Acta Montanistica Slovaca
ISSN 1335-1788
actamont.tuke.sk

Portfolio Hedging Strategy - Metals and Commodities

Martin UŽIK[1], Michal GIMERSKÝ[2], Sebastian BLOCK[1] and Hawree DIZAYE[3]*

Authors' affiliations and addresses:
[1] Berlin School of Economics and Law, Badensche Straße 52, 10825 Berlin, Germany

[2] Technical University of Košice, Faculty of Economics, Boženy Němcovej 32, 040 01 Košice, Slovak Republic

[3] Tomas Bata University, Faculty of Management and Economics, Mostini 5139, 760 01 Zlin, Czech Republic
e-mail: dizaye@utb.cz

***Correspondence:**
Berlin School of Economics and Law, Badensche Straße 52, 10825 Berlin, Germany
e-mail: martin.uzik@hwr-berlin.de

How to cite this article:
Užík M., Gimersky, M., Block, S. and Dizaye,H. (2023). Portfolio Hedging Strategy - Metals and Commodities. *Acta Montanistica Slovaca*, Volume 28 (2), 509-518

DOI:
https://doi.org/10.46544/AMS.v28i2.19

Abstract
From the perspective of portfolio management, hedging is a proactive risk management measure that aims to protect the portfolio from unwanted drawdown risk and avoid loss on investment by incorporating assets into a portfolio which moves in the opposite direction as the market. However, trying to limit the risk could result in limiting potential profits. Commodities are one of the best hedges against inflation as their price typically accelerates during such times providing benefit to the investor. We use the innovative approach of hedging commodities using a combination of CAPM and RSI Strategy to identify which of 9 observed hard commodities (Aluminium, Zinc, Nickel, Lead, Tin, Copper, Gold, Brent Oil and Natural Gas) should have been incorporated into investment portfolio during the period 2008-2023. The SML strategy is reviewed in the empirical analysis for its suitability as a hedging instrument compared to the RSI, which is regularly used to hedge metals and commodities. Our MS Excel and IBM SPSS software analysis showed that RSI was a better hedging strategy than SML in 21 out of 36 cases but without statistical significance.

Keywords
Commodities, Hedging, CAPM, RSI, Portfolio management, Security Market Line

Introduction

Commodities are defined as basic goods or raw materials used in commerce. A commodity market deals in unprocessed or fundamental goods instead of finished products. Soft commodities refer to farm-produced goods like wheat, livestock, coffee, cocoa, and sugar. On the other hand, hard commodities are mined or extracted, such as gold, rubber, natural gas, and oil. More recent additions to the commodity markets include trading in emissions, electricity, and even mobile phone minutes. (Teall, 2023)

As an investment asset, commodities can play several important roles – Diversification (as they are typically low correlated with traditional asset classes – thus making them a useful tool for diversification and risk reduction), Inflation Hedge (as commodity prices typically rise with inflation, holding them can provide protection against temporary loss of purchasing power), Speculation (as they can offer significant returns for investors willing to accept higher levels of risk, e.g., oil offers typically high fluctuation in times of geopolitical tensions) and Exposure to Global Growth (especially in developing economies, demand rises as economies develop and industrialise). Numerous methods exist for investing in commodities. These methods encompass:

1. Physical Holding (physical exposure, inflation hedge, need for storage)
2. Physically backed precious metal exchange-traded products (ETP) – (physical exposure, inflation hedge, UCITS can invest in ETPs)
3. Futures Contracts: an inflation hedge, pre-set agreements to purchase or offload a specific commodity at an upcoming date. Traded on commodities exchanges, they provide a direct route to gaining a stake in commodity prices. It is a derivative.
4. The swap-based broad commodity is considered an inflation hedge offering risk premium. It is a derivative connected to counterparty risk, operationally complex, as there is a need to manage daily collateral.
5. Commodity ETFs and Mutual Funds: These investment options offer an alternative for obtaining a stake in commodities without engaging with futures contracts. Certain funds follow particular commodities, while others track indexes associated with commodities.
6. Equities of Commodity Producers: Another way investors can get exposure to commodity prices is by purchasing shares in companies engaged in commodity production, such as oil or gold mining. The downside is that it could be a better diversifier, not hedging inflation.

(Debru, Shah, 2021)

Adekoya et al. (2023) have noted that the inflation-based predictive model can offer a better performance for the commodities returns in most cases than the historical average model. Therefore, businesses can enhance their competitiveness by increasing their returns by diversifying their portfolios, hedging against inflation, speculating on future prices, and gaining exposure to global growth. Businesses can reduce their risk, protect their profits, and increase their chances of success.

