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Content

Historical Analysis and Forecasting of Gold Price as an Economic Indicator

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Abstract

The aim of this study was to analyse the gold price development during the period 2020–2024 and subsequently to forecast the gold price development for the period 2025–2030. To achieve this objective, the content analysis and data description method was used to process historical data, and the Exponential Smoothing forecasting model was used to estimate future trends. The analysis of historical data was conducted on the basis of daily closing prices of gold, while the predictions relied on trend and seasonal components of time series. The results showed that in 2020–2024, the gold price was affected by major global events such as the COVID-19 pandemic, geopolitical conflicts and monetary policies. The most notable rise occurred in 2020, when the price peaked at USD 2,075 per troy ounce. The forecast for 2025–2030 indicated a continuous rise in the price of gold, which is expected to reach approximately USD 5,500 by the end of 2030. This growth reflects anticipated global economic conditions, in particular rising inflation and the demand for gold as a safe-haven investment. Although the Exponential Smoothing model provided accurate results, the research remains limited by its dependence on historical data, which cannot account for unexpected future events such as geopolitical changes or technological innovations. Nonetheless, the findings of this study offer valuable information for investors and analysts that can be further used to better understand the gold market's dynamics and to formulate long-term investment strategies.

Keywords: gold price evolution, forecast, investment strategy, time series, economic analysis, Exponential Smoothing model, market volatility.

Introduction

Today, commodities are a standard part of investment portfolios. They constitute a fundamental pillar for modern society, and their price fluctuations can have a major impact on macroeconomic stability, production processes and the security and well-being of the population. They can be characterised as primary raw materials or commodities that serve commercial purposes. They can be purchased in several ways. An average consumer chooses between partial one-time and long-term purchases or mass purchases. Commodity trading occurs most often on commodity markets which are strictly meant for trading raw or basic materials, not finished products. At the same time, commodity markets play a crucial role in the international competitiveness of industries and their sustainable development (Zhang et al., 2022a). Forecasting prices of precious metals is crucial for a wide range of stakeholders, including investors, traders, policy makers, and researchers. This discipline poses a major challenge due to significant price fluctuations and irregular cycles, which in turn affect the price development of these metals (Liu et al., 2020).

Commodities can be divided into two basic groups, namely soft and hard. Soft commodities include agricultural products such as wheat, cattle, coffee, cocoa, and sugar. Hard commodities, on the other hand, are obtained through mining or other extraction processes and include, for example, gold, rubber, natural gas and oil. In addition, the range of commodity markets has recently expanded to include new items such as emission allowances, electricity, and even mobile phone minutes (Teall, 2023).

The position of commodities within investment portfolios is one of the most effective inflation protection tools because their prices usually rise during inflationary periods, which brings advantages for investors. In the context of portfolio management, hedging constitutes a proactive risk management strategy designed to protect the portfolio from undesirable market fluctuations by incorporating assets whose values tend to move in the opposite direction to the market. While efforts to minimize risk can reduce losses, they can also reduce potential gains (Uzik et al., 2023). Spikes in commodity markets are rare. Extreme events occur less frequently than in equity markets (Nguyen & Prokopczuk, 2019).

In times of economic uncertainty, when inflation is rising and trust in the traditional banking system is falling, people are looking for alternatives to protect their assets. One often mentioned option is gold as a means of payment. With its thousand-year history as a store of value, gold is regarded as a stable investment. Its use as money dates back to antiquity and it still plays an important role in the global economy. One of the main advantages of gold is its limited quantity, which means it does not succumb to inflation as quickly as paper money. Additionally, gold cannot be "printed" by the government, making it a reliable investment and protector of value in uncertain times (Uzik et al., 2023).

Gold, as a commodity of substantial economic value, experiences price volatility driven by a range of factors such as macroeconomic conditions, political shifts, and market

sentiment. The interplay of these factors makes the future trend of the gold price complex and difficult to forecast. However, for investors, the ability to accurately estimate the future trend of gold prices is essential to making sound investment decisions and achieving desirable returns. Therefore, forecasting gold market price trends remains a key and critical issue in finance.

The study of gold prices prediction for better financial risk management has recently focused on the application of advanced hybrid models that combine deep learning techniques and time series analysis. Amini et al. (2024) use CNN-Bi-LSTM hybrid model with automatic parameter tuning, which, by combining convolutional neural networks (CNN) and long short-term memory (LSTM), achieved high accuracy in predicting the closing gold prices over the period 1978–2021. In this model, CNN identifies key patterns in the data, while LSTM is able to preserve the sequential relationships needed for more accurate long-term forecasting. This approach was effective in improving financial forecasts and managing the risk associated with gold volatility.

