Investing in Pairs of Precious Metals: Portfolio Theory Application

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Abstract

The paper aimed to examine the price development of gold, silver, and platinum from 1 January 2019 to 27 November 2023. The aim was also to predict the price development of pairs of metals – gold and silver, gold and platinum, and silver and platinum until the end of 2024. The Nearest Neighbours method in Wolfram Mathematica software was used to achieve the set goal. In terms of the development of metal pairs until the end of 2024, it was found that the most profitable pairs for investments are gold-platinum and silver-platinum. If an investor is to invest in a single metal, platinum is recommended. In the case of a pair of metals, it would be appropriate to choose gold-platinum or silver-platinum. The research is limited in terms of the metals selected, a narrower set of historical data to make a prediction, or the selected method.

Keywords

GARCH, Gold, Silver, Platinum, Prediction, Nearest Neighbours, Metal Commodity

Introduction

Over the past decades, people worldwide have been hit by several major crises. All types of crises have common features, such as instability in financial markets or stock markets. These problems impact the wealth of households or firms, as it is affected by inflation over time. Economic entities need to decide on how to manage their wealth so that they do not lose it and even increase it if possible. They can save funds in savings accounts in commercial banks. Witzany & Diviš (2022) found that economic entities are sensitive to the interest rate level and appropriate appreciation to a large extent. As an example, the 2008 crisis, when people deposited more funds in savings accounts than when there was no crisis, can be mentioned. Determinants of this behavior were changes in interest rates (Gerritsen & Bikker, 2020; Sinicakova et al. 2017). The decision to save their funds in a savings account as other factors influence a bank. One of them is the behavior of bank employees. If it is perceived positively by clients, they tend to save more (Birkenmaier & Fu, 2021). Another factor is psychological biases that influence potential clients in their decision to save (Tetteh & Boachie, 2021). On the other hand, knowledge about making financial savings is insufficient in some countries, and financial advisors and educators should deal with it (Despard et al., 2020; Sinicakova & Gavurova, 2017).

An alternative is investing in the stock markets. Stocks and stock indices are characterized by high volatility. Here, too, the personality traits of investors play an important role. According to a study, there are direct positive relationships between investment in the stock market and investors' personality traits and behavior (Argan et al., 2021). Investors can also invest in cryptocurrency or bonds. This decision is complex to a large extent. Therefore, companies use various decision theory methods or methods of analytical hierarchical process (Kuznichenko et al., 2019). Cryptocurrencies are considered a decentralized electronic currency. They are characterized by high volatility and are considered highly risky. Social networks, such as X (Twitter formerly), are used to predict their price development because they enable tracking people's views and attitudes towards individual cryptocurrencies and thus predict their price behavior (Rouhani & Abedin, 2019). However, trading them can harm people, just as betting can. Due to the instant access, compulsive price checking also poses a risk (Delfabbro et al., 2021). Despite these negatives, cryptocurrencies are currently a common part of the investment portfolio of any investor, as they help to improve the risk-return ratio (Trimborn et al., 2018). Another option for companies and households is real estate investment.

This type of investment is used by less experienced people because they are worried about their financial situation. In the USA, these investors typically invest in properties in the neighborhood with a lower standard of living. This is associated with high financial risk (Garboden, 2023). Research shows that returns on these investments outperform the returns of market indices. Investors can achieve higher returns if they do not finance the purchase of the investment property with a mortgage, the investment property is close to the investor's home, and the investor has some investment experience (D'Lima & Schultz, 2021).

The paper primarily focuses on investment in precious metals. During the COVID-19 pandemic, when CNB released funds into circulation, people began to look for ways to maintain and even increase their value, which could be found in this type of investment. The advantage of owning gold in the form of bullion or coins is their liquidity within tens of hours. What has not been analyzed yet is the question of when to invest in gold or other precious metals. The gold market is very efficient. Investments can be made at any time (Baur et al., 2018). However, predicting the development of gold prices is very challenging. It can be done, for instance, by using artificial neural networks, which can provide a good prediction but are not able to capture the influence of political events, which distorts the prediction (Salis et al., 2019). Nevertheless, it is certain that investors have profited from buying gold in the past. The average annual appreciation was 9 % p.a.

The objective of the paper is to analyze the price development of gold, silver, and platinum and the three combined pairs of these precious metals, specifically, gold and silver, gold and platinum, and silver and platinum, in the past and predict their development until the end of the year 2024.

To achieve the set objective, the following research questions are formulated:

RQ1: What is the predicted trend of selected metal pairs until the end of the year 2024?

RQ2: Is it better to invest in a metal pair or to choose one specific metal?

