

Price development of selected commodities

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Abstract

The aim of this paper was to map the price development of selected metal commodities - gold and silver from 1 January 2015 to 1 January 2023, to determine whether the COVID-19 pandemic had an impact on their price development and whether there is a linear relationship between the prices of these commodities. The validity of the correlation between the prices of gold and silver was examined using correlation analysis. The resulting correlation coefficient showed a very high linear dependence between the variables. This relationship is directly proportional, i.e., the price of silver increases with the growing price of gold and vice versa. The price data was obtained by content analysis and evaluated by graphical analysis. During the period under review, the price of both commodities increased, and the curves of both commodities followed a similar pattern. The gold price evolved from the original value of CZK 877.19/g to the price quoted on 1 January 2023, which was CZK 1 327/g. The price of silver also saw a price development, from CZK 11.64/g to CZK 17.43/g. From an investment point of view, the COVID-19 pandemic had a positive effect on both commodities, as prices increased significantly, especially for gold, which can serve as an investment metal in times of economic crises. The biggest limitation of this work was the COVID-19 pandemic and the war in Ukraine. These two events influenced the price development of both commodities and thus reflected in the research results.

Keywords: Gold, silver, correlation analysis, price development, COVID-19 pandemic.

Introduction

Commodities have long been considered an outsider in the investment world, often for a good reason. Unlike shares, commodities do not offer the so-called market's beta, where prices rise over time with economic activity. In contrast, they represent a set of unique price returns reflecting the underlying dynamics of supply and demand for tangible assets that serve as a building block of the global economy (Boal & Wiederhold, 2021). The literature describes a significant relationship between commodity prices and their futures and macroeconomic variables, which indicates the important role commodities play in the real economy (Ye et al., 2019). Commodity futures contracts originated as a form of agricultural insurance and were primarily used for the stabilization of commodity prices (Chadwick, 2018). Generally, the actual price of globally traded commodities is determined by supply and demand. One of the major factors determining the actual price of commodities is changes in demand for commodities associated with unexpected fluctuations in global real economic activity (Kilian & Zhou, 2018). Given that the supply of commodities is vital to modern society, fluctuations in commodity prices can significantly affect the functioning and sustainable development of macroeconomy, manufacturing activities, and people's safety and well-being. The commodity market also plays a key role in international industrial chain and sustainable development (Zhang et al., 2022). Price jumps in commodity markets are rare and extreme events occur less often than in stock markets. However, the correlation of jumps between commodities can be high depending on the commodity sectors. Energy, metal, and grain commodities show high jump correlations, while jumps in meat and soft commodity prices are only slightly correlated (Nguyen & Prokopczuk, 2019).

The objective of the paper is to map the development of selected metal commodity prices, specifically, gold and silver, in the period 1 January 2015 – 1 January 2023, to determine possible impact of the COVID-19 pandemic on the development of their prices, and to find out whether there is a linear relationship between the commodity prices. To achieve the objective set, the following research questions are formulated:

By answering this research question, it is possible to determine the development of gold and silver prices over the last eight years. The data are then used to answer RQ3.

RQ1: How did the gold and silver prices evolve in the years 2015-2023?

The question will be answered using the comparison of gold and silver prices in the period 1 January 2019 – 1 January 2023. The COVID-19 epidemic was declared pandemic by the WHO on 30 January 2020. By comparing the development of prices in this period, it is possible to determine the impact of the pandemic on the development of individual commodities.

RQ2: What was the impact of the COVID-19 pandemic on the development of the gold and silver prices?

By answering this research question, it will be possible to determine whether there is a relationship between the price of gold and silver, i.e., how the price of one commodity influences the price of the second one.

RQ3: Is there a linear relationship between the prices of gold and silver?

