PRECIOUS METALS MARKET FORECASTING IN THE CURRENT ENVIRONMENT

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Citation:
Rumyk, I., Kuzminsky, V., Pylypenko, O., & Yaroshenko, O. (2024). PRECIOUS METALS MARKET FORECASTING IN THE CURRENT ENVIRONMENT. *Economics, Finance and Management Review*, (1(17), 45–56.
https://doi.org/10.36690/2674-5208-2024-1-45

Received: March 03, 2024
Approved: March 28, 2024
Published: March 30, 2024

Abstract. *The article analyzes trends in the precious metals market. The general characteristics and assessment of the most popular precious metals are given. The key factors influencing the supply and demand of precious metals are analyzed. Precious metals market forecasts have been developed. An analysis of the state of the world gold market in recent years has been carried out. Using the method of comparative analysis, modern trends in the supply and demand of this precious metal were revealed. The dynamics and structure of world gold reserves are considered. The world's precious metal reserves in different countries were also studied. The potential gold reserves in Ukraine are estimated. The production of precious metals in the world was studied. The rating of countries producing precious metals has been compiled. The leaders in this field have been identified based on the criteria of production capacities and growth rates of precious metals extraction. The structure of consumption of precious metals in the world is analyzed. The factors that lead to an increase in the rate of consumption of precious metals in modern conditions are considered. In particular, an increase in the current rate of commissioning of new solar energy capacities and an increase in the use of electric transport have been identified, which has significantly increased the demand for precious metals in the world. The impact on price dynamics of geopolitical and other economic factors, such as changes in trade relations between countries, currency fluctuations, market crises, changes in the monetary policy of central banks in many countries, and, above all, the increase in interest rates by the US Federal Reserve, was also studied. Considering these and other influencing factors, forecasts of the price dynamics of the precious metals market for 2024 and subsequent years were developed using a graphical method.*

Keywords: *precious metals, forecasting methods, market, alloys, gold reserves.*

JEL Classification: G12; G15; G21; G23

Formulas: 0, fig.: 5, tabl.: 2, bibl.: 23

Introduction. Recently, there has been an increase in the interest of economic subjects of various countries, including Ukraine, in precious metals from abroad. Also, today the market of precious metals is growing due to the change in lifestyle and the increase in disposable income of the population. In addition, due to growing concerns about the environment, leading market participants in various industries are investing in the processing of precious metals, which can be used in the future, for example, for the production of pacemakers or other medical devices. Moreover, the governments of various countries are implementing strict emission norms, which in turn is driving the growth of the market as these metals are used to clean the exhaust gases of automobiles. Therefore, indicators of the state of the precious metals market, its price dynamics and forecasting require a comprehensive and detailed study.

Literature review. This topic was studied by many scientists, among whom it is worth highlighting theoretical developments and structural analysis of precious metal markets. Thus, Honak (2018) studied the theoretical foundations of the functioning of the global gold market. Dudchenko (2012), Fatima, Gan, & Hu (2022), Heraeus Precious Metals (2023) analyzed the current state and structure of the international gold market, Polyakova (2016), Kangalli Uyar, Uyar, & Balkan (2022) analyzed global precious metal markets metals in the conditions of the global economy.

It should be noted that a lot of attention is paid to the assessment of trends in the functioning of the world market of precious metals in conditions of global financial instability (Pukhalska, 2014, Erfan, 2017, & Ksenzhuk, 2017). According to Doskochinska (2017), Emrah, & Gazanfer (2023), it is important to study the world markets of precious metals in the context of financial globalization. Koreniuk (2018) identified and analyzed the problems and peculiarities of the formation of the precious metals market in Ukraine. Kovalenko (2020), Pierdzioch, & Risse (2023) carried out studies of the development of transactions with precious metals and the analysis of their role in stabilizing the economy.

Analyzing the market of precious metals necessarily involves the wide application of various research methods. At the same time, Pilipchenko (2021) suggests using technical analysis methods to forecast financial markets. Research by Plastun (2021) is based on the identification of impulse and reversal strategies after abnormal price fluctuations in the oil and gold markets. Pylypenko (2022) considers the features of cognitive modeling. Rumyk (2020) suggests using methods for evaluating long-term forecasting models

Instead, the constant change in the market of precious metals and the emergence of new "black" schemes for their movement require constant scientific research based on modern models and forecasting methods.