A hedging strategy should be implemented to protect the portfolio from unexpected extreme fluctuations. *In* the following table, we summarise some of the most used portfolio hedging strategies:

Tab. 1 Portfolio Hedging Strategies

Hedging Strategy	**Description**
Futures Contract	Entering into a contract to buy or sell an asset at a future predetermined price to mitigate price fluctuations.
Options	Purchasing options to protect against unfavourable price movements. This includes buying put options to hedge against price declines and call options to hedge against price increases.
Short Selling	Borrowing and selling an asset with the expectation of buying it back at a lower price in the future, thereby profiting from price declines.
Diversification	Spreading investments across different assets to reduce the impact of any individual asset's price fluctuations on the overall portfolio.
Pair Trading / Market Neutral Positions	**Simultaneously taking long and short positions in two related assets to hedge against general market movements and profit from relative price changes.**

Risk Reversal	Combining options positions to hedge against both upside and downside price risks. Typically involves buying a call option and selling a put option simultaneously.
Exchange-Traded Funds (ETFs)	Investing in ETFs that track specific sectors or indices, providing diversification and hedging potential against specific market movements.
Forward Contracts	Like futures contracts, forward contracts are agreements to buy or sell an asset at a specified price at a future date, helping lock in prices and mitigate risk.

Source: own processing

Mentioned hedging strategies are only those used mostly in investing in general to reduce market risk. Although these can be applied to commodities trading, for the purpose of this paper, we have selected the Pair Trading strategy in connection with CAPM and RSI approach to hedge commodities. This strategy is commonly employed by funds managers and investors and includes opening positions in two correlated assets and profiting from favourable spread.

Material and Methods

Material

Recently, a study considered seven industrial metals and 20 most industrialised countries and looked into the potential of using metals as a hedge against inflation. The hedging performance of metals was found to be stronger after 2008 on a country-specific basis. However, average hedging performance is vulnerable to financial shocks based on panel analysis. Interestingly, the inflation-based predictive model brought better results than the historical average model (Adekoya et al., 2023).

Multiple research initiatives have highlighted the significance of precious metals as a hedge against market uncertainties, including risks associated with oil (Rehman et al., 2018; Salisu et al., 2021), stocks (Bhatia et al., 2020) and exchange rates (Bedoui et al., 2020).

Another recent study explores the relationship between clean energy stocks and energy metals. It investigates whether energy metals can act as hedges or safe havens for clean energy stocks. The study finds evidence of a significant positive relationship as gold and silver exhibit hedging properties for certain clean energy subsectors showing safe haven properties. Cobalt shows different dynamics and may not be directly influenced by clean energy demand (Gustafsson, 2022).

Gold and silver are effective hedges against geopolitical risk (GPR) in the short and medium term, while strategic precious metals like palladium and platinum act as hedges only during major geopolitical events affecting their primary sources. The relationship between GPR and precious metals exhibits asymmetry, with gold primarily hedging against negative GPR changes in the medium term. All four precious metals can effectively hedge against GPR and its negative changes in the medium term. Gold and silver lead GPR, making them useful predictors of geopolitical risk. These findings have implications for investors, suggesting the inclusion of gold and silver in portfolios as hedges against GPR, considering the heterogeneous effects of different precious metals and a medium-term hedging horizon (Cheng et al., 2022).

The use of crude oil as a hedge was described in a study which explores selective hedging techniques for risk management and proposes a novel method using a multi-factor Hidden Markow Model (HMM) to identify market trends and measure herding effects in crude oil markets. The findings suggest that the multi-input HMM outperforms the single-input HMM in identifying market states, and combining market state and herding effect improves future market anticipation. State-dependent hedging strategies generally outperform model-dependent strategies, enhancing the return-to-risk ratio without significantly increasing portfolio variance. The study offers practical recommendations for oil industry participants, emphasising the need to consider market conditions while hedging (Yu et al., 2023). As part of risk management in the field of security management, the knowledge (Kelemen and Jevcak, 2018), experience, and skills of experts in this economic sector, as part of the state's critical infrastructure (Kelemen et al., 2018b), are valuable. Other methods make it possible to examine the interdependence between financial development, fiscal instruments, and environmental deterioration in EU countries (Zioło et al., 2020; Ahmad et al., 2022).

Using CAPM, the paper identifies a seasonal pattern in futures' price paths with trading time for natural gas and crude oil contracts. The findings suggest the existence of trading time seasonality, which may create arbitrage opportunities and challenge traditional futures pricing models. A "buy low sell high" trading strategy demonstrates positive expected payoffs with low-risk exposure. The paper acknowledges limitations in understanding the precise source of trading time seasonality and observes potential market anomalies in the backward curve of crude oil. (Ewald et al., 2022).