Methods and Data

Resistance to corrosion, rarity, and value represent basic properties that make gold a suitable medium of exchange in the financial and business sphere. Moreover, the supply and demand for gold results in its uniqueness compared to other precious metals with the same properties as gold; therefore, gold is a safe way to store funds in the case of a financial crisis or instability and volatility in world markets. Gold has long been used as a means of trade and transactions all over the world and plays an integral part in monetary, business, commercial, and financial activities. What is even more important is the fact that it is used as an economic benchmark for the global economy and will continue to play an important role in the global economy (Baguda & Al-Jahdali, 2021). Besides buying and selling gold physically, some markets also enable electronic gold trading (Nawaz et al., 2020). The movement of prices of gold as the preferred investment tool is gaining attracting an increased attention. The results show that gold is a weak hedge against political risk and this weak hedge has time-lag effects. Compared to macroeconomic factors, financial speculation shows stronger explanatory power on changes in gold returns, because international speculative forces are becoming increasingly more active. Moreover, the exchange rate and interest rate contribute less to gold returns and are negatively correlated with gold returns. As for the impact of the political risk subcomponents, external conflicts turn out to have the strongest explanatory power on the fluctuations in the gold market (Ding et al., 2022).

The unique properties of silver, especially in the form of nanoparticles, enable using it for many applications. Silver nanoparticles can be used in the production of electronic and solar energy harvesting devices, advanced analytical techniques, catalysis, and photocatalysis. Moreover, they can also be used in medicine for bioimaging, biosensors, and antibacterial therapies (Pryshchepa et al., 2020). As with most commodities, silver price is determined by speculations on the side of supply and demand, which makes the price of silver volatile due to a smaller market, lower market liquidity, and demand fluctuations between industrial and storage uses (Ayele et al., 2020).

The impact of the COVID-19 pandemic on the price volatility is different in the case of financial assets and precious metals assets. While the infection speed, i.e., the number of people infected with COVID-19, amplify the effect on the tendency towards a high price volatility regime for S&P 500 and FTSE 100 indices, in the case of futures, the effect of the infection speed as well as the number of deaths on gold and silver is moderated, which implies that the gold and silver markets act as risk-hedging safety assets alternative to financial assets during the COVID-19 turmoil.

Schweikert (2018) used a quantile cointegration model to demonstrate the relationship between the prices of gold and silver. While cointegration models, which assume constant cointegration vector, are not able to identify cointegration relationship between the prices of gold and silver, the author proved the existence of a non-linear long-run relationship. The cointegration vector was modelled as dependent on state and varied over time. Quantile cointegration estimates show considerable asymmetry in the relationship. The results indicate that the significant role of precious metals as investment opportunities, especially in period of economic upheavals, leads to the interdependence of gold and silver in these periods.

Cheng et al. (2020) examined whether the role of gold changes as a result of the introduction of gold exchange-traded funds (ETF) on the basis of sample data from seven countries where physically-backed gold ETFs have been issued. The results show that the traditional role of gold really changes after the introduction of gold ETFs, especially in the corresponding stock markets. The hedging and safe have functions gold provides are fading away in the post-ETF period in stock markets. However, in currency markets, gold still serves as a hedging asset and safe haven, and these effects become stronger in the periods after the introduction of ETFs. Moreover, golden ETFs play the role of a relatively strong safe haven compared to physical gold, while the leading (lagged) returns of stock fall extremely. Like the purposes of using physical gold assets, gold ETFs provide hedging and safe haven against the exchange rate risks. The results of the study suggest that gold could be to large extent replaced by gold ETFs, and investors could use it to avoid potential risks in financial markets.

Correlation analysis is one of the fundamental mathematical tools to identify the dependence between classes (Lai et al., 2019). This type of analysis was used by Yang et al. (2019) to identify processes and analyse alarms. However, traditional methods of correlation analysis were found to be inefficient for these purposes due to the effect of process time delays on analysis results. By converting alarm data sequences to time node sequences, the method of block matching similarity (BMS) is able to reduce the calculation burden of the correlation analysis. With regard to time delays between the alarm variables, the improved method of maximal correlation coefficient reducing the effect of time delays and improving the accuracy of the correlation analysis was introduced. To demonstrate the efficiency and effectiveness of the proposed method, a numerical case and the Tennessee Eastman process were used.