Aims. The purpose of the article is to study the current state of the global market of precious metals, analyze influencing factors and forecast its price dynamics. The specific objectives of the research include the analysis of the production of precious metals in the world, the study of the structure of consumption of precious metals, the assessment of the influence of geopolitical and economic factors on the price dynamics, the development of forecasts of the price dynamics of the precious metals market for the future.

Methodology. Various methods of theoretical generalization, analytical and graphic analyzes were used to carry out research. The following methods played a major role in the analysis:

Method of combinations of moving averages: The method of combinations of moving averages made it possible to conduct an analysis and identify the main trends in the development of the precious metals market.

Method of stochastic indicators: This method made it possible to detect and show the price levels of overbought and oversold.

Divergence and graphical analysis methods: These methods are fundamental for visual confirmation of the conducted analysis and the identification of predictive patterns in the precious metals market.

In general, the using of research methods made it possible to assess the influence of various factors on the market of precious metals and to forecast the trends of its development for the coming years.

Results. Exchange trading of precious metals takes place on various exchanges such as London Metal Exchange (LME), Chicago Mercantile Exchange (CME), Shanghai Futures Exchange (SHFE) and Tokyo Commodity Exchange (TOCOM). Such metals as gold, silver, platinum, palladium and others are traded on these exchanges. Exchange prices for precious metals are determined based on supply and demand on the exchange, as well as fundamental and technical market factors.

Precious metals can be in any state (type), including native and refined, as well as in raw materials, alloys, semi-finished products, industrial products, chemical compounds, jewelry, coins, scrap, production and consumption waste. Three countries of the world have a complete set of production – USA, Germany, Japan.

Precious metals are natural elements with a bright shine. These metals are rare, hard, less chemically active, and have high economic value compared to base metals. They are also plastic, pliable, corrosion resistant and good conductors of heat and energy. As a result, they are used in jewelry, consumer electronics, automobiles, chemicals, and medical equipment all over the world. Precious metals such as gold, silver, platinum and palladium are also used as valuable assets for investment purposes (Precious metals, 2023).

The main factors determining the price of precious metals are:

- The ratio of supply and demand.

Metal prices are primarily driven by supply and demand and can be extremely volatile at times. The supply of precious metals is limited, while the demand is generally constant, although it can often rise sharply.

- World macroeconomic trends.

Gold and silver are often considered safe investments because they retain their value and purchasing power better than other assets during times of volatility and economic uncertainty. During economic or political crises, the prices of precious metals tend to rise. On the other hand, a strong and healthy world economy tends to lower gold and silver prices; demand falls as investors look for riskier and more profitable areas of investment.

- Inflation, monetary policy, exchange rates.

Inflation rates play an important role in many countries' monetary policy decisions, as most central banks consider price stability to be their primary objective. Therefore, any changes in inflation indicators can affect the decisions of central banks, which, in turn, will affect the value of their currencies. Of course, the most important currency when it comes to precious metals is the US dollar, because it is the world's reserve currency (Polyakova, 2016).

A certain amount of gold is in the possession of central banks or finance ministries of almost all countries of the world. To date, almost 190,000 tons of precious metal have been mined throughout the world. More than half of this amount of gold has been mined in the last 70 years. 30,000 tons of gold are concentrated in the possession of gold and currency reserves of all countries of the world.

About 2.5-3 thousand tons of precious metal are mined annually in the world. The gold and currency reserve provides the following tasks: stabilization of the exchange rate and fight against the crisis. The USA, Germany, the IMF, Italy, and France have the largest gold and currency reserves (Table 1).

Table 1. Countries with the largest gold reserves, 2023

№	Country	Volume (tons)	% of gold in the country's gold and currency reserves %
1.	USA	8134	75
2.	Germany	3355	70
3.	Italy	2452	66
4.	France	2435	61
5.	China	1948	2.5
6.	Switzerland	1040	5.5
7.	Japan	846	2.5

Source: built on the basis of data from the Gold Statistics and Information (2023)

As for Ukraine, one of the features of raw material bases is that most of them are of high quality and meet international standards. Also, Ukraine has significant reserves of rare metals, such as cerium, praseodymium, neodymium and others, which are used in high-tech industries. However, unfortunately, some branches of the raw material base of Ukraine need modernization and development in order to ensure their effective use and competitiveness on the international market.