Literature Review

As already mentioned in the Introduction, precious metals, and gold in particular, provide an interesting alternative for maintaining the wealth of households at the same level. Therefore, it is necessary to mention the fact that besides investment in physical gold, e-gold investment is becoming increasingly popular as well, as it is more advantageous in terms of its better liquidity and security (Rangasamy & Raghavi, 2022).

Many researchers have addressed the development of precious metal prices. Plakandaras et al. (2021) deal specifically with the development of the prices of metals and gold, as they rank it among preferred choices along with equity investments. They created their model to predict the development of the price of gold, where econometric methods and machine learning methods are compared first, which is then used to create the model above. Empirical findings indicate that the created model was able to make better predictions of the gold price

development compared to the common least squares regression (Plakandaras et al., 2021). The same issue is addressed in a study in Pakistan, where Shabbir et al. (2020) focused on the development of the historical prices of gold and the impact of the price on the stock market, which was significant according to their findings obtained using descriptive statistics, correlation, Augmented Dickey-Fuller test, and autoregressive distributed lag test. Research conducted in Turkey deals with the returns of gold prices and Turkish real estate investment trusts. Using the vector autoregression model and Augmented causality tests, it was found that the index performs better in times of crisis than gold. The authors recommend including both instruments in portfolios for future investments, as similar development is expected (Sumer & Ozorhon, 2020). A study conducted in India analyzed the development of gold prices in the period after the COVID-19 pandemic because, at that time, there was instability in the markets, global inflation was growing, the FED or the Federal Banking System was raining interest rates, or governments of individual countries were implementing fiscal policy restrictions. Using the research methods ARCH, GARCH, E-GARCH, A-PARCH, and GARCH-M and collecting daily spot prices of gold in the period from January 2009 to December 2022, the authors found that investment in gold will be relevant in the future, as gold prices in India are highly persistent (Kumaraswamy et al., 2023). This statement is refuted by Beretta & Peluso (2021), who confirm that gold has historically been considered the so-called safe haven and does not show price fluctuations. In contrast, it is very volatile currently. Using a logical-analytical macroeconomic approach and statistical and empirical evidence, it was found that there is a liquidity surplus in the world economy, which is increasingly invested in gold. Moreover, it has been outlined that the price of gold could rise or fall suddenly in the case of speculations (Beretta & Peluso, 2021). Machová & Vochozka (2019) used an artificial Kohnen neural network for a larger amount of data and split it into a 70:30 ratio for training and testing the data, respectively, for better prediction.

According to (2022), the COVID-19 pandemic was and will still be a suitable tool for predicting the development of gold prices in the future. Using statistical analyses, specifically the Johansen cointegration test and the Granger causality test, the impact of the number of COVID-19 cases on the gold price was analyzed. According to the authors, there was cointegration for almost three weeks. The Granger causality test also showed the response of gold prices to the trend of the number of COVID-19 cases (Gautam et al., 2022). Liu (2018) used Chernoshukov quantile regression to examine gold and state bonds as potential safe-haven assets in the future. The application of this method shows that state bonds can be considered a potential safe asset, while gold can be considered a potential passive safe-haven asset, which is not correlated with market turmoil (Liu, 2018). The data on gold prices in the years 1980 - 2016 are used to determine the effect of external and internal macroeconomic performance in the form of exchange and interest rates. Bartoš et al. (2022) use artificial intelligence techniques, such as recurrent neural networks with Long Short Term Memory layers, to process and estimate copper and aluminum prices using time series data from Market Business Insider. An inferred equilibrium real effective exchange rate is used for the investigation, which is estimated using panel cointegration. Furthermore, a panel regression model with a monotonic transition function called Panel smooth transition regression is estimated. The findings suggest that gold serves as a hedge only in the event of high financial risk (Giannellis & Koukouritakis, 2019). For predicting gold price, Dash et al. (2021) developed an efficient prediction model – the Pi-sigma Neural Network, i.e., a neural network model whose advantage is fast learning and better implementation compared to other neural networks. For prediction, Divisekara et al. (2020) used time series modeling to forecast daily prices of financial instruments – gold in this case. The most suitable models for this type of commodity are EGARCH and TGARCH (Divisekara et al., 2020). Yang (2019) used the ARIMA model to predict the development of gold prices in USD for the first half of 2018, considering ARIMA to be the best forecasting model. In contrast, Baguda & Al-Jahdali, (2021) developed an interesting model for predicting gold prices – a so-called intelligent system for predicting and describing trends in the gold market. According to the results of the simulation, the model was able to predict the gold price with high accuracy (Baguda & Al-Jahdali, 2021).

