

Hedging basic materials equity portfolios using gold futures

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Abstract. Commodities can be treated as an alternative investment, a hedging strategy, or a diversification opportunity. Various types of commodities, especially metals, usually are not strongly affected by inflation, and the trends of their prices are not correlated with other investment instruments. To participate in the metals area of the commodity market, an investor can buy shares of companies from the basic materials sector. Such companies are involved in discovering, developing, and processing raw materials. However, as not all the companies from the basic materials sector deal with precious metals, it is worth adding gold futures to such a portfolio. The aim of this paper is to compare a portfolio of the basic materials sector stocks against a similar portfolio hedged with gold. Our findings revealed that hedging a commodities' portfolio with gold minimizes both profits and losses and can be suitable for risk-averse investors. The research results can be applied by individual investors and investment managers to choose the most appropriate investment approach.

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1. INTRODUCTION

Commodity markets have gained substantial interest from investors in recent years (Lombardi & Ravazzolo, 2016). Including commodities in an investment portfolio can be a good diversification, providing a reasonable risk-return trade-off during high volatility and inflation. Even if there is still a strong need for broad research in this field, it can be noticed that the prices of commodities usually do not positively and strongly correlate with stock prices (Creti et al., 2013; Hammoudeh et al., 2014). For this reason, investors often include a set of commodity futures contracts in their portfolio. Along with that, precious metals, such as gold, are considered a good hedge in times of unstable financial markets. Moreover, the recent popularity of commodities trading is determined by growing technical opportunities and the availability of this market for non-professional traders (Hayes, 2023). Steep ICT development facilitates these opportunities (Bilan et al., 2023; Straková et al., 2022).

Looking back to 2022, a severe economic slowdown and fears of an economic recession around the world have affected the commodity market (World Bank, 2022). According to World Bank (2022), factors unfavourable to precious metals overshadowed favourable factors, which led to a fall in the prices of precious metals in the third quarter of 2022. World Bank (2022) singles out weak investment volume, low physical demand for precious metals, and high interest rates as the key risks for precious metal prices. On the other hand, the following drivers of the prices of precious metals are distinguished: rising demand for low-risk financial instruments due to the war in Ukraine and growing global inflation.

According to the most recent World Bank Report data (2023), in March 2023, global commodity prices decreased by 30 percent, compared to their highest value in June 2022. For 2023, the overall price decline is forecasted to be about 21 percent, with energy commodities' prices declining more than the prices of non-energy commodities and a moderate increase in precious metals' prices. At the same time, the prices of non-precious metals are projected to decrease by 8 percent in 2023 and by 3 percent in 2024. In 2024, commodity prices will more or less remain at the same level but still higher than before the COVID-19 pandemic. The main barriers to increasing global commodity prices are thought to be weaker energy supply and disruptions in metals supply, more robust demand from China, geopolitical tensions, and extreme weather events (World Bank, 2023).

Considering different price trends of various groups of commodities, investing in this sector, if adequately diversified, is deemed as an opportunity. However, in order to participate in the commodities market, it is not necessary to physically buy commodities. Investors can invest in commodity stocks, exchange-traded funds (ETFs) that track a basket of commodity shares, mutual funds, or derivatives (Green, 2022; Užík et al., 2023). According to IG (2023), commodity stocks, or commodity-based stocks, are issued by companies involved in excavating or nurturing natural resources that are processed and packaged for resale. While trading on financial markets, it is worth knowing that commodity and commodity-based stock prices do not always move in the same direction and to the same extent. Commodity trading depends on the actual price of the commodity itself. Market supply and demand, weather patterns, and economic and political situations are critical factors that affect the price of commodities (Agnello et al., 2020; Majewski & Mentel, 2022)). However, other external factors often impact the company's stock price, and these factors, as well as the strength of their impact, change over time. As already mentioned, many different conditions

are forecasted to influence commodity market behaviour in 2023-2024. Thus, it is worth analysing whether investing in commodities portfolios is relevant under such a volatile and challenging environment.