According to the US Geological Survey (USGS), Ukraine ranks 28th in the world in terms of gold reserves. The total reserves of gold in Ukraine amount to about 45 tons. According to the Geological Service of Ukraine, the total silver reserves were about 25 tons. However, compared to other countries, Ukrainian reserves of gold and silver are insignificant.

The largest reserves of gold in the world are concentrated in countries such as Australia, Canada, China, the USA and others. Mexico, Peru, China, and Australia are the world leaders in terms of the volume of the raw material base of silver. However, the silver reserves may be underexplored in Ukraine and there are opportunities to expand them through geological exploration (Gold Statistics and Information, 2022).

According to the Geological Service of Ukraine, the country contains significant reserves of platinum group metals (PGM), including platinum, palladium, rhodium, iridium, ruthenium and osmium. The largest PGM reserves are concentrated in the

Kryvyi Rih Basin. PGM reserves belong to complex metal ores, which also contain iron, nickel, copper and other metals. Estimates of PGM reserves on the territory of Ukraine are quite different and depend on the level of research and assessments of different geologists and companies. According to data provided by state authorities, the total reserves of PGM in Ukraine can reach from 20 to 100 million tons of ores with an average PGM content of 3-4 g/t.

According to the US Geological Survey (USGS) for 2022, the largest reserves of platinum group metals are located in Russia (88 thousand tons); South Africa (63 thousand tons); Zimbabwe (38 thousand tons); Canada (10 thousand tons); USA (9 thousand tons) (Platinum prices, 2022).

According to the Institute of Metal Carbon Materials, in recent years' global consumption of platinum was about 8 million ounces (more than 248 tons), palladium - about 9 million ounces (more than 280 tons), and rhodium - about 1.1 million ounces (more than 34 tons). According to forecasts, the consumption of platinum group metals will continue to grow in the future, especially in connection with the increase in the production of cars and the use of environmentally cleaner technologies.

According to the World Gold Council, in 2022 the leading countries in terms of gold reserves are: The United States – 8,133 tons; Germany – 3,368 tons; Italy – 2,452 tons; France – 2,436 tons.

As for gold production, the leading countries are: China – 368.3 tons; Australia – 295.8 tons; USA – 190.0 tons; Canada – 182.2 tons.

According to the Silver Institute, global silver production in 2021 was about 789 million ounces (24,532 tons). The largest producers of silver in the world are Mexico, Peru, China, and Australia. Mexico is the leading producer of silver in the world with production of about 189 million ounces, which is 24% of the total world production. Peru is in second place with a production of about 137 million ounces, and China is in third place with a production of about 110 million ounces (Table 2).

Table 2. The leading countries are producers of primary silver

№	Country	Production in recent years, tons	Share in world production, %
1	Mexico	6300	24
2	Peru	3800	14
3	China	3500	13
4	Australia	1200	5

Source: built on the basis of data from Polyakova, (2016)

Other producers of primary silver in the world include Chile, Bolivia, Kazakhstan, Argentina and the United States. Also, it is important to note that much of the silver is mined as a by-product in the mining of other metals such as gold, copper and zinc.

According to the World Steel Association, global platinum production in recent years was approximately 202 tons. The majority of platinum is produced in South Africa, where in 2021 about 78 tons of this metal were mined. The second place in terms of platinum production is occupied by Russia with a production of about 21 tons, and the third place by Canada - with a production of about 18 tons. Ukraine is not included in the list of leading platinum producing countries (Platinum prices, 2022).

In recent years, the world production of rhodium amounted to about 240 tons. The largest producers of this metal are South Africa (more than 80% of world production) and Russia (more than 10%). Rhodium is mainly used in catalysts, electronics, production of glass melts and other industrial processes. A significant part of the world's rhodium production is consumed in the automotive industry, where it is used in exhaust gas catalysts. Rhodium is also used in the production of cosmetics and pharmaceuticals. In order to reduce dependence on supplies from South Africa, where the majority of rhodium reserves are located, some countries, such as Canada, the United States and Russia, are searching for new deposits of this metal and developing their own production.

According to the US Geological Survey, in recent years the world production of iridium amounted to about 3.5 tons (Gold Statistics and Information, 2022). The largest producers of iridium in the world are South Africa, the Russian Federation and Canada. These three countries together produce more than 90% of the world's iridium production.