As for research in the Czech Republic, Hájek & Novotný (2022) use their model to predict the development of the gold price. The model is based on the so-called fuzzy rules, with a component processing various aspects of news. The system was tested on historical data, and according to the results, the prediction corresponded to the development of gold prices in the past. The proposed model is more precise and easier to interpret compared to the model of neural networks (Hájek & Novotný, 2022). Brabenec et al. (2020) use daily data on the gold price from the years 2006 - 2020. Within their research, they applied neural networks, decision trees, gradient-boosted trees, linear regression, and the Nearest Neighbours method to predict the development for the next year. Gold was purchased at the beginning of the recession to keep the property value (Brabenec et al., 2020).

As already mentioned in the Introduction, silver is considered an investment alternative to gold. Rowland et al. (2021) dealt with the price development of this precious metal from 2011 to 2021 and the prediction of its further development for the year 2022. They used content analysis and time series smoothing using multilayer perceptron neural networks to achieve this goal. According to their research, silver is capable of keeping its value at any time. According to the prediction, gold should be bought in the first two months of 2022, as it is expected to double its return by the end of that year (Rowland et al., 2021). Wang et al. (2023) developed their model to predict the development since the conventional time series model showed some shortcomings, such as inaccurate

prediction or poor ability of nonlinear fitting. The authors proposed a model that combines conventional neural networks, a self-attention mechanism, and a new gated unit. The model shows better results compared to other models (Wang et al., 2023).

Schweikert (2018) deals in particular with the relationship between gold and silver, applying the quantile cointegration recession model to the prices of gold and silver and the corresponding futures contracts. Assuming a constant cointegration vector, cointegration models are not able to detect the relationship between gold and silver; it is possible to show that a nonlinear long-run relationship exists. During periods of financial turmoil, the price of gold and silver increases (Schweikert, 2018). Eryiğit (2017) developed a vector autoregression model to investigate the relationship between gold and other metals, including platinum. According to the results, platinum shows a short-term correlation with the prices of gold and silver. Naeem et al. (2019) focused on the volatility trend in the case of four precious metals – gold, silver, platinum, and palladium. According to their research, the best model to capture this trend is MSGARCH (Naeem et al., 2019). A recurrent neural network is used to find the platinum's viability as an investment, revealing that it's a valuable asset for investors holding Czech koruna due to its rarity and industrial uses (Vochozka et al., 2022).

The issue of investment in pairs of metals or one metal only is not addressed in detail in scientific databases. From a general perspective, it is analyzed by Thazhugal Govindan Nair (2021), who uses Johansen cointegration and the vector error correction model to investigate the potential of pairs trading of metals in 2008 – 2019. According to the study's findings, current futures prices represent a relatively accurate future estimate of metal spot prices. Thus, the potential of pairs trading of metals is emphasized (Thazhugal Govindan Nair, 2021). Fernandez-Perez et al. (2020) focus on pairs trading using Chinese and international contracts from January 2004 to February 2018 using time series and an out-of-sample test to assess the performance of the pairs. Applying this strategy to metal futures or the portfolio of commodities yields high returns (Fernandez-Perez et al., 2020).

To answer the first and second research questions, document analysis will be used to collect data on platinum, silver, and gold price trends in the past years. Time series regression will be used to determine the future trend until the end of 2024 and to select pairs of metals or a single metal for investment. Gold, silver, and platinum prices are predicted using the GARCH model, similar to Naeem et al. (2019) or Kumaraswamy et al. (2023).

If the data obtained shows low heteroskedasticity, the Nearest Neighbour method will be used to predict the prices. This method was used, for instance, in the research by Brabenec et al. (2020) to predict gold prices.

Material and Methods

As already mentioned, document analysis is used for this study. The same resources are used for both research questions. The data on price development are obtained from the investing.com website, which takes information about prices from the London Metal Exchange. On the homepage, the Commodities section, with an overview of the gold and silver price trends, is presented. By selecting the concrete metal, the daily price movement is shown. This study focuses on the development over the last four years, i.e., from the beginning of 2019 to 27 November 2023. The daily data for gold and silver for the desired period are downloaded from the Historical Data section in .csv format. The trend of the platinum prices for the same period can be found in the section Metals at the top of the page. The same procedure as in the case of gold and silver is followed.

The obtained data need to be edited before working with them. First, it is necessary to convert the three documents from the .csv format into .xlsx so that the data can be further processed in Excel. Since the data are in one cell, the Text function is used to divide them into columns. The last two columns are then deleted, as they are not needed for the research. For numerical values, the format of the numbers needs to be edited. The points that represent commas are replaced by commas using the Replace function. The numbers in the cells then move to the right edge. In the end, the values are transformed into numbers, and the dates in the first column are adjusted to the correct format.