A recent study investigated the capabilities of the hybrid VMD-RES.-CEEMDAN-WOA-XGBoost model (Guo et al., 2024), which uses the Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) to decompose complex information. Here, the XGBoost algorithm, optimized by the Whale Optimization Algorithm (WOA), yields better performance than traditional forecasting models. The results show that this hybrid model provides better gold prices predictions based on COMEX data and confirms the effectiveness of combining optimization and analytical tools that can work with complex market data structures.

In another study, Garcia-Gonzalo et al. (2024) discuss the construction of time series datasets using three techniques: direct multi-step, recursive multi-step and direct-recursive hybrid scheme. This research introduces new methods, nonlinear autoregression with exogenous variables (NARX SVR) and Gaussian process regression (GPR) optimized by differential evolution (DE), which leads to higher accuracy in forecasting gold spot prices from COMEX. The NARX DE/SVR method has proven to deliver the best results, highlighting the importance of new regression methods and hyperparameter optimization in prediction of price time series.

The forecast of monthly gold prices from 1978 to 2023 using ARIMA and multilayer perceptron (MLP) models was analysed in Gbadamosi et al. (2024). The study showed that the optimized hyperparameter setting significantly improves the forecasting abilities of MLP while reducing the mean squared error and mean absolute error (MSE and MAE). The results clearly show that MLP outperforms the ARIMA model, confirming the advantages of using neural networks in financial analysis.

Qiu et al. (2024) come up with an innovative two-stage hybrid model that combines feature extraction and residual correction techniques in order to predict gold prices. In this model, a variational modal decomposition is used to categorize the time series data, while convolutional neural networks (CNN) and long short-term memory (LSTM) provide higher accuracy of the analysis. The model has proven that the two-stage approach not

only improves prediction results but also provides valuable insights into the dynamics of gold markets.

Further research by Quan and Shi (2024) focuses on improving the predictive ability of LSTM in forecasting gold futures prices. By integrating the CEEMDAN technique to decompose complex time series, the data can be separated into different components of intrinsic mode function (IMF), which are then independently modelled by LSTM. The use of the Random Forest algorithm for weighted aggregation of individual component predictions reduces the prediction error by 30–50%, highlighting the importance of combining CEEMDAN and LSTM in more accurate analyses.

Economic shocks such as trade wars or the COVID-19 pandemic cause significant gold prices fluctuations. In response to this volatility, Yang et al. (2024) propose a hybrid model that combines Hurst-oriented reconfiguration with machine learning. The model analyses decomposed time series and identifies a negative correlation between the Hurst exponent and prediction error, thereby outperforming traditional methods in terms of directional forecasting accuracy.

Manickam et al. (2023) propose a hybrid Grey-Fourier-Markov model that combines Grey models, Fourier series, and Markov state transition to predict daily changes in gold prices in Indian rupees. The three-step prediction process involves data simulation by Grey models, trend analysis of residual error using Fourier series, and final correction, which shows that this approach achieves more accurate results than conventional prediction strategies.

In the study by Zhang et al. (2022b), a wavelet transform was applied to bitcoin and gold data to reduce noise, resulting in increased prediction accuracy using the LSTM-P model. The high-frequency noise components were eliminated, which allowed significant accuracy for both bitcoin and gold, and outperformed traditional LSTM models.

Wavelet analysis was also applied in the study of Lee et al. (2021), where its combination with LSTM provided a more efficient prediction of gold futures even for non-stationary data. The results show that wavelet analysis combined with LSTM significantly improves the prediction accuracy under volatile market conditions.

Chen and Zhang (2019) employed a combinatorial model using a pursuit algorithm and BP neural network to select relevant factors and incorporate them into a gold price forecasting model. This approach simplified the network structure and increased the learning rate, leading to more accurate predictions.

Khan and Bhardwaj (2019) investigated the prediction of gold prices in India using data mining and RapidMiner modelling tool to analyse the MCX Gold time series from Quandl database. Data mining enabled efficient extraction of relevant patterns and factors, leading to accurate predictions of gold prices in INR.

In their paper, Xie et al. (2019) examine the Dilated Convolution Long Short-Term Memory (DCLSTM) model, which integrates CNN and LSTM and includes multiple prediction variables. The results show that this model significantly outperforms

traditional approaches such as ARIMA and CNN, demonstrating the high potential of advanced neural networks in forecasting.

E et al. (2019) present ICA-GRUNN technique that combines independent component analysis (ICA) and Gated Recurrent Unit Neural Network (GRUNN) for accurate gold price prediction. The results show that ICA-GRUNN outperforms commonly used methods such as ARIMA or RBFNN and provides higher accuracy, making it an effective tool for financial forecasting.

For the first research question, the method of content analysis and data description will be utilized to determine the development of gold prices in the period 2020–2024.