In this paper, we aim to develop a portfolio of commodity-based stocks – the stocks from the basic materials sector – and hedge it using gold futures. We will compare the results of this portfolio with the portfolio without gold hedging. Thus, we will find out whether it is enough to invest in commodity-based stock or whether a commodity future contributes to minimizing risk and maximizing return. To reach our research aim, we constructed portfolios using such methods as equal weights portfolio, Monte Carlo simulation, Sharpe ratio, sequential least squares programming, mean-variance portfolio optimization, and considering gold futures.

The paper is structured as follows. The first section provides a literature review on the topics of commodities trading, metals trading, and gold as a hedging instrument. In the second section, the scheme of research and a description of the main methods applied is presented. Research results of the constructed portfolios are described and compared in the third section. The discussion section provides a comparison of the research results with previous findings in this area. The last section presents the overview of results, implications, limitations, and future research directions.

2. LITERATURE REVIEW

Commodities are an important part of the global economy, and trading in commodities has occurred throughout human history. The main groups of commodities are energy, agricultural, and metal commodities. Commodities contribute substantially to economic growth and development and make an impact on international trade. More and more, commodities are perceived as financial assets. Thus, their price formation and volatility issues, as well as their relationship with other financial assets, such as stocks, achieve great attention (van Heullen, 2020; Ding et al., 2021; Marfatia et al., 2022; Widodoatmodjo & Setyawan, 2022). Mbarki et al. (2023), while examining commodity connectedness, distinguish such prevailing trends in commodity research as the relationship between oil and other financial markets, especially the stock market, and point out some of the most recent research trends, such as links of commodities to renewable energy and cryptocurrencies. Moreover, Mbarki et al. (2023) developed some future directions for analysing commodity markets with regard to other factors, including market sentiments, uncertainties of the pandemic and the Russia-Ukraine war, and digital currencies.

Since 2004, many investors started using commodities for financial hedging and investment, thus increasing the level of financialization in commodities (Li et al., 2023; Xiao et al., 2023). A vigorous discussion started among researchers and practitioners on whether financialization distorts commodity prices (Tang & Xiong, 2012; Cheng & Xiong, 2013). Kang et al. (2023) found that financialization increases the correlation between commodity and stock market returns. Also, Kang et al. (2023) outlined that after the financialization of the commodities market started, the number of non-commercial traders in this market increased, and these traders were mainly institutional. Accordingly, the number of small retail traders and their impact on the market diminished.

Metals are one of the oldest traded commodities in history (Lazzarino et al., 2022). Non-precious (sometimes called base or industrial) metals (aluminium, lead, zinc, copper, and nickel) are essential for manufacturing and other economic activities, and precious metals are an attractive instrument of financial investment and hedging (Todorova et al., 2014). The effect of financialization, particularly on metal prices (especially on non-precious metals), has not been studied deeply in the literature. However, Mayer et al. (2017) analysed major metal commodities (copper, gold, silver, platinum, and palladium), not distinguishing them into precious and non-precious, and made a conclusion that commercial and long positions influence behaviour of prices more than institutional traders. They also found that palladium and platinum prices are

more strongly influenced by trading performed in the market compared to other metals. Mensi et al. (2021) analysed the dependence between particular precious and non-precious metals and concluded that precious metals strongly contribute to the insurance of the investment portfolio in the long run. In their research, Liu et al. (2023) showed that metals are a suitable hedge against inflation, with industrial metals being more effective for hedging than precious metals.

Still, far more research is performed in precious metals than in the industrial metals area, considering them as an investment or insurance instrument. According to Darst (2013), for centuries, gold and other precious metals have served as a financial instrument that holds value. At the beginning of a possible economic crisis, investors often filled their investment portfolios with precious metals. Historically, gold has served its function as a hedge against inflation. Because metals can maintain their demand and have a low correlation with most other financial instruments, precious metals are considered suitable for diversification (Darst, 2013).