The price of the selected metals is predicted using the GARCH model. This model can be used in the computer program Wolfram Mathematica, where it can be found as GARCHProcess. The GARCH model is essentially a generalized autoregressive conditionally heteroskedastic process or p and q orders driven by white noise. It is a random process with discrete time and continuous state. The model has the following form:

$$GARCHProcess[\kappa,\{\alpha_1, ..., \alpha_q\},\{\beta_j, ..., \beta_p\}]$$ (1)

The coefficients α_i and β_j, as well as κ should not be negative.

GARCHProcess $[q, p]$ also presents the GARCH process of ordering q and p for using the EstimatedProcess function. Using the dataset, it can also be used for this study in the form of the TimeSeriesForecast function to predict the future trend of the selected commodities' prices.

The Nearest Neighbours method will be used for selection or prediction. It infers the class or the value of a new case or example by analyzing its nearest neighbors in the space of elements. It is a type of instance-based learning. In its simplest form, it chooses the most common class or average values among κ nearest neighbors.

In the case of investment in metal pairs, it is necessary to specify the representation in which the imaginary investment shall be made. The budget is one million dollars; for each pair, the amount will be allocated 50:50, i.e., 500,000 USD will be allocated to one metal and 500,000 USD to the other metal.

Results

Since data showed low heteroskedasticity after the final adjustment, the Nearest Neighbour method was used to predict metal prices until the end of 2024. This method is also used in the Mathematica software.

Figure 1 below shows the price development of Troy ounces of gold in the period from 1 January 2019 to 27 November 2023. The prediction is made from the date of 28 November 2023. In the figure, the prediction is represented by a blue dashed curve. At the beginning of the period under review, the price per Troy ounce was around USD 1,300. From the second half of 2019 until the first half of 2020, the price of gold grew gradually, reaching finally USD 2,100. The exception is February 2020, when there was a significant drop to USD 1,400 due to the beginning of the COVID-19 pandemic. This was followed by a slight increase, with prices fluctuating around USD 1,700 per ounce at the beginning of 2021 and USD 1,700 – 1,800 at the end of 2022. From 2023, the price grew again to USD 2,000 and then decreased to USD 1,900 at the end of the period under review. According to the prediction, until the end of 2024, using the Nearest Neighbour method, the price of gold will not change as much as in previous years, with expected fluctuations of around USD 1,800 – 1,900 per ounce. At the beginning of 2020, a short-term increase to USD 2,00 is predicted.

Fig. 1. Trend of price per Troy ounce of gold from 1 January 2019 and 27 November 2023 and the prediction until 31 December 2024
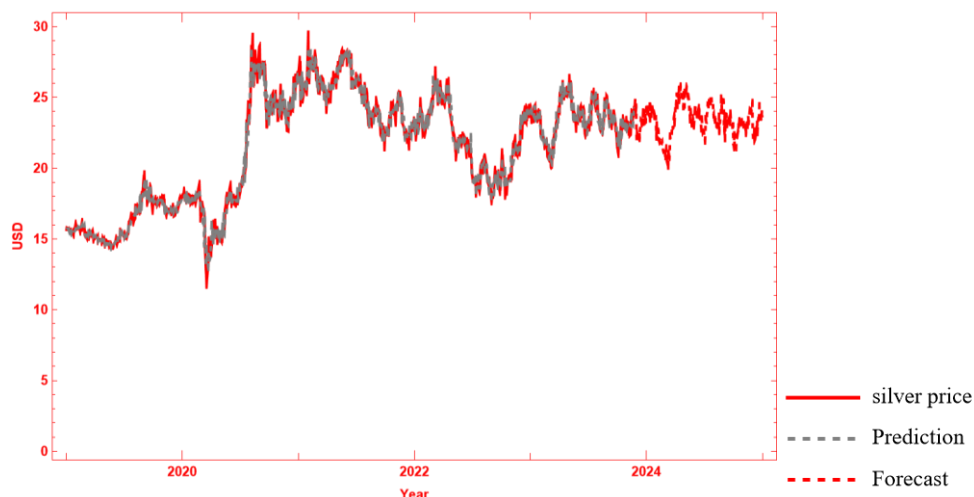

Fig. 2. Trend of Troy ounce of silver from 1 January 2019 to 27 November 2023, with the predicted trend until 31 December 2024

Figure 2 shows the development of the silver price where the price trend of a Troy ounce of silver is examined in the same reference period. In the first half of 2019, the price seems to be stable, about 15 dollars for one ounce of silver. In the second half of the year, the price grows nearly to USD 20. As in the case of gold, the silver price in the first quarter of 2020 declined significantly to USD 11 per Troy ounce. Thereafter, the price rises steeply to USD 30, and until the beginning of 2022, the price ranges between USD 22 and 28. In the first half of 2022, the

price was about USD 20 per Troy ounce, but afterward, it showed a similar trend as in previous years, fluctuating around USD 25. The prediction for the following year is rather consistent with this trend; only at the beginning of 2024 is a fall to USD 20 per Troy ounce of silver predicted.

