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Economic Indicator-Based Algorithm for Gold Price Forecasting

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ABSTRACT

Gold is considered one of the most stable and trusted investment assets in global financial markets. Its price is strongly influenced by economic conditions such as inflation, interest rates, crude oil prices, and currency fluctuations. Because these factors interact in complex ways, forecasting gold prices accurately remains a difficult challenge. This study introduces a prediction framework that combines macroeconomic indicators with machine learning and deep learning models to estimate future gold price movements. Historical market data covering the period from 2010 to 2025 was collected along with relevant economic indicators from publicly available financial databases. The dataset was prepared through preprocessing techniques including normalization and correlation analysis to determine the most influential variables. Three predictive approaches Random Forest, XGBoost, and LSTM were implemented and compared. Model effectiveness was evaluated using MAE and the coefficient of determination (R^2). The experimental findings show that the inclusion of economic indicators improves forecasting capability. Among the tested approaches, the LSTM network produced the most accurate predictions because of its ability to capture temporal relationships within financial time-series data.
Keywords—Gold price prediction, macroeconomic indicators, deep learning, LSTM, machine learning, financial forecasting

1. INTRODUCTION

Gold has maintained its significance as a financial asset for centuries and is widely viewed as a secure investment option during periods of economic instability. Investors often rely on gold as protection against inflation, currency depreciation, and market volatility. Because of its importance within global financial markets, predicting the future value of gold has attracted considerable attention from researchers and financial analysts.[1]

Gold prices are affected by several economic variables that reflect broader market conditions. Factors such as inflation levels, crude oil prices, currency exchange rates, and interest rates influence investor behavior and therefore contribute to fluctuations in gold prices. These relationships create a complex environment in which multiple variables simultaneously influence price movements.[1][4] Conventional forecasting methods such as regression analysis and statistical time-series models have historically been applied to commodity price prediction. Although these techniques provide useful insights, they often struggle to represent nonlinear relationships and dynamic patterns present in financial data.[2] Financial markets generate large volumes of sequential information where historical patterns and external economic influences interact over time.

Recent developments in machine learning have significantly improved the ability to analyze complex datasets. Machine learning algorithms can discover relationships between variables that may not be evident through traditional statistical techniques. As a result, they have become widely used in financial prediction problems.[3][5]

Deep learning models have shown particularly strong performance when dealing with time-series data. LSTM networks are a specialized form of recurrent neural networks designed to retain important information across long sequences of data. This capability allows LSTM models to recognize temporal patterns that influence future price trends.[2][3] Research also indicates that incorporating macroeconomic indicators into prediction models improves forecasting reliability. Economic variables provide valuable context that helps algorithms understand the underlying causes of price changes.[4][6]

In response to these observations, this research develops a forecasting framework that integrates historical gold market data with selected macroeconomic indicators. We trained and evaluated predictive models to establish the most effective approach for forecasting gold prices.

2. RELATED WORK

Several research studies have been conducted on the use of different techniques for forecasting commodity prices. Past research on forecasting commodity prices was primarily based on statistical and econometric models, autoregressive models, and regression models. Although these methods were successful in modeling simple relationships, they encountered problems in modeling complex nonlinear relationships, which are typical of financial data.

The development in machine learning has led to more sophisticated techniques in predictions. Ensemble methods like Random Forest have shown promising results in financial prediction problems due to their potential in learning from structured data.

This is achieved by generating a large number of decision trees during training. Each decision tree produces a prediction independently, and then a final prediction is made by aggregating all the predictions.

The second most important algorithm in predictive modeling is XGBoost. It is a machine learning algorithm that falls under the category of gradient boosting algorithms. This algorithm aims at boosting the accuracy of a model by reducing errors in a model. It also uses a regularization technique to avoid overfitting in a model.

Other than traditional machine learning, deep learning has also been paid a great deal of attention in recent times as a potential tool that can be utilized for financial forecasting. This is owing to the fact that recurrent neural networks are particularly developed for sequences, which is a property of time series.

Among all the above architectures, the effectiveness of the LSTM Memory networks has been remarkable in financial prediction. This is because the networks have demonstrated the capability of storing information using their memory. This has helped the networks in capturing the dependencies that may occur between past and future events.

Another significant observation that has been noted by previous studies is that there is a need to include macroeconomic indicators in the predictive models. This is due to the economic indicators such as inflation rates, interest rates, and energy prices that have an effect on commodities. The need for this is significant in order to ensure that the accuracy of the predictions is enhanced.

Even though there have been developments in this area, there is still a need to have an integrated approach that will include macroeconomic indicators and predictive algorithms. This research aims to fill this gap by ensuring that an integrated predictive system is developed.