In a study conducted by scientists Bredin et al. (2017), it was proven that gold performs a hedging function, protecting the investment portfolio from significant losses. According to Bredin et al. (2017), Alkhezali and Zoubi (2020), and Alqaralleh and Canepa (2022), gold helps protect the portfolio in the short to medium period. An empirical study by Bredin et al. (2017) found that including precious metals in an investment portfolio reduces its Sharpe ratio. This indicates that investors, in many cases, potentially sacrifice higher returns by adding precious metals to their portfolios but reduce portfolio risk.

Darst (2013) and Jiang (2022) distinguish the main advantages of gold:

- 1) Historically, gold maintains its purchasing power relative to other commodities.
- 2) Gold prices historically have a negative or very low correlation with other financial instruments.
- 3) During various economic periods, including inflation, financial market instabilities, monetary system collapses, and geopolitical instabilities, gold was considered a financial instrument creating hedging and protection.

Gold typically generates higher returns in global financial market downturns and lower returns when global financial markets rise. As a safe financial instrument, gold is important in creating a diversified investment portfolio (Jiang, 2022). Salisu et al. (2021) revealed that even during the COVID-19 pandemic, gold was the best risk-reducing property compared to other precious metals.

3. METHODOLOGICAL APPROACH

Portfolio insurance is a method of hedging an investment portfolio against market risk by short-selling futures (Alshammari and Obeid, 2023). Futures can be either stock index-based or commodity-based. Institutional investors often use this hedging technique in times of market uncertainty. Short-selling of futures can diminish potential losses, but it also prevents from obtaining greater gains.

Derivative financial instruments are mainly used for portfolio hedging, but speculators also use basis trading for profit. The basis is the difference between the spot price and the futures price (Mattson & Vikström, 2011):

$$\text{Basis} = \text{Current spot rate} - \text{Future price} \quad (1)$$

The price of a futures contract can approach the price of the asset, but it can also diverge. Speculators' attempt to guess the size of the basis and take advantage of it is called a basis strategy. The ability to speculate using a predictive basis allows investors to expect a profit. If the price of the asset rises more than the futures contract, the asset must be bought and the futures contract sold; if the price of the asset is expected to fall, then the asset is sold, and the futures contract is bought. Most often, these strategies

are applied to assets whose changes are related, such as stocks of a particular industry and the future contract of the index of that industry.

According to Cifarelli & Paladino (2015), formula (1) can be expressed in terms of price changes during the hedging period:

$$r = \Delta S - H\Delta F \quad (2)$$

Where ΔS is the change in stock prices over the period, and ΔF is the change in the futures price over the period. The ratio of the number of units of the futures assets in the portfolio to the number of units of the spot assets in the portfolio is known as the hedge ratio H . If the spot and futures periods were the same, then $H=1$. However, H is not equal to 1 when building a portfolio of stocks and taking a futures contract on a stock index or other related asset. The purpose of portfolio hedging is to reduce risk, so the authors (Cifarelli and Paladino 2015) expressed portfolio risk $\sigma(rp)$ through the correlation between spot and futures $\rho(S,F)$ and their standard deviations $\sigma(rS)$ and $\sigma(rF)$ in period t :

$$\sigma^2(rp) = \sigma^2(rS) + H^2\sigma^2(rF) - 2H\rho(S,F)\sigma(rS)\sigma(rF) \quad (3)$$

Thus, the expression for the dynamic hedge ratio is:

$$H = \rho(S,F)\frac{\sigma(rS)}{\sigma(rF)}. \quad (4)$$

The following formula will be used to measure the effectiveness of the portfolio insurance:

$$\Delta risk = \frac{\text{hedged } \sigma(rp) - \text{unhedged } \sigma(rp)}{\text{unhedged } \sigma(rp)}. \quad (5)$$

Different portfolio optimization methods in two different periods will be used for comprehensive portfolio insurance research. The chosen research process is shown in Figure 1.