Secondary data analysis can be a benefit for advanced academic researchers, as it provides large data samples and various data on multiple topics (Renbarger et al., 2019). Qualitative content analysis is a research method conducted either inductively or deductively. Inductive method is often used by qualitative researchers and is more widely presented in qualitative research manuals than the latter one. While in an inductive approach, the researcher draws categories/topics from data collected at the beginning of the research, in deductive, also called guided, approach, researchers draw from (existing) theories in order to determine categories/topics that guide the research. Deductive, or

guided qualitative content analysis is used for testing, confirming the relevance of a theory/theories guiding the research, or to extend the application of the theory/theories to contexts/cultures other than those in which the theory was developed. This approach is used by quantitative rather than qualitative researchers for creating data (Kibiswa, 2019). Quantitative information represent “hard” data, which are considered more persuasive than qualitative data (Liu, 2022). The purpose of the content analysis/Purpose content analysis is a methodology used in many academic disciplines as a tool to obtain quantitative measures from textual information. Content analysis can be used for pharmacy educators and is useful in examining a wide variety of data, including textual, image, and audio datasets (Kleinheksel et al., 2020)

For the purposes of this paper, content analysis is primarily used for secondary data collection. The findings are analysed using correlation analysis, graphical analysis, and comparative analysis, which will enable answering all the research questions formulated.

The first research question will be answered using the content analysis, which will analyse data obtained from the Kurzy.cz (Kurzy.cz, b.r.) website and the Czech Statistical Office (ČSÚ, 2023). The period under study is 1 January 2015 – 1 January 2023. Data will be monitored at the beginning of each month and recorded in an MS Excel spreadsheet. The subject of each observation is the gold price in individual years in CZK/g. The obtained data are then graphically processed and used for answering the third research question.

Data necessary for answering the second research question are analysed using quantitative content analysis based on the data obtained from the Czech Statistical Office (ČSÚ, 2023) and Kurzy.cz (Kurzy.cz, 2023). There will be monitored the development of the prices of gold and silver in the period 1 January 2019 – 1 January 2023 and subsequently, both trends will be compared. Data will be monitored at the end of each month and recorded in an MS Excel spreadsheet. The monitored period is selected so that it covered the year before the outbreak of the COVID-19, the year in which the pandemic started, and the period after the massive spread of the virus stopped. These results enable understanding the impact of the COVID-19 pandemic on the development of both metal commodities’ prices.

To be able to answer the third research question, data obtained to answer the first research question. Correlation analysis with the help of Pearson correlation coefficient will be used to confirm possible existence of the linear relationship between the prices of gold and silver. This is a sample correlation coefficient, which can be calculated as follows (MUNI MED, 2018) (1):

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2} \sqrt{\sum_i (y_i - \bar{y})^2}} = \frac{\sum_{i=1}^n x_i y_i - n \bar{x} \bar{y}}{(n - 1) s_x s_y} \quad (1)$$

where:

\bar{x} – sample average gold price [CZK/g]

\bar{y} – sample average silver price [CZK/g]

s_x – sample standard deviation of gold price

s_y – sample standard deviation of silver price

The correlation coefficient r is calculated using the data analysis in MS Excel. For the purposes of this paper, the correlation coefficient is divided into five categories, specifically, very weak linear dependence, weak linear dependence, moderate linear dependence, strong linear dependence, and very strong linear dependence. The classification will serve to better interpretation of the identified correlation relationship between the given commodities.

Very weak linear dependence $r = 0 - 0.2$

Weak linear dependence $r = 0.2 - 0.4$

Moderate linear dependence $r = 0.4 - 0.6$

strong linear dependence $r = 0.6 - 0.8$

very strong linear dependence $r \geq 0.8$

If the correlation coefficient equals zero, there is no linear dependence between the variables. Positive values indicate a directly proportional relationship, i.e., the price of one commodity grows with the rising price of the second commodity. Negative values suggest an indirectly proportional relationship, i.e., the price of one commodity decreases with a rising price of the second commodity. The closer the value of the correlation coefficient is to one or minus one, the stronger the linear relationship is. The chosen significance level α is 5 %.

To verify the normality of the data, it is necessary to refute or confirm the formulated null hypothesis, for which an alternative hypothesis is formulated as follows.