3. RESEARCH METHODOLOGY

The proposed prediction framework aims to forecast gold prices by combining historical market data with relevant economic indicators. The methodology consists of several stages, including data collection, preprocessing, feature selection, model training, and evaluation.

A. Data Collection

Historical gold price information covering the period from 2010 to 2025 was obtained from publicly accessible financial data sources. To capture broader economic influences, additional macroeconomic indicators were also collected.

The economic variables considered in this research include:

- Inflation rate
- Interest rate
- Crude oil price
- Currency exchange rate

These variables were selected because they have been widely recognized in financial literature as important drivers of gold price behavior.

B. *Data Preparation*

Financial datasets frequently contain irregularities such as missing values and inconsistent scales. Therefore, the collected data was processed before model training.

- Data preparation involved:
- Removing incomplete or inconsistent entries
- Standardizing numerical values using normalization
- Structuring the dataset for time-series analysis Normalization ensures that all variables contribute proportionally during model training.

C. Feature Selection

Identifying the most influential variables is an important step in building effective predictive models. Correlation

analysis was applied to evaluate the relationship between economic indicators and gold prices.
This process helps eliminate variables that have minimal impact on prediction accuracy while retaining those that strongly influence gold price movements.

D. Predictive Models

Three different algorithms were implemented for forecasting purposes.

- Random Forest

Random Forest is an ensemble learning method that generates predictions by combining the results of multiple decision trees. This approach improves prediction stability and reduces overfitting.
In Figure 1, the comparison chart for the actual gold price and the AI-predicted gold price using the Random Forest Regressor model is presented. The blue color represents the actual gold price, while the orange dashed line represents the predicted gold price using the AI model.
It is clear that the predicted values are following the actual gold price trend over time. This indicates that the model is able to capture the short-term and long-term trends in the gold price series.
The performance of the Random Forest Regressor model is checked using various statistical values. It is observed that the accuracy of the Random Forest Regressor model is 99.76%. It is also observed that the R^2 value is 0.9996, which indicates that there is a high level of correlation between the actual values and the predicted values. It is also observed that the Mean Absolute Error value is as low as 191.45 INR, which indicates that the error in the predictions made by the Random Forest Regressor model is low compared to the actual values.
It is also observed that the Random Forest Regressor model is used for predicting the future values of gold prices. It is also observed that the Random Forest Regressor model predicted that the gold prices will be around 189,059.24 INR by 1st February 2026.
It may be concluded that the Random Forest Regressor model is performing extremely well in the prediction of gold prices with high accuracy, which indicates that the Random Forest Regressor model is a reliable model for gold price predictions.

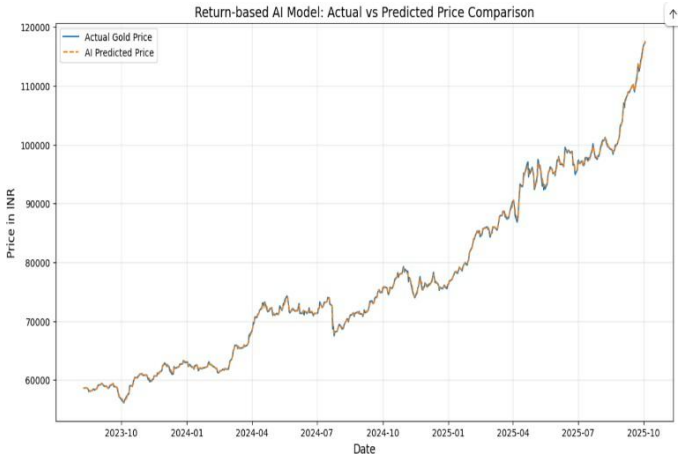

Fig. 1. Actual vs Predicted Gold Price using Random Forest Regressor

- XGBoost

XGBoost constructs predictive models through a boosting process where each new model corrects the errors produced by earlier models. This iterative process improves prediction accuracy and efficiency.
Figure 2 shows the comparison between actual gold price values and predicted values using the XGBoost model for one-day forecasting.
In the above figure, actual gold price values are represented by the blue line, while predicted values using the XGBoost model are represented by the red dashed line.
It can be observed that predicted values are following the actual gold price trend during the entire time period.
The performance of the XGBoost model is tested using statistical values, where the accuracy of the model is found to be 99.51%. The R^2 score of the model is found to be 0.9986, indicating that there is a strong correlation between predicted values and actual gold price values. The Mean Error of the model is found to be 386.09 INR, indicating that the mean error between predicted values and actual gold price values is very small compared to the gold price range.
Apart from this, the trained model has also been used for making a prediction about the future gold prices. If we consider that the date is 3 October 2025 and the initial gold price is 117370 INR, then it has been predicted by the model that the gold price as of 1 February 2026 will be around 190026.33 INR. Therefore, it can be concluded that the

XGBoost model is extremely accurate in its predictions and is effective in maintaining trends in the data.
The XGBoost model is a reliable model for financial time series prediction using machine learning techniques.