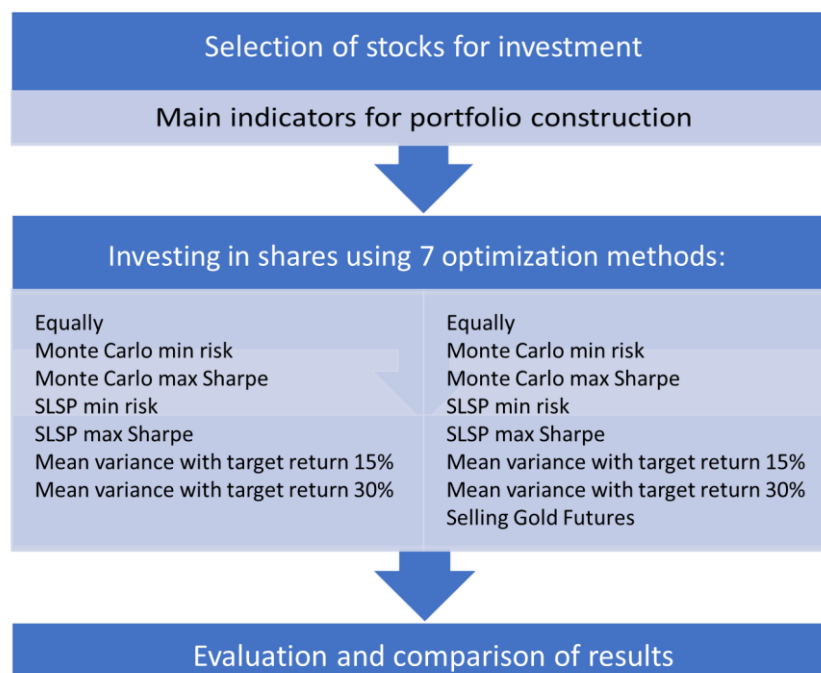


Figure 1. Diagram of research

Source: own compilation

The shares of the basic materials sector are taken from the list to link them to the gold industry since gold futures are the best for the basis strategy. The leading indicators for optimizing portfolios are monthly and annual returns, annual volatility, and the Sharpe ratio. Python code creates seven different portfolios:

1. Equal weight portfolio is the simplest distribution of funds equally to all shares.
2. The Monte Carlo simulation method estimates the parameters of all possible portfolios by assigning them a certain probability. The resulting probability distribution allows investors to choose a portfolio:

- with the minimum risk;
- with the maximum expected return.

3. The sequential least squares programming (SLSP) method replaces the original problem with a sequence of quadratic problems (QPs) whose objective is a second-order Lagrangian approximation and whose constraints are linear initial constraints. It then uses optimization techniques to ensure convergence toward a portfolio with:

- minimum risk;
- maximum expected return.

4. Mean-variance analysis is a mathematical process that allows the user to maximize returns for a given level of risk. The author of this optimization method, known since 1952, is Harry Markowitz (Markowitz, 1952). Portfolios with a chosen return corresponding to a certain risk are called efficient portfolios. Greater risk is required to achieve higher expected returns. Based on the information provided by the Python code, we have chosen two levels of expected return: 15% and 30%.

Thus, 7 different portfolios are formed: 1) Equal weight portfolio; 2) Monte Carlo with minimum risk; 3) Monte Carlo with maximum return; 4) SLSP with minimum risk; 5) SLSP with maximum return; 6) Mean-variance with target return of 15%; 7) Mean-variance with target return of 30%.

Moreover, two different strategies will be compared by calculating portfolio returns for the two different periods (01/03/2022 to 01/03/2023 and 01/03/2023 to 01/11/2023):

- without futures, investing only in shares of the basic materials sector (without CG-F);
- long the stock and short the gold futures, allocating funds equally to the stock and futures (with CG-F).

The hedging efficiency is evaluated by the rate of returns (RoR) of the portfolios of the test periods, and the hedge ratio of the portfolios is calculated according to formula (5) for each differently optimized portfolio. The absolute risk is estimated by the standard deviations of the portfolios (StDev), and the return per unit of risk with the Sharpe ratio.

