reveal the association between gold prices and mining stock returns, even when slight disparities were seen during periods of acute market shocks.

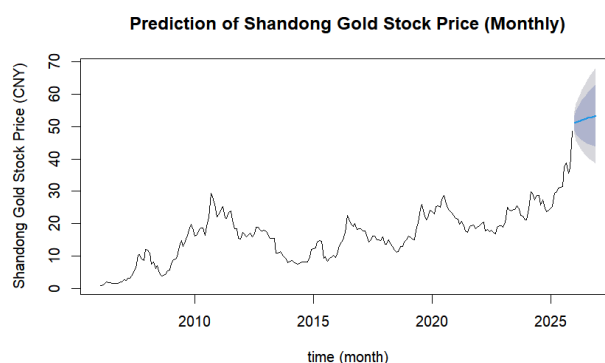


Figure 3. Prediction of Shandong Gold stock price (monthly)

Figure 3 presents the forecasting ability of the ARIMA model of the monthly share price of Shandong Gold in China. Strong domestic market characteristics and world gold prices affect the share price of Shandong Gold, which is a leading company in the domestic gold mining industry. It is especially effective at determining the variations on the medium-term scale, and the share price patterns described by the model are quite close to the actual history of the real share prices.

As it is seen in the figure 3, the share price of Shandong Gold exhibited significant upward trend during the second half of the sample period. This strengthening pattern at the late stage was exactly reflected in the model, which justified the use of the ARIMA model on the prediction of the returns on the Chinese domestic mining equities. The fact that the ARIMA model developed in this paper has performed well in cross-regional and cross-asset class forecasting is also evidenced by the fact that the model forecasts are very close to the actual values further confirming that the spillover effect of changes in prices of gold prices in the share prices of the local listed mining firms is significant.

4. Discussion

As noted under empirical results, it is observed that monthly data fits model accuracy and prediction better than weekly data, due to two major reasons. First, weekly data is prone to the influence of short-term market noise and other transient news, as well as investor sentiment, compared to monthly data; second, the primary cause of changes in gold prices is the macroeconomic factors, such as inflation, interest rates, and monetary policy of the world in general, and their impact is normally realized over a time period of a month [10]. Consequently, monthly data is closer to the actual cycles of operations of the gold market and the mechanisms that relay its price. Based on the above research findings, the following three recommendations will be made in this paper: Firstly, as the correlation between the share prices of gold mining companies and the gold prices showed as it is, that investors need to focus on monthly data, focus on long-term tendencies in the gold prices, and invest in the shares of gold mining companies accordingly in making the medium- and long-term investment decisions.

Besides this, gold mining companies should enhance risk management in response to fluctuations in the market. They are able to enhance sustainability of their operations by mitigating the impacts of price volatility in the short term by ensuring they put in place reasonable business practices and appropriate hedging methods.

5. Conclusion

This paper analyzes the dynamic relationship between global gold prices and stock returns of two major gold mining companies, Newmont and Shandong Gold, on weekly and monthly basis between 1 February 2006 and 1 January 2026. The ADF test indicates that all the variables are non-stationary in their original form, however after first-order differencing, the variables turn to be stationary at 5 per cent level, and hence the time series modeling conditions are met. The ARIMA was then used to analyze and predict the price patterns at different frequencies. The results indicate that monthly data gives the projections which are more accurate, and errors are less and it successfully eliminates short-term market noise but it includes long-term volatility properties. The model was able to identify the correct spillover effects of changes in gold prices on the mining equities a strong positive relationship between the two was established. Besides offering a valuable source of decision-making information to investors and regulators in the market, this also provides empirical evidence on the safe-haven properties of gold and mechanism of market transmission of gold price shocks.

The study has some limitations: the sample size is only two gold mining businesses, and further studies are required to determine whether the results can be generalized to the entire gold mining industry. Moreover, the ARIMA model framework fails to consider the effects of structural market movements or macroeconomic events such as interest rate changes and geopolitical events that

might limit the accuracy of the forecasts. Future research may enhance the scientific value and utility of the gold price forecasting through an expansion of the sample size, inclusion of macroeconomic variables, or a side-by-side comparison of the machine learning models.

References

- [1] Baur, D. G., & McDermott, T. K. J. (2016). Why is gold a safe haven? *Journal of Behavioral and Experimental Finance*, 10, 63-71.
- [2] Baur, D. G. (2014). Gold mining companies and the price of gold. *Review of Financial Economics*, 23(4), 174-181.
- [3] Xu, L. P., & Luo, M. Z. (2011). Short-Term Analysis and Forecast of Gold Price Based on ARIMA Model. *Finance and Economics*, (1), 26-34.
- [4] Si, J. (2016). Short-Term Prediction of Gold Prices Based on ARIMA Model. *Times Finance*, No. 17, 221-222.
- [5] Hyndman, R.J. (2014). Measuring Forecast Accuracy. In: *Business Forecasting: Practical Problems and Solutions*, John Wiley & Sons, Hoboken, 177-183.
- [6] Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). *Time series analysis: Forecasting and control* (5th ed.). Wiley.
- [7] Guha, B., & Bandyopadhyay, G. (2016). Gold price forecasting using Arima model. *Journal of Advanced Management Science*.
- [8] Yang, X. (2019). The prediction of gold price using ARIMA model. In *Proceedings of the 2nd International Conference on Social Science, Public Health and Education (SSPHE 2018)*, pp. 276–278. Atlantis Press.
- [9] Blose, L. E., & Shieh, J. C. P. (1995). The impact of gold price on the value of gold mining stock. *Review of Financial Economics*, 4(2), 125–139.
- [10] Caporale, G. M., Gil-Alana, L., & Plastun, A. (2019). Long memory and data frequency in financial markets. *Journal of Statistical Computation and Simulation*, 89(10), 1763-1779.