For the second research question, Python is used to forecast gold prices for the period 2025–2030.

The aim of the paper is to evaluate the development of gold prices and predict their future trends in the next five years.

To achieve this objective, the following research questions were defined:

RQ1: What was the development of the gold price in the period 2020–2024?

This question focuses on the analysis of the gold price trend from 2020 to 2024, a time period heavily influenced by global events such as the COVID-19 pandemic, subsequent economic uncertainty and geopolitical conflicts. An examination of the gold price during this period will offer insight into how gold responded to the increased volatility in the markets. This analysis will result in the identification of the main trends and influential factors that have contributed to the rise or fall in the value of gold.

RQ2: How will the gold price evolve in the period 2025–2030?

This question focuses on forecasting the future price of gold over the period 2025–2030 based on an analysis of past trends and patterns of market behaviour. Answering this question will allow a better understanding of the potential influences and trends that could shape the gold market in the coming years. Forecasting gold price developments over this horizon will contribute to better planning of investment strategies and provide useful information for risk management and long-term financial decision-making.

Methods and Data

To answer the first research question - "What was the development of the gold price in the period of 2020–2024?" - secondary data obtained from the Stooq platform, which provides freely available financial and economic data, were used. Historical data on gold prices was downloaded directly from the website www.Stooq.com. The data download was set from 1 January 2020 to 31 November 2024 with a frequency of daily records. The file contained the following variables: date (Date), opening price (Open), high and low price (High, Low), closing price (Close) and trading volume (Volume).

The downloaded CSV file was subsequently converted to Excel format named

Vyvoj_zlata.xlsx and saved in the same directory, where further data processing was carried out using Python. The analysis primarily utilised the closing price of gold (Close), which provides key information on the daily market trend.

Methods

For the analysis of the historical development of gold prices in 2020–2024, the method of content analysis and data description was chosen. This method allowed to analyse the characteristics of the price development on the basis of summary statistics and visual representations of the data. The data were processed in Python (version 3.12) using the pandas and matplotlib libraries. First, the data were read from an excel file and filtered for the period from 1 January 2020 to 12 December 2024. Subsequently, basic indicators such as mean, median, standard deviation and variance of closing prices were calculated. The results were visualized using a chart that provided an overview of the trends and volatility of gold prices over the period analysed.

For the second research question - "How will the gold price evolve in the period 2025–2030?" - the Exponential Smoothing forecasting model was employed and implemented via the statsmodels library. This method, which is suitable for time series with a trend and seasonal component, was applied to historical data from 2020–2024. First, a model with an additive trend and a seasonal component with a period of 365 days was created, which corresponds to annual cycles in the time series. The model was fitted to historical data that were used to produce a forecast up to 31 December 2030. A corresponding date was generated for each predicted value, allowing the forecasted prices to be linked to specific days.

The result of the analysis was Table 2, which includes the forecasted data. The table contained columns with the dates, the closing prices for the historical data and the forecasted prices for the period 2025–2030. The outputs also included a graph that combined the historical data with the forecast. This graph illustrated the trend in gold prices over the period analysed and facilitated the interpretation of the results.

Results

This chapter presents the results of the analysis of the historical development of gold prices in 2020–2024 as well as forecasts for the period 2025–2030. The description of the results is based solely on the methods presented in the chapter Data and Methods, thus ensuring a factual and logical structure. The presentation of the results includes graphs and tables that provide a more detailed view of the data analysed.

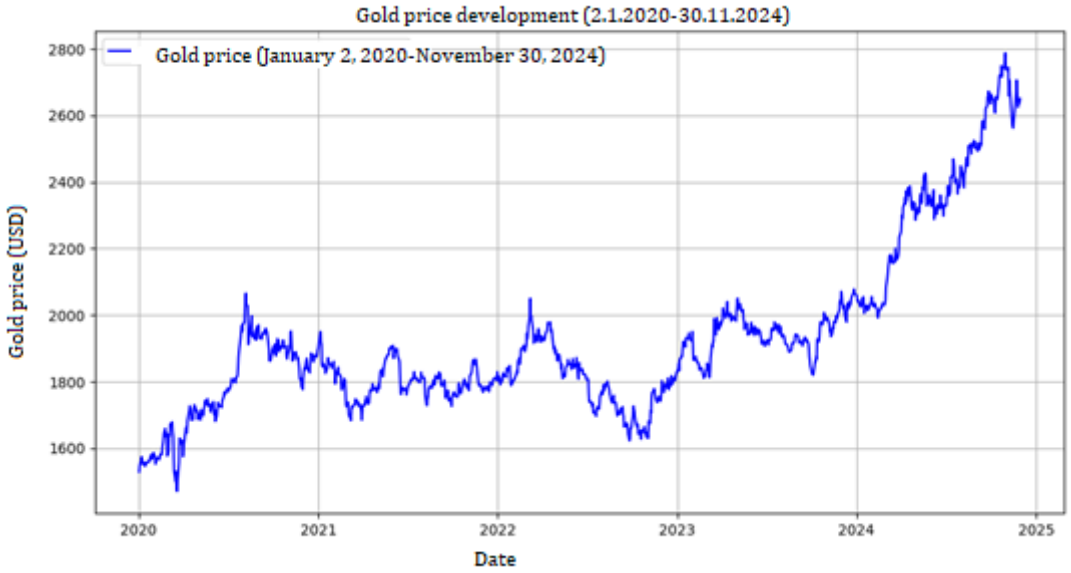
The Evolution of Gold Prices in 2020–2024