4. CONDUCTING RESEARCH AND RESULTS

Gold futures and shares of the basic materials sector were selected for the study (Table 1), paying attention to the availability of five years of data. Monthly data for the compilation of portfolios are taken from 01/03/2018 to 01/03/2022, and the investment evaluation period covers 01/03/2022 to 01/03/2023. March was chosen because detailed annual reports of joint-stock companies are available around that time. The data source was the Yahoo Finance website (Yahoo Finance, 2023).

Table 1

Selected companies

No	Code	Company name	Industry	Headquarters	Stock exchange
1	RIO	Rio Tinto Group	Different materials	UK	NYSE - Nasdaq
2	VALE	Vale S.A.	Different materials	Brazil	NYSE - Nasdaq
3	FCX	Freeport-McMoRan Inc.	Copper	USA	NYSE - Nasdaq
4	SCCO	Southern Copper Corporation	Copper	USA	NYSE
5	GOLD	Barrick Gold Corporation (NYSE)	Gold	Canada	NYSE
6	FNV	Franco-Nevada Corporation	Gold	Canada	NYSE - Nasdaq
7	ALB	Albemarle Corporation	Specialty chemicals	USA	NYSE - Nasdaq
8	ABX.TO	Barrick Gold Corporation (TSX)	Gold	Canada	Toronto
9	SBSW	Sibanye Stillwater Limited	Gold	South Africa	NYSE
10	MAG	MAG Silver Corp.	Silver	Canada	NYSE

Source: own compilation

Although the key information about the selected companies is presented in Table 1, it is worth revealing some additional facts from the profiles of these companies (Yahoo Finance, 2023). RIO processes aluminium, copper, iron ore, lithium, and some other materials. This activity greatly contributes to renewable energy production and decarbonization. VALE mainly produces and sells iron ore. However, this company has two segments: Iron Solutions and Energy Transition Materials. The first operates in producing iron ore, manganese, and related logistics services, while the second produces a broader range of non-precious and precious metals for vehicles, the construction industry, and electric equipment. Although the primary material in FCX operation is copper, it also explores gold, molybdenum, silver, oil, and gas. The company performs mining activities in North and South America, as well as Indonesia. SCCO is engaged in the production of copper but also, to a smaller extent, produces refined silver and gold and mines zinc, copper, molybdenum, silver, gold, and lead. The primary countries of operation are Peru, Mexico, Argentina, Ecuador, and Chile. GOLD's activity is the mining and production of gold and copper. It participates in the ownership of mines located in North and South America, as well as in some African countries.

FNV company relates its core activity to gold, but it also has silver and platinum in its portfolio and sells oil and gas. The operation territory is North America and Latin America. ALB area of activity – specialty chemicals. It has three segments of operation: Lithium, Bromine, and Catalysts. Lithium compounds are used in batteries, car tires, plastic bottles, pharmaceutical industries, and other areas. Bromine-based products are required for application in the chemical industry. ABX.TO stands for Barrick Gold Corporation in the Toronto Stock Exchange and trades stocks in CAD. SBSW produces gold, metals of the platinum group, and other metals such as chrome, nickel, silver, cobalt, and copper. The company operates in South Africa, the USA, Europe, and Australia. MAG explores and develops silver, gold, lead, copper, and zinc. The company is in Canada, but its biggest mining project is in Mexico. We can see that the industry and geographical diversification of selected companies are sufficient. Thus, in the next step, some statistical parameters of their stock prices should be analysed.

Table 2 shows the correlation coefficients of all monthly data for stocks and gold futures and the hedging coefficients calculated according to formula (4). ALB, SBSW, and MAG stand out from other stocks as we see negative correlation and negative hedge ratios. According to formula (2), a negative hedging ratio can create favorable conditions for the hedged portfolio to receive profit. All stocks have very low hedge ratios (< 0.1) except for ALB (-0.29) and SCCO (0.1).