Iridium is one of the rarest metals. It is widely used in the production of special steels, in the electronics, chemical industry and in jewelry. In particular, iridium alloys are used in the production of lasers, thermocouples and other devices where corrosion resistance and high temperatures are important. Also, iridium is used to make high-quality jewelry, for example, to create expensive engagement rings with large diamonds.

The main osmium-producing countries are the Russian Federation and Canada. According to the US Geological Survey, for example, in 2021, Russia produced 50 tons of osmium, which is more than 80% of world production. Canada ranks second in the production of about 10 tons of osmium.

Osmium is an extremely rare metal, its extraction and production is a very difficult and expensive process. It is used in electronics, catalysts, in the manufacture of medical equipment and other industrial applications. According to the United States Geological Survey (USGS), global osmium production has been around 63 tons in recent years, a significant decrease from previous years.

Analysis of trends in the market of precious metals shows that the price of gold on the world market in recent years was as follows: 2020 – $1,773 per ounce, 2021 – $1,817 per ounce, 2022 – $1,890 per ounce, 2023 – $1,950 per ounce.

Accordingly, the price of silver on the world market in recent years was as follows: 2020 – 20.55 USD per ounce, 2021 – 25.89 USD per ounce, 2022 – 23.31 USD per ounce, 2023 – $23.24 per oz.

One of the important factors affecting price dynamics is the high current rate of introduction of new solar energy capacities (CAGR 2019-2023 – 9%, according to Solar Power Europe). This will allow stable consumption of 3,000-3,500 tons of silver annually until the end of 2023, which is a conservative estimate. The use of electric vehicles (HEV and EV variants) and modern intercity express trains (ICE) requires about 1,500 tons of silver annually. According to the GFMS estimate, by 2025, consumption will increase to 2,300 tons of process silver, which dominates the world market (Figure 1).

Figure 1. The structure of world demand for gold and silver

Source: built on the basis of data from the Global mine production (2023)

Precious metal prices depend on many factors, such as the state of the global economy, inflation, the geopolitical situation, and others. However, at the moment, precious metals such as gold, silver, platinum and palladium are important tools for preserving value and reducing investment risks. This applies not only to investors, but also to central banks and large corporations.

Because precious metals are deflationary instruments, meaning they retain their value in the face of rising inflation, they can be attractive to investors during periods of economic instability and market volatility. In addition, demand for platinum and palladium is forecast to increase due to their use in the production of hydrogen fuel cell vehicles, which may lead to an increase in the prices of these metals (Figure 2).