The gold price trend from 2020 to 2024 was analysed based on historical data obtained from the Stooq platform, which included daily closing gold prices in USD per troy ounce, with the reported period beginning on 2 January 2020 and ending on 30 November 2024. This data provide a detailed overview of the daily gold price development and form the basis for trend analysis and predictive modelling. Data processing was done in Python, using the pandas library for time series analysis and the matplotlib library for

visualization.

Figure 1 shows the evolution of the gold price over the period under analysis. The graph illustrates the significant volatility of the gold price, which reflects the major events of the period.

Figure 1: The evolution of gold prices in 2020–2024



Source: Authors (via Python)

Year 2020

Figure 2: The evolution of gold prices in 2020

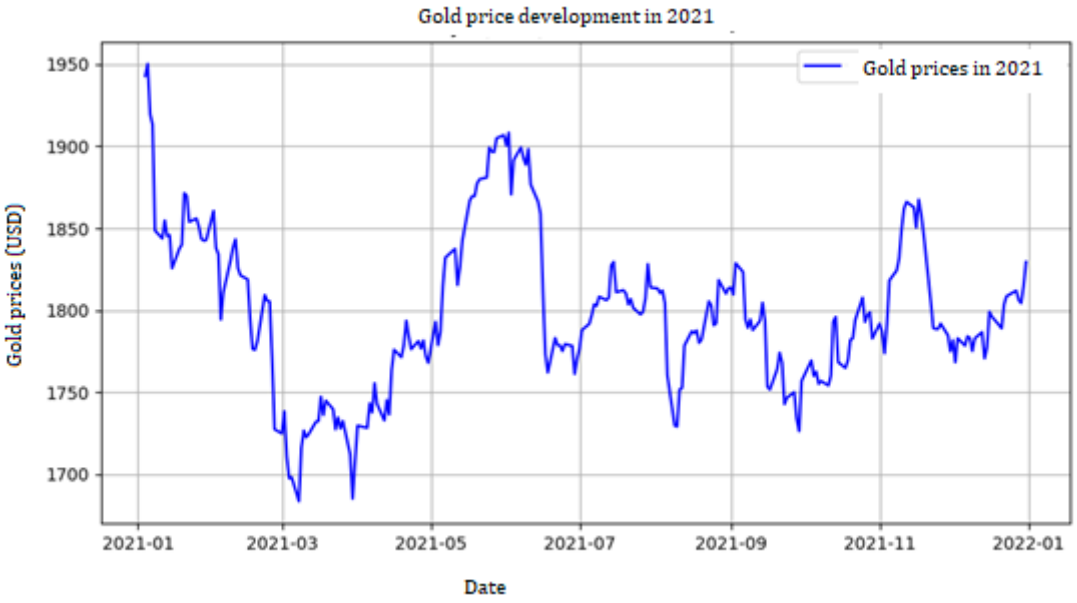
Source: Authors in Python

The year 2020 was characterised by a dramatic rise in the price of gold, with the horizontal axis showing each day in 2020, while the vertical axis shows the gold price in

USD per troy ounce. Each point on the graph represents the daily closing gold price. The gold price ranged from USD 1,550 to USD 2,075. This growth was driven by the COVID-19 pandemic, which caused uncertainty in financial markets and increased demand for safe investments. Gold reached its highest value in August 2020, when it exceeded USD 2,075 per troy ounce. This peak was followed by a slight decline and a stabilisation of the price around USD 1,900 towards the end of the year.