Table 2

Correlations and hedge ratios

	GC=F	RIO	VALE	FCX	SCCO	GOLD	FNV	ALB	ABX.TO	SBSW	MAG
GC=F	1.00	0.49	0.24	0.58	0.84	0.42	0.51	-0.70	0.48	-0.14	-0.17
RIO		1.00	0.94	0.86	0.52	0.77	0.59	-0.08	0.78	0.57	0.56
VALE			1.00	0.75	0.27	0.82	0.56	0.15	0.81	0.74	0.73
FCX				1.00	0.75	0.70	0.76	-0.07	0.71	0.44	0.45
SCCO					1.00	0.28	0.52	-0.46	0.34	-0.18	-0.17
GOLD						1.00	0.74	-0.05	0.99	0.79	0.67
FNV							1.00	0.03	0.75	0.50	0.52
ALB								1.00	-0.09	0.33	0.39
ABX.TO									1.00	0.73	0.64
SBSW										1.00	0.90
MAG											1.00
StDev	108.03	7.53	2.22	5.84	12.23	2.70	12.20	44.59	3.03	3.56	1.91
H		0.03	0.005	0.03	0.10	0.01	0.06	-0.29	0.01	-0.005	-0.003

Source: own compilation

The allocation of funds in the portfolios is presented in Figure 2. The least diversified are the one sequential least squares programming portfolio and two mean-variance portfolios, which selected only two or one stock for the portfolio. The most diversified are the portfolios made using the Monte Carlo method. Most often, ALB (11/12) and SCCO (10/12) stocks were included in the optimized portfolios, and less often, FCX and MAG stocks were included (only twice each).



Figure 2. Allocations of funds in portfolios

Source: own compilation

The test results for two different periods of 7 analysed portfolios, presenting the rate of return (RoR), the change of RoR, standard deviation (StDev), Δ risk, and the Sharpe Ratio, are shown in Table 3. The selected stocks have had challenging periods. Only two portfolios tested in 2022 – SLSP with minimum risk and maximum Sharpe indicator – generated positive returns, while all others showed losses of 8-20%. The ten months of 2023 were even more difficult for selected stocks, with 12-49% losses. Theoretically speaking, the investor should not have chosen such stocks or used other stock selection criteria. However, the selected

companies are part of the ecosystem of basic materials; they exist and have shareholders who care not only about stock market results but also about the possibility of hedging against falling stocks.

Hedging portfolios using gold futures mitigated losses across all portfolios. Gold futures are published for one month. During the tested period of 2022, monthly purchases of gold futures of 51 units generated a loss of 306 EUR. During the tested period of 2023, the monthly use of 54 units for hedging yielded a profit of 5475.6 EUR.

Table 3

Results of hedged and not hedged portfolios

Portfolio	Equal		Monte Carlo				SLSP				Mean Variance			
	Low		Min Risk		Max Sharpe		Min Risk		Max Sharpe		Target 15%		Target 30%	
Date	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
RoR without CG-F	-14.8%	-12%	-10%	-13%	-8%	-25%	9%	-18%	14%	-29%	-20%	-18%	-8%	-49%
RoR with CG-F	-15.1%	-3%	-5%	-3%	-2%	-10%	4%	-6%	7%	-12%	-10%	-6%	-4%	-22%
Change of RoR (%)	1.76	-75.00	-51.82	-76.92	-75.25	-60.00	-54.58	-66.67	-49.83	-58.62	-50.63	-66.67	-50.13	-55.10
StDev without CG-F	6.23	5.31	10.51	8.95	10.68	9.54	16.10	13.82	18.19	15.66	9.80	9.48	6.51	6.30
StDev with CG-F	32.03	38.91	31.76	38.68	32.28	39.0807	32.07	38.88	32.30	39.17	34.39	41.09	31.45	39.20
Δ risk	4.14	6.33	2.02	3.32	2.02	3.10	0.99	1.81	0.78	1.50	2.51	3.33	3.83	5.23
Sharpe ratio without CG-F	-0.30	-0.76	-0.17	-0.45	-0.17	-0.44	-0.10	-0.30	-0.09	-0.27	-0.20	-0.43	-0.28	-0.70
Sharpe ratio with CG-F	-0.07	-0.10	-0.06	-0.10	-0.06	-0.10	-0.06	-0.10	-0.06	-0.10	-0.06	-0.10	-0.06	-0.11