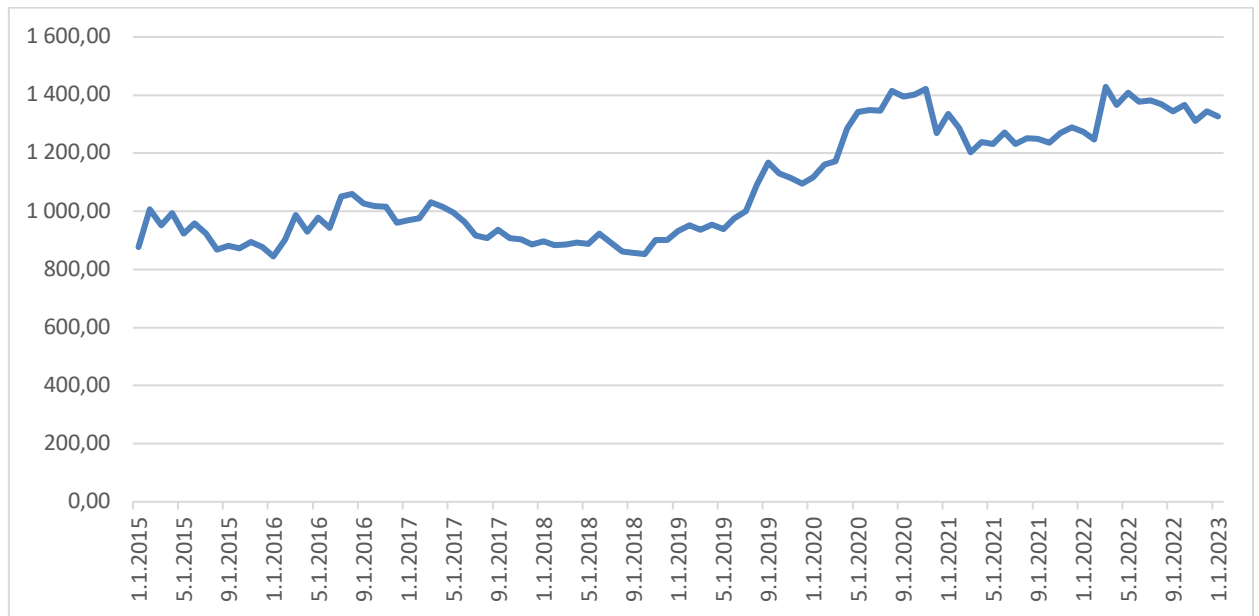
H0: There is a linear relationship between the prices of gold and silver.

H1: There is no linear relationship between the prices of gold and silver.

Results

Data on the prices of both commodities were monitored always on the first day of each month. A table showing the prices of gold and silver in the monitored period is presented in the appendix.

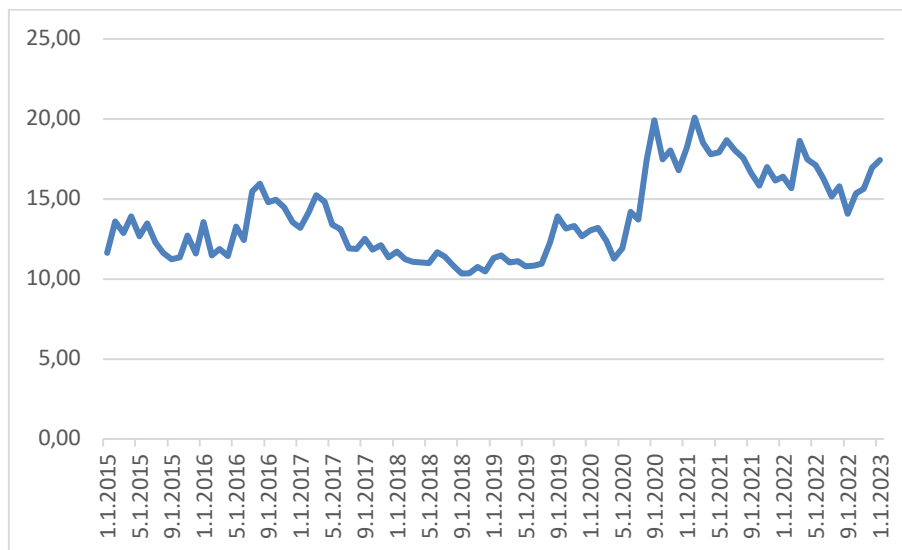
Graph 1. Trend of gold prices in [CZK/g]



Source: Authors according to (Kurzy.cz, 2023).

Graph 1 shows the trend of the gold price in the period 1 January 2015 – 1 January 2023. The data about the prices of this commodity were obtained from the Kurzy.cz website and are given in CZK/gram. The maximum gold price was recorded in March 2022. From 2015, the price of gold grew by approx. 51 %. In the period 1 January 2015 – 1 February 2015, one of the biggest price jumps in the gold price was recorded, specifically, an increase of approximately 15 % compared to the preceding month; between 1 February 2022 – 1 March 2022, the increase was about 14.5 %.