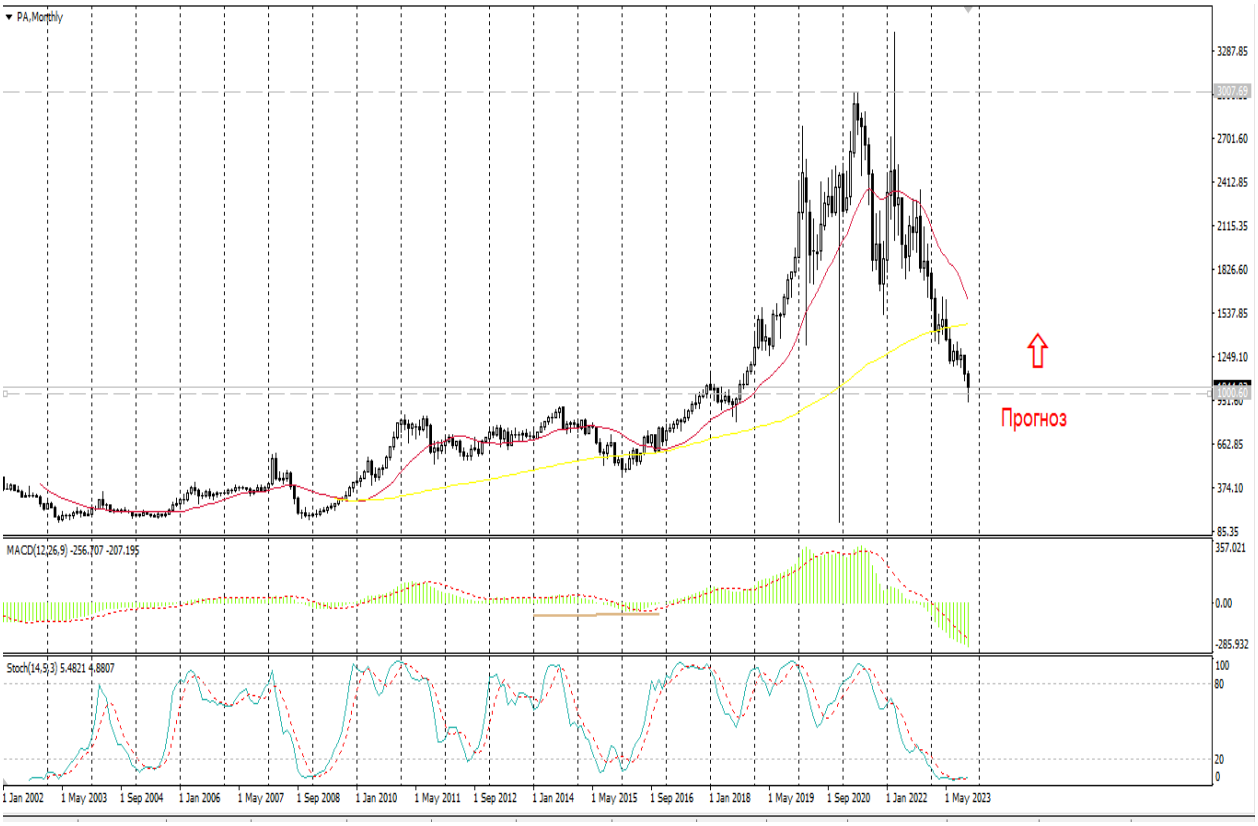

Figure 2. Forecast of palladium price dynamics

Source: built on the basis of data from the Gold Statistics and Information (2023)

Forecasting the palladium market for the coming years is associated with the complexity of assessing the economic situation and production needs of industrial sectors. However, many experts currently believe that demand for palladium will increase in the future due to increased production of electric vehicles, the use of palladium in catalysts to reduce emissions from internal combustion engines and hydrogen production. Demand for palladium may also increase due to its use in the production of solar cells and the production of hydrogen fuel cells. As for palladium prices, in our view, they are more likely to rise due to increased demand and limited supply in the market.

However, price dynamics can be affected by geopolitical and economic factors, such as changes in trade relations between countries, currency fluctuations, crisis situations on the markets, and others. Forecasting the platinum market for the coming years can be a challenging task, as this market is quite vulnerable to changes in consumption and production, as well as to geopolitical and economic turbulence (Figure 3).