Figure 3 captures the trend and predicted price development of the remaining metal under review, i.e., platinum, in the same monitored period. The price is given for a Troy ounce. The price of a Troy ounce of platinum grew gradually from the beginning of 2019. The initial value of the monitored period was the price at the level of USD 800 per ounce. Again, the price grew until the first quarter of 2020, reaching up to USD 1,000. This is followed by a shock drop to the level of USD 600 per ounce, as in the previous cases. Then, the price grows again until 2021, reaching the value of USD 1,300, followed by another slight decrease until the second half of 2023. In this period, the price fluctuates around USD 900 – 1,100 per Troy ounce of platinum. According to the prediction, an increase to USD 1,100 per ounce is predicted for January 2024 and March 2024. This is followed by a decrease. The price for a Troy ounce of platinum is predicted to fluctuate between USD 800 – 900.
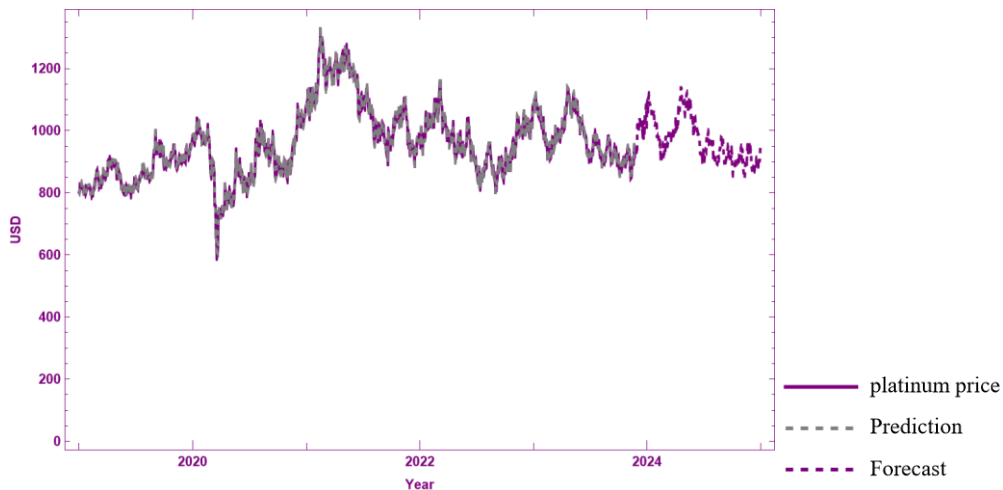

Fig. 3. Trend of Troy ounce of platinum between 1 January 2019 and 27 November 2023 and the predicted trend until 31 December 2024

Figure 4 shows the first pair of metals mentioned in the introduction of the paper, specifically gold and silver. We are particularly interested in predicting the price of the metals, not their trend in the past; therefore, the prediction for the period from 28 November 2023 to 31 December 2024 is presented. To capture the trend of the pair of the selected metals and their final accuracy, it is important to observe the trend of individual metals and the curves that indicate the price of the given pair. The gold-silver pair clearly shows considerable volatility, and its value decreases significantly, especially in March.
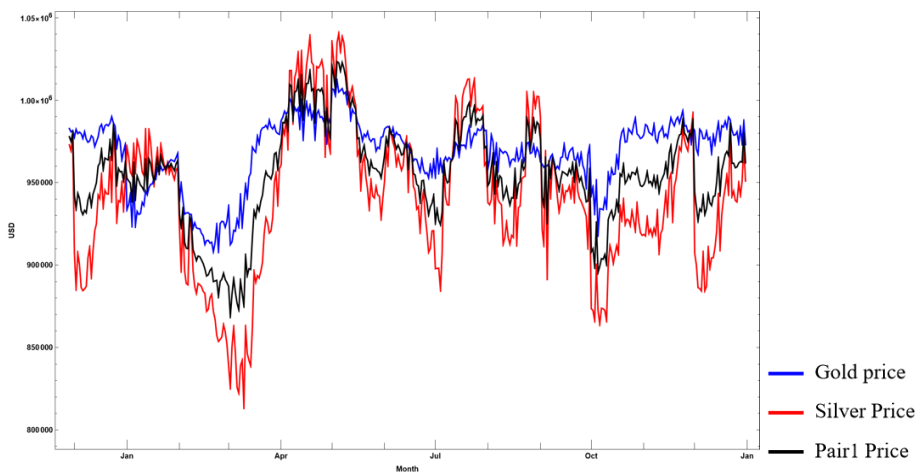