Year 2021

Figure 3: The evolution of gold price in 2021

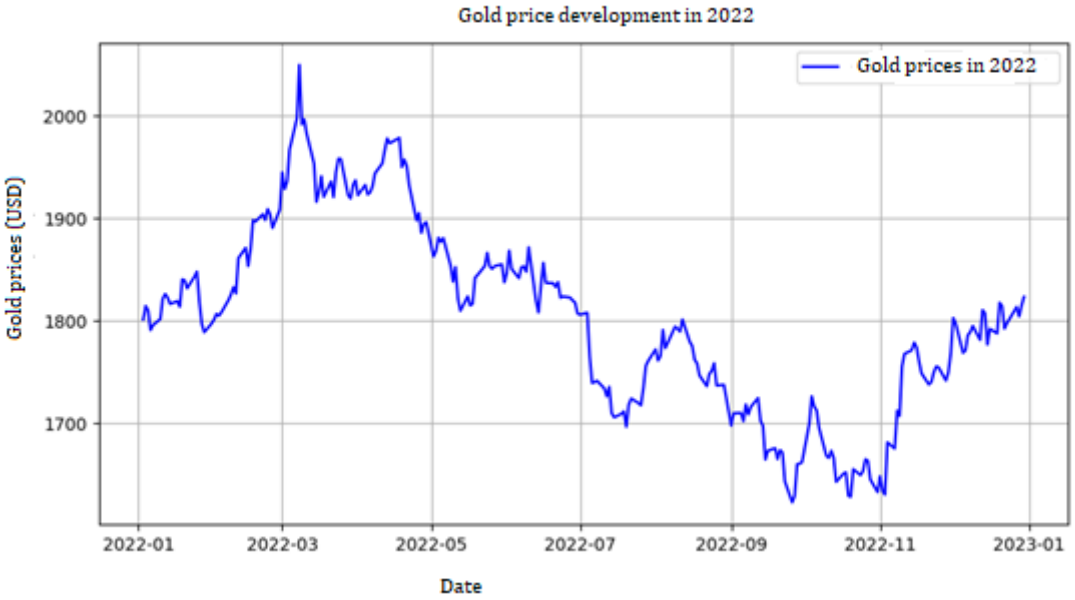


Source: Authors (via Python)

The year 2021 shows a stabilization of the gold price after a sharp rise in the previous year. The horizontal axis shows days in 2021, and the vertical axis shows the gold price in USD per troy ounce. Each point on the graph corresponds to the daily closing price of gold. That year, the gold price ranged between USD 1,750 and USD 1,900. The year was characterised by relative stability as economies began to recover from the pandemic. Inflation helped to keep the gold price higher, but its growth was limited by expectations of rising interest rates.

Year 2022

Figure 4: The evolution of gold price in 2022

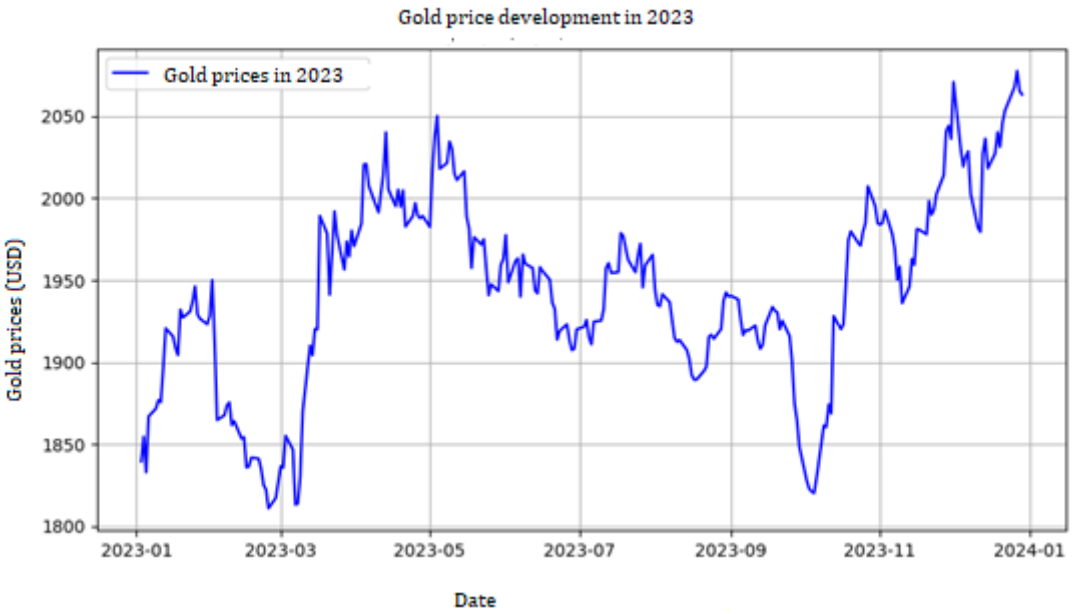


Source: Authors (via Python)

In 2022, the impact of geopolitical events was reflected in the price of gold. The horizontal axis shows days in 2022, and the vertical axis shows the gold price in USD per troy ounce. Each point represents the daily closing price of gold. The gold price ranged from USD 1,800 to USD 2,000. The highest levels were reached at the beginning of the year when the gold price rose sharply due to geopolitical uncertainty related to the conflict in Ukraine. However, the price went down in the second half of the year and stabilised at around USD 1,800.