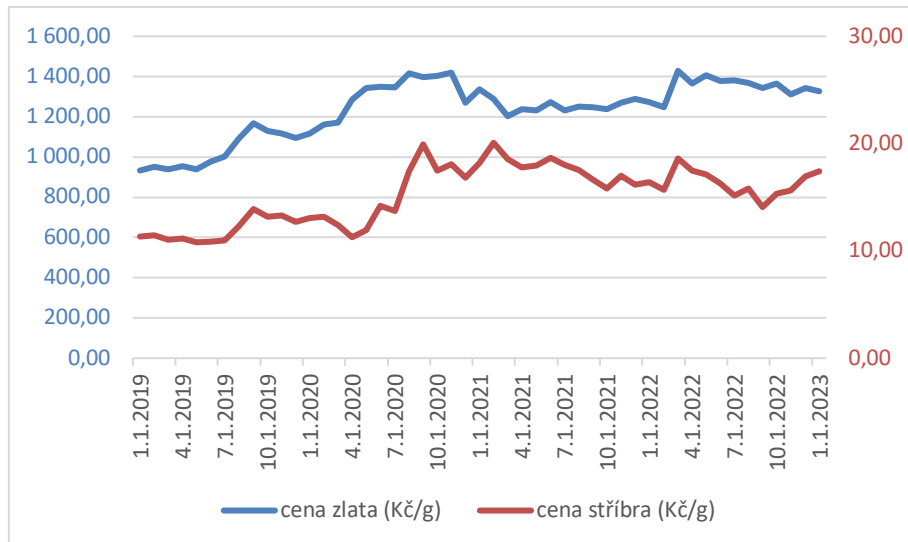
Graph 2. Trend of silver prices in [CZK/g]



Source: Authors according to (Kurzy.cz, 2023).

Graph 2 shows the development of the silver prices between 1 January 2015 and 1 January 2023. The data about the prices of this commodity were obtained from the Kurzy.cz website and are given CZK/gram. As seen in the graph, the maximum price was recorded in February 2021. From the year 2015, the price of silver grew by about 50 %.

Graph 3. The impact of COVID-19 pandemic on commodity prices [CZK/g]



Source: Authors according to (Kurzy.cz, 2023).

Legend: cena zlata (Kč/g) - price of gold (CZK/g); cena stříbra - price of silver

Graph 3 shows the impact of the COVID-19 pandemic on the prices of gold and silver. The monitored period covers the year before the pandemic, during the peak of the pandemic (declared by the WHO on 30 January 2020), and the period until the beginning of 2023, when the COVID-19 virus and its mutation were still active, but the number of infected people fell sharply, and the pandemic crisis was on the wane. As seen in the graph, the situation had an impact on the prices of both commodities. The development of gold prices showed a gradual growth without any significant price jumps; however, considerable fluctuations could be observed. Within the monitored period, the price of gold rose from the initial 877,19 CZK/g to 1 327 CZK/g on 1 January 2023, while the price of silver rose from 11,31 CZK/g to 17,43 CZK/g. The results thus confirm that the COVID-19 pandemic had an impact on the development on the gold and silver prices. In times of crisis, gold serves as a hedging investment metal, as its value increases during global crises.

Table 1. Correlation between gold and silver prices

| | gold | silver |
|--------|----------|--------|
| Gold | 1 | |
| silver | 0.802981 | 1 |

Source: Authors according to (Kurzy.cz, 2023).

A correlation analysis was performed on the basis of the data obtained from the Kurzy.cz website. The resulting correlation coefficient is equal to the rounded value of 0.80, which means that there is a very strong linear dependence between the prices of gold and silver, and this relationship is directly proportional, i.e., the value of one variable increases with the growing value of the second variable. The significance level was set to 0.05 for this purpose. This value is lower than the value of the correlation coefficient; therefore, the alternative hypothesis H1 is rejected and the hypothesis H0 stating that there is a linear relationship between the prices of gold and silver is accepted.

Discussion

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

RQ1: How did the price of gold and silver evolve in the last eight years?