Fig. 4. Predicted trend of pair of metals – gold and silver – for the period of 28 November 2023 – 31 December 2024

Figure 5 below shows the trend of the second pair of metals, namely gold-platinum. In this case, considerable price volatility can also be seen. The price of platinum is higher than the gold price for the whole reference period.
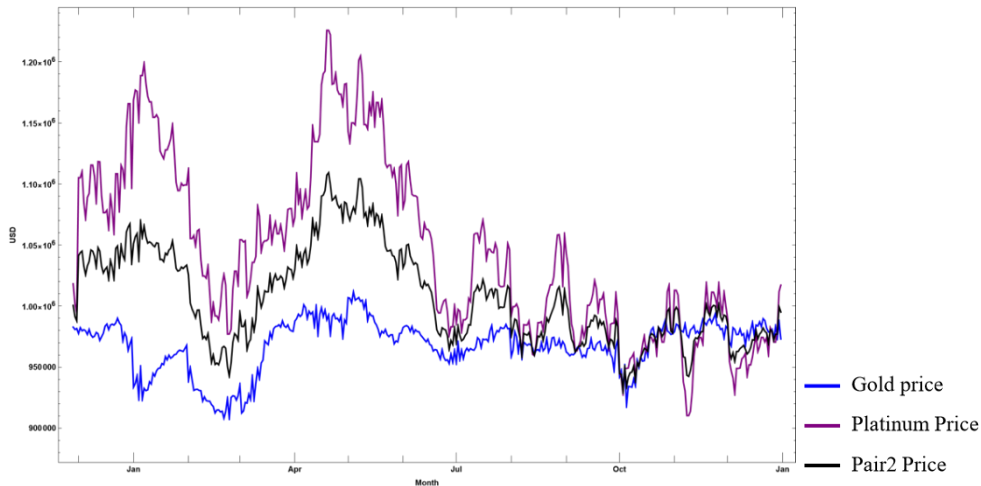
Fig. 5. Prediction of pair of metals – gold and platinum – for the period of 28 November 2023 – 31 December 2024

Figure 6 illustrates the predicted trend of the remaining pair of metals, i.e., silver and platinum. Unlike the other cases, it can be seen that in certain periods of the year, the trend of the silver price was more favorable than the trend of the given pair, specifically from March to April, July – August, and the second half of September.
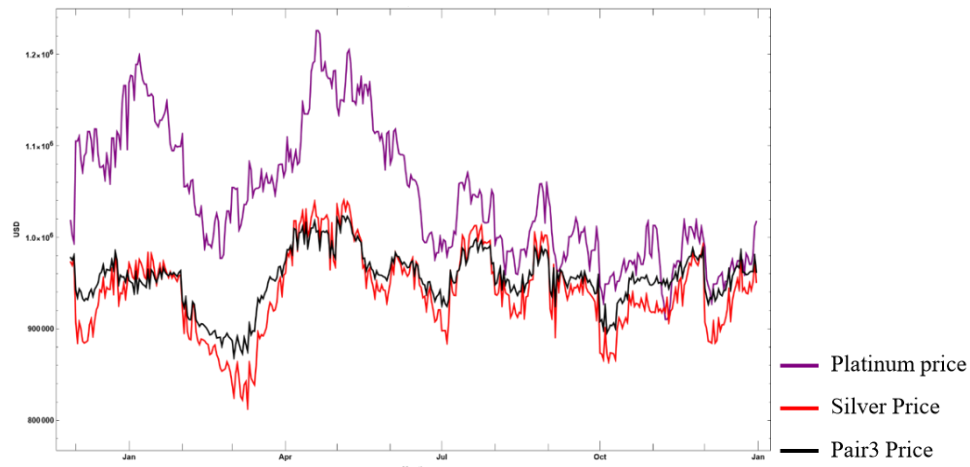

Fig. 6. Predicted trend of metal pair – silver and platinum – for the period of 28 November 2023 – 31 December 2024