Year 2023

Figure 5: The evolution of gold price in 2023

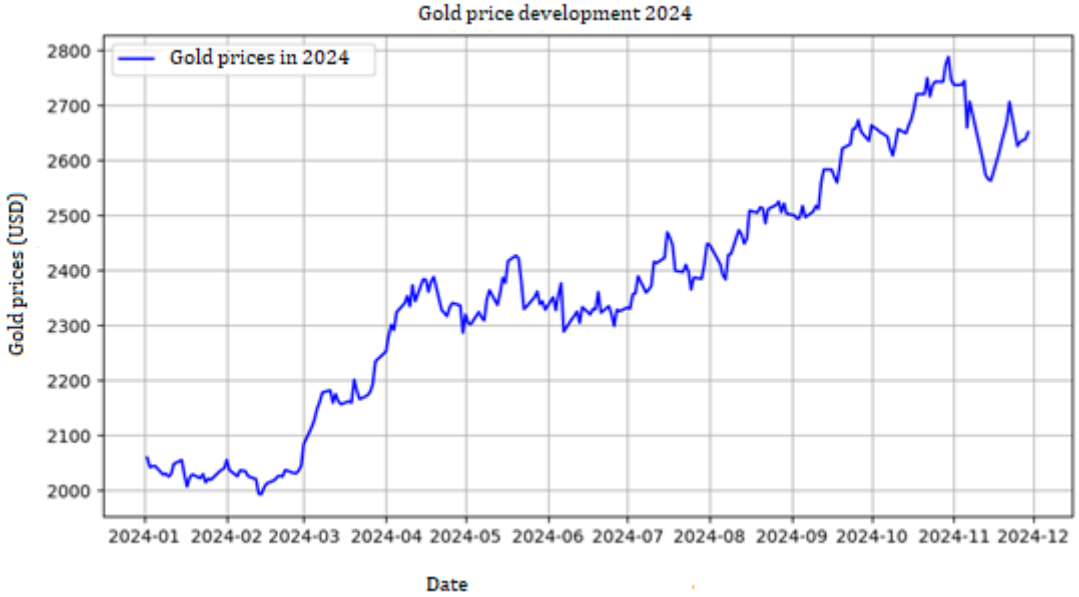


Source: Authors (via Python)

In 2023, the growing trend resumed mainly due to the weakening of the US dollar and rising inflation, which boosted demand for gold as a store of value. At the end of the year, the gold price reached approximately USD 2,050 per troy ounce. This rise was also influenced by increased demand from central banks, which continued to diversify their reserves.

Year 2024

Figure 6: The evolution of gold prices in 2024



Source: Authors (via Python)

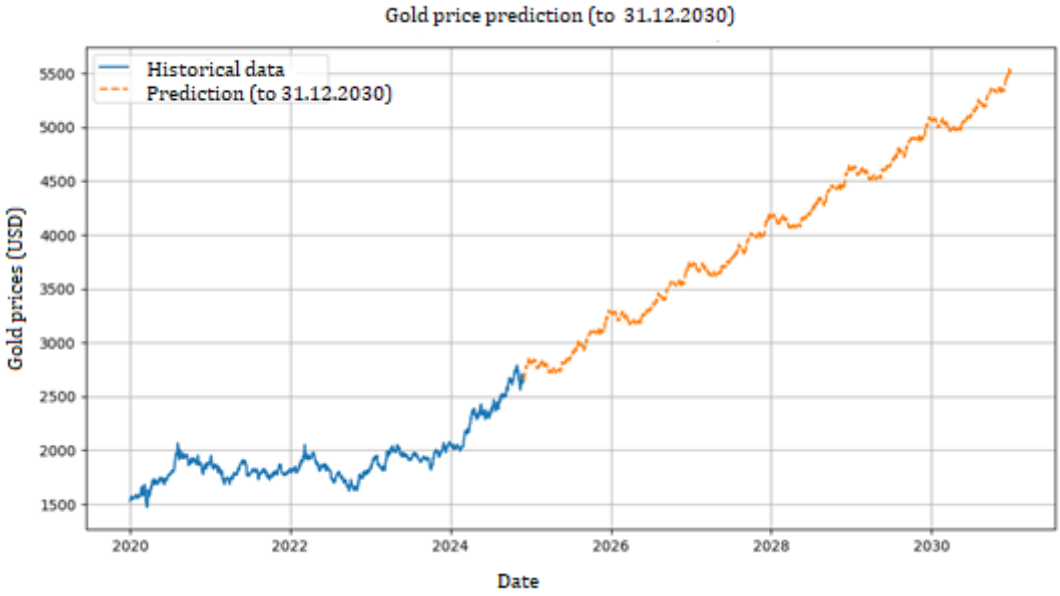
This year shows one of the most significant increases in the gold prices over the period under consideration. The horizontal axis represents days in 2024, and the vertical axis represents the gold price in USD per troy ounce. Each point on the graph corresponds to

the daily closing price. In 2024, the gold price ranged from USD 2,000 to USD 2,800. The largest increase was recorded in the second half of the year, when demand for gold as a safe investment increased due to geopolitical uncertainty and inflation.