Source: own compilation

The least and most diversified portfolios were especially unsuccessful: mean-variance, equal weights, and Monte Carlo. Only two consecutive least-squares programming portfolios tested in 2022 were profitable, but in 2023, their streak ended. The use of futures softened the results, reducing both profits and losses. Gold hedging had the least impact on the profitability of the SLSP max Sharpe (2022) portfolio and the loss of almost all Mean-Variance portfolios, except for the Equal (2022) portfolio, whose loss remained almost the same. The effectiveness of portfolio hedging, Δ risk, calculated according to formula (5), showed that hedging had the most significant effect on Mean-Variance target 30% portfolios and equal parts portfolios but a minor effect on all SLSP portfolios. The testing periods chosen for the basic materials sector were unsuccessful: in 2022, only two companies, SCCO and ALB, grew, and in 2023, only three – SCCO, GOLD, and MAG – showed an increase in stock price. Shareholders of other companies suffered losses that could have been hedged using monthly gold futures (GC-F) and partially offset the losses.

5. DISCUSSION

The body of literature on the possibilities of hedging an investment portfolio with commodities, particularly – with gold, is quite versatile and often depends on the analysed period and country. There are

more studies in favour of gold as a hedging instrument than criticizing such an approach, but still, some contradictory studies are also worth pointing out. Moreover, some researchers pay special attention to hedging during unstable times.

Chalid and Handika (2023) investigated the possibilities of hedging portfolios of stocks, bonds, and foreign currencies with various types of commodities (energy, metals, and agriculture). Hedging a stock market portfolio resulted in a conservative strategy, while hedging a portfolio of bonds and currency exchange rates demonstrated an aggressive approach. As in our case, half of their portfolio was devoted to a certain selected group of instruments (stocks, bonds, or currencies), and the other half was dedicated to commodities. Chalid and Handika (2023) found that adding commodities reduces the stock portfolio volatility but not bond or foreign exchange portfolio volatility. Also, commodities can improve bond and foreign exchange portfolio Sharpe ratio and the hedging performance of foreign exchange portfolios. Finally, commodities can reduce volatility and improve the Sharpe ratio of the equally weighted portfolio containing all types of the mentioned assets. Thus, the hedging strategy should be applied accordingly, with precise regard to the underlined asset. Vieira et al. (2023) found that gold is a hedge for European stocks (for EURO STOXX Banks and several national indexes) but a diversifier for the STOXX Europe 600 index.

The examples already described were not based on any separate country, as several stock indexes from different stock markets were applied. But many researchers concentrated on a separate country or region. For example, Mensi et al. (2015) analysed the Saudi stock market and found that stock index and commodity futures generally have an insignificant correlation; thus, commodities can be successfully added to a stock portfolio. However, this is not the case with silver, as silver has a stronger correlation with the Tadawul All-Share Index. Also, including non-ferrous metals in portfolios during bearish times can bring significant losses. In this case, other commodity futures should be considered. Pruchnicka-Grabias (2020) continued the research about market type impact on the hedging efficiency and analysed the hedging of the Polish stock market portfolio with gold. She demonstrated that the results depend on the trend of the gold market. Gold helps increase portfolio return and decrease risk during a bull market. Alternatively, during a gold bear market, it minimizes both risk and return. These results are in line with the results we obtained, though we have not distinguished bull and bear markets.

Arouri et al. (2015) added gold as a hedging instrument to a portfolio of Chinese stocks and assessed it with the most common volatility models. They proved that adding gold increases risk-adjusted return over time while insurance costs are relatively low. It especially works during crises. Similar results were obtained by Hoang et al. (2015), checking Paris stocks being hedged with gold, especially during unstable financial times. Boubaker and Larbi (2022) analysed hedging stock portfolios in BRICS countries with oil futures. Such portfolio insurance proved effective, especially during the COVID-19 pandemic. Also, the variance of the hedged portfolio was lower than that of the unhedged. Continuing the analysis of hedging possibilities in unstable times, Abuzayed et al. (2022) analysed hedging the UK stock portfolio using oil and gold during Brexit. Both oil and gold are suitable as insurance instruments, but a short position in oil is more desirable than a short position in gold. Such an effect is achieved regardless of the low correlation between the stock index and gold. They highlight that the positive effect of shorting the hedging instrument plays a key role in this situation.