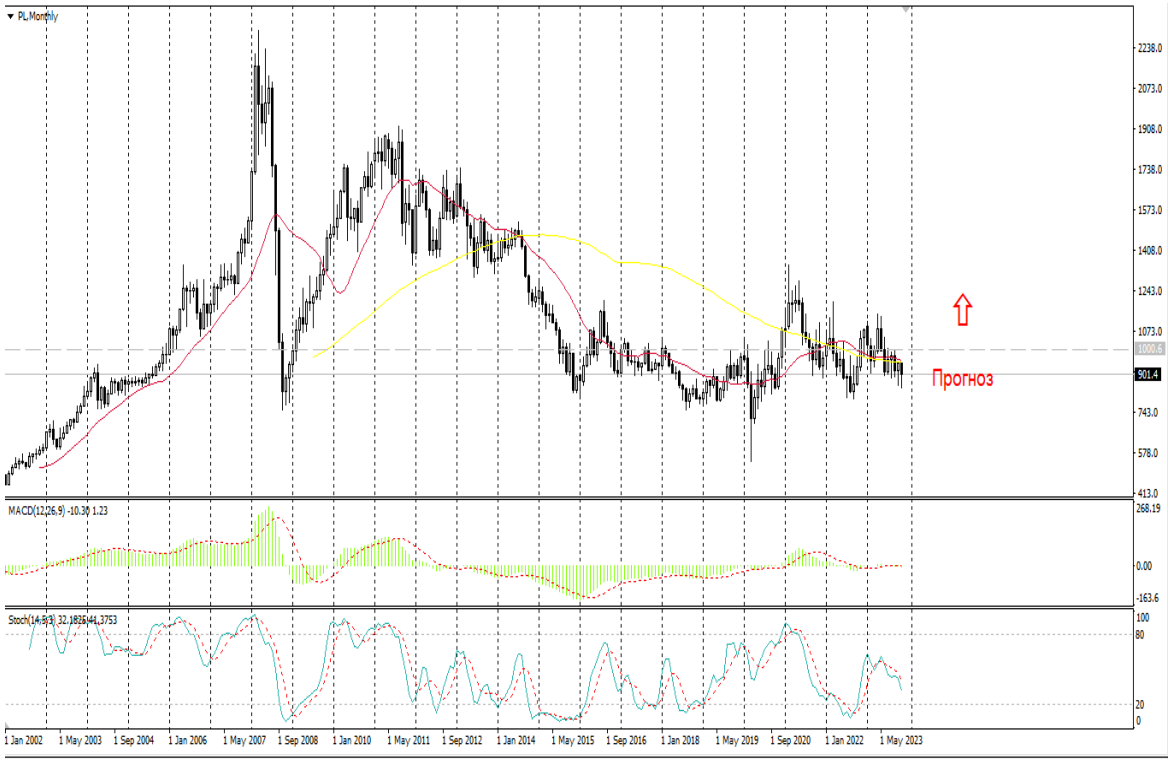

Figure 3. Forecast of platinum price dynamics

Source: built on the basis of data from the Gold Statistics and Information (2023)

At the moment, several key trends can be identified that may affect the platinum market in the coming years:

- growing demand from car manufacturers: platinum is used to make catalysts for cars with internal combustion engines, so the growing demand for cars, especially hybrid and electric cars, could increase the demand for platinum;

- increased hydrogen production: platinum is used in electrolyzes to produce hydrogen, which, in turn, can be used as an alternative fuel source. An increase in demand for hydrogen may lead to an increase in demand for platinum;

- geopolitical turbulence: The Republic of South Africa, which is one of the world's largest platinum producers, has significant political and economic instability, which may affect platinum production and exports. Also, sanctions against Russia may limit access to platinum from that country, which may increase its price;

- technological development: growth in the development of technologies using platinum and other precious metals can lead to an increase in demand for these metals.

Therefore, the platinum market remains quite volatile in the coming years, and its forecasts may depend on many factors, including changes in the global economy and technological trends. But in general, we believe that the dynamics of platinum prices will be positive in the coming years.

Gold prices depend on many factors, such as the geopolitical situation, the state of the world economy, financial policies of leading countries, etc. However, in recent years, gold prices have shown an upward trend, which may indicate that they may remain at a high level in the future (Figure 4).