The aggregate trend of all three metal pairs can be seen in Figure 7. At first glance, it could be seen that the third metal pair, i.e., silver and platinum, reaches the highest price. This pair is followed by the first selected pair, gold, and silver, which, however, represents the most stable metal pair in the second half of the year.
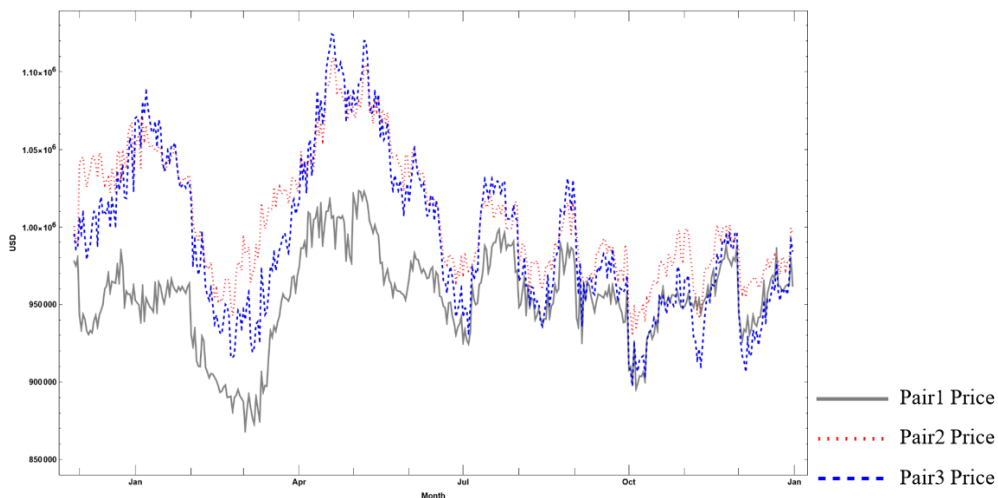

Fig. 7. Prediction of the three selected metal pairs' prices

Figure 8 below provides an overall view of the trend of gold, silver, platinum, and the selected three metal pairs, specifically, gold and silver, gold and platinum, and silver and platinum.
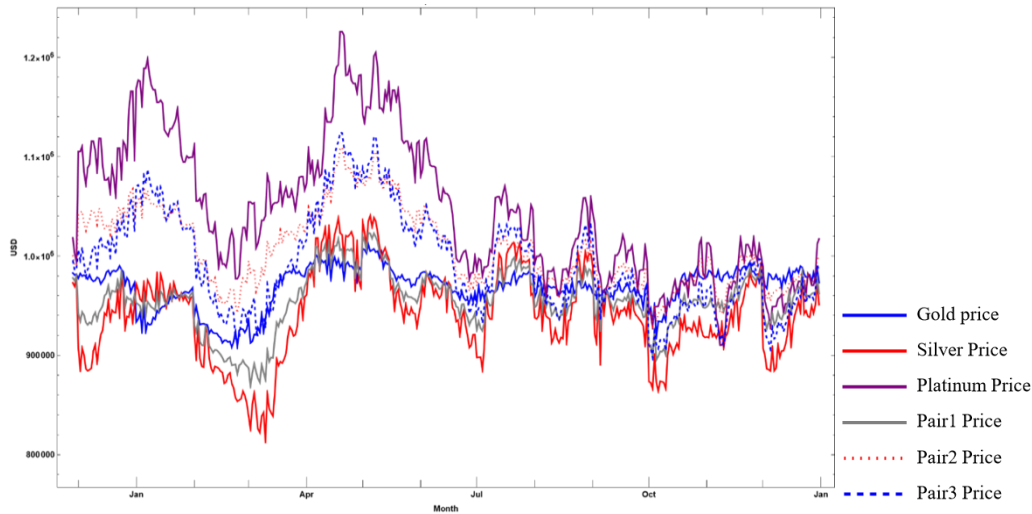

Fig. 8. Prediction of metal and metal pairs prices

Figure 8 will be used to make a complex comparison of individual metal prices as well as metal pairs in the period from December 2023 to the end of the year 2024 and to assess their profitability.

Discussion

Based on the results achieved, it is possible to answer the formulated research questions:

RQ1: What is the predicted trend of selected metal pairs until the end of the year 2024?

The future trend until the end of the year 2024 is predicted for the following three pairs: gold-silver, gold-platinum, and silver-platinum. This trend is presented in Figure 7. As already mentioned, one million dollars is invested in the metal pairs – half a million in each of the metals in the pair. The conditions of the potential investment in all pairs are thus comparable. As seen in the figure, investment in the first metal pair (gold-silver) is not suitable for investment, as for the entire year for which the prediction is made using the Nearest Neighbours method, the investment would be a loss, or the investor would make no profit and remain at a similar level. The investment is predicted to lose its value in the period between the beginning of the year 2024 and April. After that, a slight loss or remaining at the level of the initial investment is expected until the end of the year. This means that this metal pair is suitable in terms of holding value, not for making a profit. The gold-platinum pair looks more favorable in terms of its predicted trend. At the beginning of the year, the investment is predicted to appreciate quickly if the investment is made. For April, certain decrease is predicted. This is the moment when investment should be made, as according to the prediction, reappreciation is expected. It is advisable to sell the metal pair with appreciation in May and June, as its further holding would not be appropriate or rational, and no further appreciation could be assumed. As for the third metal pair, silver-platinum, the trend is also positive. According to the prediction, buying it immediately in December 2023 and selling it in January would be ideal. The potential appreciation is about 10 %. The price of this metal pair declines gradually until March. From this month onwards, it is recommended that this metal pair should be invested in again and then sold in May, as the model used predicts a fairly good appreciation. According to the prediction, the trend of this metal pair seems to be the most favorable.