The data needed to answer this research question were obtained using a content analysis and processed and evaluated using a graphical analysis. At the beginning of the monitored period, the price of gold was 877, 19 CZK/g. From the year 2015, the price of gold rose by approx. 51 %. The maximum price (1 428,29 CZK/g) was recorded in March 2022. In the period 1 January 2015 – 1 February 2015, one of the biggest price jumps was recorded of approx. 15 %. Another large fluctuation was recorded between 1 February 2022 and 1 March 2022 (a rise by about 14.5 %). The price of silver was 11,64 CZK/g at the beginning of the monitored period. From the year 2015, the price of silver rose by approximately 50 %, with the maximum price being recorded in 2021, reaching the value of 20,8 CZK/g. The results thus indicate a similar price development of both commodities.

RQ2: What was the impact of the COVID-19 pandemic on the development of the gold and silver prices?

The data necessary to answer this research question were obtained from the content analysis and graphically processed. COVID-19 was a global pandemic on 30 January 2020. The results show that this situation affected the price development of both commodities. The gold and silver curves show price jumps, which are more pronounced in the case of the silver price. The values of gold and prices grow in the periods of economic crises; both metals can thus serve as hedging assets. It is primarily gold, which serves as a hedging investment metal in times of crisis.

Kanamura (2022) examined the impact of the COVID-19 pandemic on the volatility of financial assets and metal prices. The findings of the author are thus in line with the findings resulting from the presented research, stating that from the perspective of investment, the COVID-19 pandemic had a positive impact on the price development of these commodities, which can thus be considered hedging assets and alternatives to financial assets in times of economic crises.

RQ3: Is there a linear relationship between the prices of gold and silver?

The data needed to answer this research question were obtained through a content analysis and graphically processed. The value of the correlation coefficient obtained through a correlation analysis was 0.80 after rounding. It can thus be concluded that there is a very strong linear dependence between the prices of gold and silver. If the value of one variable increases, the value of the other variable rises as well. The significance level, which was set at 5 %, is lower than the value of the correlation coefficient; therefore, the alternative hypothesis H1 is rejected and the null hypothesis H0, stating that there is a linear relationship between the prices of gold and silver, is accepted.

In his study, Schweinkert (2018) used a quantile cointegration model to prove the relationship between the prices of gold and silver. The authors agree with the finding that there is a relationship between these two commodities, especially in the periods of economic turmoil.

Conclusion

The objective of the paper was to map the development of the selected metal commodities – gold and silver between 1 January 2015 and 1 January 2023, to determine whether the COVID-19 pandemic had any impact on the development of their prices, and whether there is a linear relationship between the prices of these two commodities. The objective of the paper was achieved.

The price of both metal commodities rose in the monitored period. At its beginning, the price of gold was 877,19 CZK/g, while the final price was 1 327 CZK/g. Similarly, the price of silver grew as well in the monitored period, rising from the initial value of 11,64 CZK/g to 17.43 CZK/g. The curves of both commodities showed a similar trend.

Furthermore, it was found that the COVID-19 pandemic affected the price development of both commodities. Its influence was positive from the perspective of investment, as the prices of both commodities grew significantly. Before the pandemic, the price of gold ranged between 932,79 – 1 095,15 CZK/g, while the price of silver was between 11,31 and 12,69 CZK/g. After the end of the peak of the COVID-19, the price of gold was about 1 327 CZK/g and the price of silver about 17,43 CZK/g. This implies that mainly gold can serve as an investment metal in times of economic crises.

The results of the correlation analysis confirmed the existence of a linear relationship between the prices of gold and silver. The value of the correlation coefficient equals 0.80 after rounding, which indicates a very strong linear dependence. In practice, a positive correlation coefficient means that if the price of one commodity increases, the price of the other commodity will grow as well and vice versa.

The biggest limitation of this research was the COVID-19 pandemic and the war in Ukraine. These two events influenced the development of both commodities' prices and were thus reflected in the research results.

A recommendation for further research is to collect the data again after the effects of the global crisis have subsided and to make new calculations and compare whether the results will match. Furthermore, it is recommended to increase the frequency of data collecting, i.e., collect data not only at the beginning of each month. With a higher frequency, more accurate results could be obtained.

The findings could be used also for predicting the future development of the gold and silver prices.

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