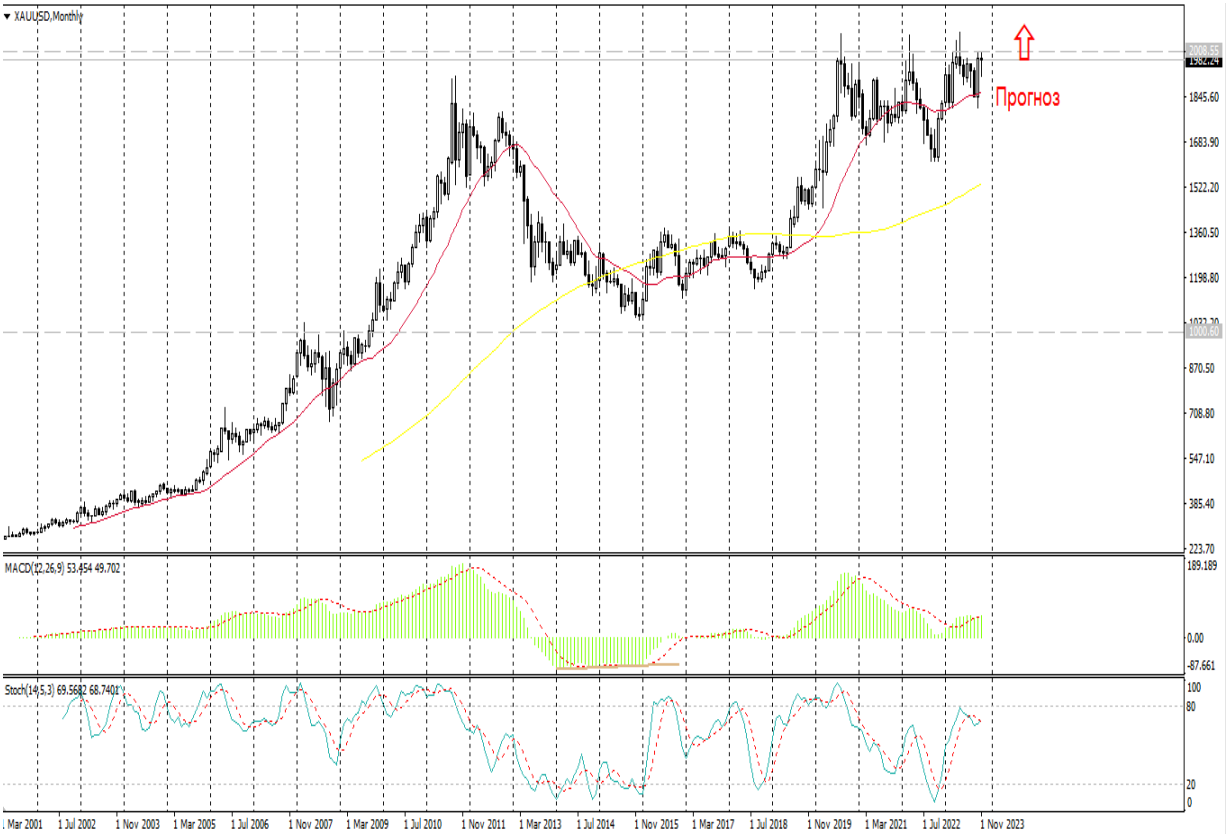

Figure 4. Forecast of gold price dynamics

Source: built on the basis of data from the Gold Statistics and Information (2023)

According to experts, one of the key factors that can affect gold prices in 2024 is inflation. Rising inflation usually leads to higher gold prices as investors look for ways to protect their holdings from currency devaluations and rising prices.

Another possible factor contributing to the growth of gold prices is geopolitical instability. Conflicts and issues between countries can cause unrest in markets and increase demand for safe-haven assets, including gold. On the other hand, the reduction of geopolitical risks and the improvement of the economic situation in the world can affect the reduction of demand for gold and, accordingly, the reduction of its prices.

However, in recent years there has been an increase in gold prices, which indicates that demand factors outweigh supply factors and this trend may continue in the future.

Silver prices depend on many factors, such as changes in demand for silver in manufacturing and industrial markets, political turbulence, changes in exchange rates and monetary policies of various countries, and so on. We believe that silver prices may rise in 2024, as its use in the field of renewable energy and electronics continues to grow (Figure 5).