RQ2: Is it better to invest in a metal pair or to choose one specific metal?

This question can be answered using Figure 8, which presents a comprehensive view of the predicted prices of individual metals and metal pairs. If the investor decides to invest in individual metals only, from my point of view, platinum is the best option, particularly in December 2023 or March 2024. Some risks can be seen in the decrease in its price from June.

In the following months, the potential investment would lose its value if the investor kept the metal in their portfolio, but the investor would likely not make a loss. As for the investment in gold, it shall be stated that gold serves rather for preserving value and a hedging tool, as suggested by Abu-Doush et al. (2023) and Brabenec et al. (2020). No significant growth is predicted for the whole year, but rather, a steady state is expected. However, Kumaraswamy et al. (2023) predict price growth. In some phases, silver shows a more positive trend than gold, but it is very volatile. According to Rowland et al. (2021), however, it can preserve its value at any time. As for investing in metal pairs, it is advisable to focus on platinum pairs. Until about October, the focus should be on the third pair, i.e., silver-platinum. As mentioned in the case of the previous research question, investment in this pair should be made in December, and in mid-January, it should be sold if the investor wants to make a profit.

Thereafter, the price of the metal pair declines until March. This month, the price of buying the silver-platinum should be considered, as the price is low and should be sold in May and June. Nevertheless, from the half of the year, the price of the pair starts to be volatile, and investment is thus not advisable. At that time, it is good to focus on the second platinum pair, i.e., gold-platinum. From July, the price has not been that volatile, and there are several opportunities for potential investment appreciation, according to the prediction.

Thus, The question remains whether investing in individual metals or metal pairs is ideal. As shown in Figure 8, the most advantageous option is suitable, and investing in a single metal – platinum is advisable. Here, the problem is the aforementioned volatility of this metal or the metal pairs containing platinum. As in the case of investing in metal pairs, there is a second metal in which the same amount of money is invested. The volatility of such pairs does not show up as much. Hence, the point of diversification is where investing in more than one instrument reduces the risk of loss. Therefore, from my point of view, the decision has to be made by the investor, who shall consider whether to take the risk of investing in platinum only. Otherwise, it is more suitable for the investor to invest in the gold-platinum or silver-platinum pair. As stated by Fernandez-Perez et al. (2020), in addition to diversification, the advantage of investing in a metal pair is its good return. In the case of the selected pairs of metals, this is confirmed by the prediction.

Conclusions

The objective of this study was to analyze the price trend of gold, silver, and platinum, and three metal pairs, namely gold and silver, gold and platinum, and silver and platinum, and using the Nearest Neighbour method to predict the price trend of these pairs until the end of the year 2024. During the COVID-19 pandemic, people started to invest their funds in various ways so that their funds would not lose their value due to inflation. Precious metals represent one such way to preserve the value of funds and even increase it.

The trend of individual metal pairs was identified using the Nearest Neighbour method applied in the Wolfram Mathematica program. From my point of view, the trend of the gold-silver pair seems to be unfavorable and not very suitable for investment. The gold-platinum and silver-platinum pairs show a more positive trend. The silver-platinum pair is more volatile in the second half of the year 2024, and its value decreases slightly. The gold-platinum pair seems to be more stable in terms of the price trend. As for the investment in individual metals or metal pairs, it shall be stated that in some respects, this decision depends on the investors' personality and willingness to take a risk. If the investors are interested in one metal only, I would recommend investing in platinum, which is predicted to have a good return. However, it should be noted that its price will be volatile in the second half of the year. If the investor decides to invest in a metal pair, pairs involving platinum are recommended, i.e., gold-platinum or silver-platinum. In the first half of the year, the silver-platinum pair seems to be more favorable; in the second half of the year, the gold-platinum pair shows a more stable trend.

The objective of the paper was achieved. The study has several limitations, the first being the selected research method. As the literature research shows, authors dealing with a similar issue use various methods, such as GARCH, ARIMA, or neural networks. The results of the present study can thus be different when compared with the findings of other authors. Another limitation can be the selected metals. Other metals suitable for similar research could be, for instance, aluminum, silicon, or palladium. Certain limitations can be a narrower dataset when the trend of metals' prices is examined from 1 January 2019. The benefits of the study can be seen in the prediction of the price trend of individual metals and metal pairs that can be the subject of investment, as predictions of future prices of metals and especially metal pairs, are not addressed in scholarly papers.

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