Gold Price Forecast for the Period 2025–2030

Forecasting gold prices was performed using the Exponential Smoothing model, which was implemented via the statsmodels library in Python. The model included an additive trend and a seasonal component with a period of 365 days, which corresponds to the annual gold price cycle. The input data included historical data from 2020–2024, as recorded in Table 1.

Figure 7: Gold price forecast for 2025–2030



Source: own processing from Python

The forecast graph for 2025–2030 includes the evolution of the gold price. There are two curves in the graph, the blue curve shows historical data on the gold price in 2020–2024, the orange curve shows the gold price forecast in 2025–2030. The horizontal axis represents the period from 2025 to 2030, and the vertical axis shows the predicted gold price in USD per troy ounce. Each point on the graph corresponds to the predicted daily price. The forecast suggests a gradual rise in the gold price from USD 2,800 at the beginning of 2025 to around USD 5,500 at the end of 2030. This growth reflects the long-term trend of increasing demand for gold as a store of value, particularly in emerging markets. The biggest jump in the price is expected between 2027 and 2030 when gold will exceed USD 5,000.

Year 2025

In 2025, the predicted gold price starts at around USD 2,800 per troy ounce. A steady increase is seen during the year, with the price reaching approximately USD 3,000 by the end of the year.

Year 2026
In 2026, the gold price will continue to rise. At the beginning of the year, it will be around USD 3,000 and at the end of the year it will reach approximately USD 3,500.

Year 2027
The forecast for 2027 suggests a stronger increase in the gold price. During this year, the price will exceed USD 4,000 per troy ounce and reach about USD 4,200 at the end of the year.

Year 2028
In 2028, gold is forecasted to continue to rise, with the price at the beginning of the year around USD 4,200 and around USD 4,500 at the end of the year.

Year 2029
In 2029, the gold price will exceed the important threshold of USD 5,000 per troy ounce. At the beginning of the year, the price will be approximately USD 4,500. By the end of the year, it will reach approximately USD 5,200.

Year 2030
The year 2030 is closed at around USD 5,500 per troy ounce. The gold price at the beginning of the year will be around USD 5,200.

The results of the forecast suggest that gold will continue its upward trend due to its stable position in the market as a safe investment instrument. The expected values suggest a gradual increase in price from around USD 2,800 at the beginning of 2025 to around USD 5,500 at the end of 2030. This evolution reflects anticipated global economic conditions such as rising inflation and increasing demand for precious metals, particularly in emerging markets. Although the forecast shows a consistent upward trend, it should be borne in mind that the results may be affected by unexpected factors such as geopolitical changes or economic shocks. However, this analysis provides valuable insights for investors and other stakeholders interested in the future development of the gold market.

Discussion

RQ1: What was the development of the gold price in the period 2020–2024?
The results of the analysis showed that the gold price was subject to significant fluctuations between 2020 and 2024, which were influenced by key global events. 2020 saw a sharp rise in the gold price, which peaked at USD 2,075 per troy ounce in August. This increase was a direct result of the COVID-19 pandemic, which caused uncertainty in the financial markets. This period was followed by price stabilisation around USD 1,900. The years 2021 and 2022 were characterised by lower volatility and stabilisation of prices within the range of USD 1,750-2,000. Major geopolitical events, such as the conflict in Ukraine in 2022, led to a temporary increase in prices, which later stabilised. In 2023 and 2024, the gold price rose again due to the weakening of the dollar, inflation and increased demand from central banks.

The identified trends are consistent with the findings of studies such as Guo et al. (2024),

which highlights the influence of geopolitical and economic factors on gold price volatility. Similarly, the results corroborate the findings of Liu et al. (2020), who identified the pandemic as a significant factor in the rise of precious metal prices.

RQ2: How will the gold price evolve in the period 2025–2030?
The predictive analysis shows a continuous rise in the gold price between 2025 and 2030. At the beginning of 2025, the price is around USD 2,800 per troy ounce, reaching approximately USD 5,500 at the end of 2030. This growth reflects the long-term trend also identified in Amini et al. (2024), which shows that demand for gold as a store of value remains strong. The greatest acceleration in rise was predicted for the period 2027–2030, consistent with the anticipated uncertainty in global markets and growing demand from developing markets, particularly in Asia.