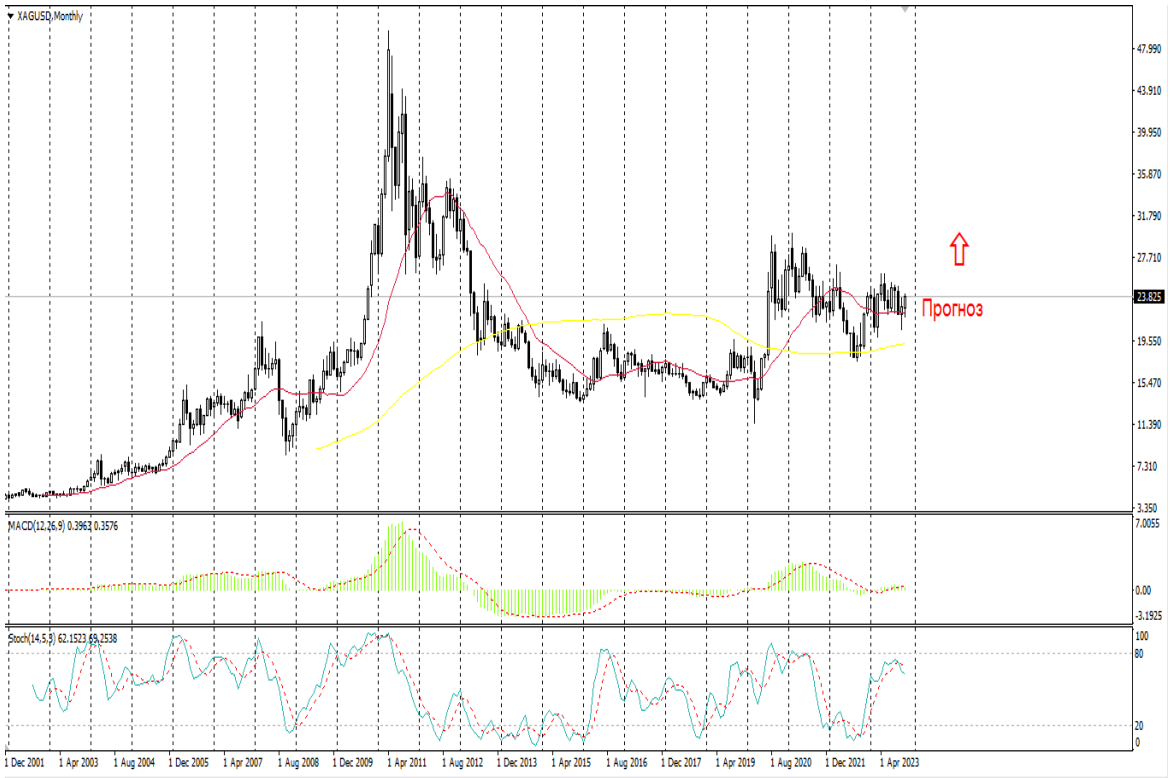

Figure 5. Forecast of silver price dynamics

Source: built on the basis of data from the Gold Statistics and Information (2023)

In addition, silver is also a popular tool for preserving capital in times of economic instability, so demand for silver may increase for this reason as well.

Discussion. In the world market of precious metals, the beginning of 2024 became exceptional. Gold prices have never exceeded the $2,000 mark in the first days of January. Market participants expect that by the end of the month, the price of gold may set a new historical high.

One of the key influencing factors is the expectation that the US Federal Reserve System will soon start reducing the key rate. The excessively high interest rate, which is currently held at the level of 5.25 - 5.50% per annum, is slowing economic activity in the United States. After that, a decrease in the yield of American treasury bonds was immediately recorded, which led to the transfer of funds by investors to other profitable assets, including gold.

Taking into account the specifics of the market, the following main reasons for such fluctuations can be identified:

The interest rate race of the ECB and the US Fed, which continues against the background of persistent inflationary problems in Europe and the States. So far, the

Fed is winning in terms of the effectiveness of the measures taken by its European counterparts. This is evidenced by the fall in inflation in the US in November to 7.1% year-on-year against the background of alarming price dynamics that persist in Europe.

Increasing geopolitical and military tensions in the world. This traditionally, on the contrary, plays in favor of increasing quotations of gold and partly of silver. First, conservative investors tend to go to gold in case of any cataclysms. Secondly, the industrial consumption of gold and silver is growing: these precious metals are actively used in many military technologies, and during the period of active arms races, the demand for them increases accordingly. The increase in demand is pushing up the prices of both gold and silver.

Changes in the structure of demand for gold and silver in China, India and other major consumer countries of these metals for the jewelry industry. Nowadays, the demand from the jeweler is growing again. This is facilitated by the gradual recovery of the solvency of the citizens of the Chine and India, which, taking into account the population of these countries, significantly affects the increase in prices for these precious metals. The wealthier part of the population of these countries prefers gold jewelry and coins, the less wealthy are limited to silver. As a result, the demand for both metals is increasing.

Thus, the world price of precious metals, primarily gold, depends both on the rational expectations of investors and on the uncertainty of global economic processes. As further research in accordance with the chosen topic, it is important to investigate the impact of a wider list of factors affecting the dynamics of the precious metals market, in particular, changes in the geopolitical situation in the world, supply disruptions, crisis financial phenomena, increasing demand for precious metals in the sphere of the latest high-tech sectors of the economy.

Conclusions. The volumes of the precious metals market are constantly growing. However, prices have been falling recently. This is due to the strengthening of the monetary policy of the central banks of many countries and, first of all, the increase in the interest rates of the US Fed. The decline in value is also due to a strengthening dollar and rising US government bond yields. According to projections for 2024, it can be argued that global silver production has begun to slow down and may continue to decline. At the same time, platinum markets may be supported by increased consumption in the production of heavy duty trucks and fuel cell buses in the US and China. This will support platinum and palladium prices.

In general, the market for precious metals is determined by many factors, such as supply and demand, geopolitical situation, financial and economic trends. In addition, one of the main reasons for geopolitical difficulties in the precious metals market is political instability and conflicts. Countries with large reserves of precious metals can become the target of geopolitical ambitions of other countries, which can lead to supply disruptions, increased costs and market instability.

Author contributions. The authors contributed equally.

Disclosure statement. The authors do not have any conflict of interest.

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