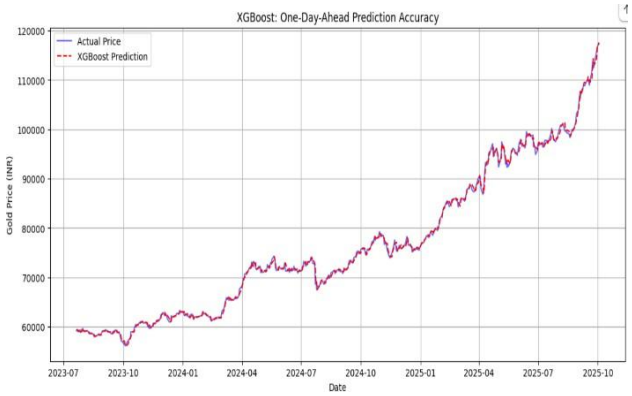

Fig. 4. Actual vs Predicted Gold Price using XGBoost Model

- LSTM

LSTM networks belong to the family of recurrent neural networks designed to process sequential data. Their architecture allows them to remember important information over long periods, which makes them well suited for financial time-series prediction.
The performance evaluation of the proposed Long Short-Term Memory (LSTM) model has been carried out using statistical error measures after the completion of the training process on the historical data with gold prices and economic factors.
From the experimental results, it has been observed that the proposed model has achieved a Mean Absolute Error MAE of 2307.20 INR along with an accuracy level of 97.03%. The low value of MAE indicates that the closeness between the predicted gold prices and actual gold prices in the market is high.
Furthermore, it has been observed that the proposed model has also been effective in predicting the future gold prices in the market. For example, it has been observed that the proposed model has predicted a gold price of 140,068.82 INR on 1 February 2026.
From the experimental results, it has been observed that the proposed deep learning based gold price prediction approach has been effective in predicting the gold prices, which can help in understanding the trends in the future.

I. MODEL EVALUATION

To determine the effectiveness of the implemented models, several performance metrics were used.

- Mean Absolute Error MAE

MAE calculates the average magnitude of errors between predicted and actual values. Lower MAE values indicate higher prediction accuracy.

- Coefficient of Determination (R^2)

The R^2 metric measures how closely predicted values match actual observations. A higher R^2 value indicates better model performance.
Each predictive model was trained using historical data and evaluated using a separate testing dataset.

4. EXPERIMENTAL RESULTS

For the experimental evaluation, the focus was on the evaluation of the performance of the Random Forest, XGBoost, and LSTM models.
The results show that the inclusion of the macroeconomic factors allows the performance of the prediction models to better reflect the market movements.
For the models, it is clear that the highest accuracy in terms of prediction is achieved by the LSTM model.
This is attributed to the capability of the model to learn the dependencies, hence better understanding the patterns in the data.
However, the performance of the Random Forest and XGBoost models, though accurate, is lower compared to the performance of the LSTM model.

5. COMPARATIVE ANALYSIS

To assess the efficacy of various prediction methods, the performance of the models developed using the LSTM, Random Forest Regressor, and XGBoost algorithms is compared in terms of their accuracy and error.

The analysis indicates that the overall trend in the movement of gold prices is successfully captured by the three models. However, the accuracy and error values differ based on the learning method adopted.

The accuracy value for the LSTM model is 97.03%, and the Mean Absolute Error MAE is 2307.20 INR. Although the LSTM model is appropriate for sequential data in time series problems due to its ability to learn dependencies in time series data, the error value is slightly higher compared to the tree-based models.

The Random Forest Regressor had the best performance for all the models. It achieved an accuracy of 99.76%, along with a low mean absolute error of 191.45 INR. This implies that the predicted gold prices were very close to the actual values.

The XGBoost model had good predictive capability for the given data set, achieving an accuracy of 99.51%, an R^2 score of 0.9986, and a mean error of 386.09 INR. The performance of the model is slightly low, but it is still on the higher side, showing good trend-following capability.

Table 1 : Compares the three models in a clear way -

Model	Accuracy	Error Metric	Predicted Price for 01- Feb-2026
LSTM	97.03%	MAE=2307.20 INR	140068.82 INR
Random Forest	99.76%	MAE = 191.45 INR	189059.24 INR
XGboost	99.51%	MAE = 386.09 INR	190026.33 INR

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