The prediction model used in this paper proved to be a suitable tool for time series analysis with trend and seasonal components. This approach enabled more accurate results than traditional methods such as ARIMA, which was also confirmed in the studies of Gbadamosi et al. (2024).

Although the chosen methods provided detailed insights into the development and prediction of gold prices, several limitations should be considered. The prediction is based on historical data which cannot take into account unexpected events such as new geopolitical conflicts, economic crises or technological changes that may significantly affect the gold market. In addition, the Exponential Smoothing model does not include all possible exogenous factors, such as demand and supply dynamics at the micro level.

The results of this study are in line with previous research that emphasizes the importance of macroeconomic and geopolitical influences on gold prices. However, the paper provides a better prediction due to the applied model and detailed analysis. Unlike studies using simpler forecasting approaches such as ARIMA, the model employed here provides higher accuracy and better captures seasonal trends. This result is consistent with the findings of Guo et al. (2024) and confirms the efficiency of advanced hybrid models in forecasting.

The results of this analysis provide not only answers to the research questions posed, but also useful insights for investors and analysts interested in the evolution of the gold price in the context of changing global conditions.

Conclusion

The aim of this study was to analyse the gold price evolution in 2020–2024 and to forecast the gold price for the period 2025–2030. To achieve this objective, content analysis and data description methods were used for historical analysis and the Exponential Smoothing prediction model was applied to forecast future trends. The results of the study thus answer both research questions and provide a comprehensive view of gold price evolution.

The analysis of historical data showed that, in 2020–2024, the gold price was affected by key global events such as the COVID-19 pandemic, geopolitical conflicts and economic uncertainties. The gold price reached its highest level in 2020, when it exceeded USD 2,075 per troy ounce. This sharp rise was driven by high uncertainty in financial markets and demand for safe investments. Subsequently, the price stabilised within a range of USD 1,750-2,000, with an upward trend again observed in 2023 and 2024. During these years, there was an increase in demand for gold as a store of value, particularly in response to inflation and growing economic uncertainty. These findings confirm the importance of gold as a safe investment in times of economic uncertainty.

The Exponential Smoothing forecasting model used historical data to create a forecast for 2025–2030. The results of the forecast suggest a continuous rise in the gold price from approximately USD 2,800 at the beginning of 2025 to USD 5,500 at the end of 2030. This growth reflects anticipated global economic conditions such as rising inflation, geopolitical uncertainty and continued demand for gold, particularly in emerging markets. The analysis shows that gold will retain its role as a strategic investment in the future. Additionally, the model has shown the ability to accurately predict long-term trends and identify seasonal influences, which increases its utility for forecasting purposes.

One of the main contributions of this paper is the emphasis on combining historical analysis and forecasting, which together provide a comprehensive view of the gold market. The historical analysis revealed key factors influencing the gold price, such as macroeconomic stability, geopolitical events and monetary policy. The forecast for 2025–2030 offers specific outcomes that can be useful for investors and analysts. Moreover, the identification of a stable growth trend underlines the importance of gold as a store of value in an environment of rising inflation.

The findings meet the stated objective of the study and contribute to the understanding of gold market dynamics. The results answer both research questions, showing not only the historical evolution of the gold price but also its potential development in future years. Apart from enabling the retrospective analysis of historical events, this approach also provides tools for future decision-making. The applied methodology, particularly the use of the Exponential Smoothing model, proved to be suitable for this type of analysis as it helped to capture both long-term trends and seasonal fluctuations.

However, some limitations of the research need to be considered. Forecasting is based on historical data, which means that unexpected events such as new geopolitical crises, technological innovations or major changes in supply and demand can affect the results. Also, the Exponential Smoothing model does not include all possible exogenous factors, such as dynamics in other precious metals markets or the impact of emerging economies' monetary policies. Nevertheless, these limitations do not diminish the contribution of the paper, but they rather suggest directions for future research.

Historical analysis and forecasts provide valuable information for investors looking for safe and stable investment opportunities. Furthermore, the results can be used by

analysts to develop investment strategies and manage risk. In addition, identifying key trends and factors influencing the gold price contributes to a better understanding of the market and its dynamics. This approach may inspire future studies aimed at analysing other commodities or currency markets.

In conclusion, the aim of the thesis was fulfilled. The historical analysis has provided a comprehensive view of the gold price evolution in 2020–2024, while the forecasting model has made it possible to create a specific forecast for the period 2025–2030. This study not only answered the research questions posed, but also provided useful findings that can benefit a wide range of stakeholders from investors to academics. Despite some limitations, the results clearly confirm that gold remains a key commodity with a significant role in global markets, both in terms of current analysis and future forecasts.

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