There were also some studies that contradicted the majority of previous findings and our results. Manuj (2021) analysed whether gold is a good hedge in the US and Indian stock markets. The researcher proved that it is not, neither in stable times nor during crises. Investment possibility during unstable times is often called a safe haven in the literature (Baur and McDermott, 2010). Consequently, there were studies assigning an asset to a safe haven category if it helps to avoid losses during adverse market conditions and to a hedge category if it is uncorrelated with other assets on average (including both stable times and crises) (Baur and Lucey, 2010). Thus, Baur and McDermott (2010) found that gold is a safe haven in Europe but not a safe

haven during crises in Australia and Asia. Chen and Wang (2019) determined that the properties of gold as a safe haven or a hedge vary and depend on the industry sector of the stock. However, assessing gold as a safe haven and separating this characteristic from hedging was not a goal of our paper. Thus, this phenomenon has not been analysed in the conducted research.

Evaluating the contribution of our research to the current body of literature, first, the regional allocation can be pointed out. Some previous studies were of regional or international extent, while most researchers concentrated on one specific country. In our case, some basic materials-related companies were primarily based in the US, but almost all of them had subsidiaries or mines in other regions of the world, such as South America, Africa, or Europe. Also, nearly all of our selected companies trade their stocks on the NYSE or Nasdaq stock exchange. Next, even if our study period was 2018-2023, and the COVID-19 pandemic happened during that time, we have not distinguished a crisis period separately. And finally, in the literature, we often noticed that more than one hedging instrument was tested. Usually, there were contracts based on various types of commodities. Nevertheless, our research concentrated only on gold futures because other precious and non-precious metals, to some extent, were included in companies' activity, thus already having a certain effect on their stock prices. Overall, to the best of our knowledge, this is the first study where the hedged stock portfolio was formed only of commodity-related stocks.

6. CONCLUSION

The selected basic materials sector and companies related to precious metals such as gold, silver, platinum, lithium, and copper are of interest to investors due to growing demand in unstable times. Investors interested in shares of companies related to these metals have a considerable choice and can invest quite safely after a detailed analysis. Basis trading strategy is often associated with gold futures.

Seven different portfolio construction methods were selected for the study, which used historical data from 01/03/2018 to 01/03/2022. Excluding gold futures, five portfolios (equal weight, two Monte Carlo, and two mean-variance portfolios) from 01/03/2022 to 01/03/2023 and from 01/03/2023 to 01/11/2023 were loss-making, and only two SLSP portfolios showed a positive return. The practical application of the basis trading strategy revealed that the inclusion of short gold futures in portfolios did not change the direction of the result but mitigated both profits and losses. Thus, the basis trading strategy acted as a hedge during the two testing periods.

From the theoretical point of view, the conducted research demonstrates the possibility of comparing hedging results using several different methods of portfolio formation, which can contribute to a more objective perception of the expected portfolio return. Moreover, the proposed portfolio insurance strategy illustrates a comprehensive portfolio optimization approach, even concentrating on one particular industry. Such a strategy could be treated as an alternative to diversification throughout various industries. At the same time, it does not deny risk management principles. Practically, portfolio hedging using futures contracts can stabilize an investment portfolio, but stability comes at a price. The proposed investment strategy using gold futures could be applied by risk-averse investors who would like to invest in the commodities market but are not prepared to take high risks. Furthermore, the elaborated strategy can be used by investment managers who seek to satisfy different groups of clients by offering them well-informed hedging strategies and various levels of risk management.

Despite the abundance of portfolio optimization methods used, a limitation of this study may be the time periods chosen. Also, the period of the COVID-19 pandemic has not been separately distinguished and compared with relatively stable periods. In the future, the research could be broadened using different share selection methods, combinations of industrial and precious metals, and other commodity futures, such as oil or gas.

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