Following the Asian crisis in 1997, there is evidence of equity market contagion, where financial crises in one market transmit shocks to other markets. This leads investors to seek diversification by investing in commodities, resulting in the financialisation of commodities (Sinicakova & Gavurova, 2017). This phenomenon was observed during the great recession when institutional investors turned to commodities, causing price increases. Empirical studies have documented the equity-commodity shock transmission during crisis periods (Masood et al. 2017). This study examines the contagion between equities from the USA, Western Europe, and the BRICS regions, and various commodities across four crises using the DCC GARCH and international three-factor CAPM. The findings indicate significant decoupling of commodities from the global financial crisis (in line with Carter, Giha, 2023). The investment benefits did not meet expectations, as evidenced by the underperformance of commodity index funds. The literature discusses whether the scale of financialisation reduced historical risk premiums in commodity futures markets. The study's results support that risk premia declined after 2007 with increased financialisation, based on an analysis of eleven commodities. (Carter, Giha, 2023) This Trend worsened even more after the Irish banking crisis and the European debt crisis. However, during BREXIT, positive contagion occurred as investors sought diversification. This study examines the contagion between equities and commodities, suggesting the need for appropriate portfolio allocation to optimise risk management during crises.

Gil (2022) developed and optimised artificial intelligence (AI) trading systems for intraday trading of five precious metals, using two technical tools: the Relative Strength Index (RSI) and Keltner Channels (KC). The system was fine-tuned using Particle Swarm Optimization, enabling it to handle complex optimisation involving multiple objectives and numerous variable constraints. The RSI system yielded better results than Buy-and-Hold strategies for Gold, Silver, Platinum, and Palladium but underperformed for Copper trades. The respective excess returns for these metals were 106.2%, 63.7%, 22.4%, and 326.3%. RSI and KC systems demonstrated the ability to trade profitably for these metals in both long and short positions, though the performance was typically better for long trades. (Gil, 2022)

Another recent study investigates a hedge fund trading strategy based on the correlation of two assets. It uses technical analysis to predict price movements of their spreads, focusing on commodity, equity, and currency spreads traded between 1990–2016. Multiple hypothesis testing methods addressed the data mining issue using a large pool of predictive rules, which adjusted thresholds for significant t-statistics. Manipulation-Proof-Performance-Measure was employed to determine if Out-Of-Sample performance resulted from unpriced risk or skill. Findings indicate that technical trading still provides significant Sharpe ratios for many spreads, with commodity pairs outperforming equity and currency ones, and technical analysis performance has not worsened over time, even with increased hedge fund activity. Time-series regressions revealed a significantly negative relationship between the portfolio's returns and the momentum factor, suggesting that spread trading's performance is significantly driven by market volatility. (Psaradellis et al. 2023)

Methods

Based on Uzik & Block 2023, we incorporate CAPM Model /Security Market Line to identify an over- or undervaluation of commodities. We have chosen the following nine commodities – Aluminium, Zinc, Nickel, Lead, Tin, Copper, Gold, Brent Oil and Natural Gas. We identify the expected return of a portfolio of selected commodities using CAPM while considering a certain risk-free investment based on data for Germany obtained from the website www.marktrisikoprämie.de. The CAPM yields were determined based on daily rates for 250 trading days before the respective key date at the end of the quarter. MSCI World Price Index represents the market portfolio. By creating a Security Market Line, we visualise the expected return of commodity in the portfolio from the risk of the market portfolio (expressed by the covariance of returns). We thus identify the overvaluation/ undervaluation of commodities.

Based on these assumptions, we formulate the following hypothesis, which will be tested within this research paper:

H0: SML strategy does not lead to better hedging results than the RSI strategy.

The period from the first quarter of 2008 to the first quarter of 2023 was examined, although due to the calculation method of the RSI with four quarters, a comparison is only possible from the first quarter of 2009. CAPM Model is described as follows:

if

$$r_{CAPM_i,t} > ln\left(\frac{r_{i,t}}{r_{i,t-1}}\right) \tag{1}$$

then go short and sell the asset,

or

if

$$r_{CAPM_{i,t}} < ln\left(\frac{r_{i,t}}{r_{i,t-1}}\right) \tag{2}$$

then go long and buy the asset.

CAPM is calculated as follows:

$$r_{CAPM} = r_f + \left(r_M - r_f\right) \times \beta \tag{3}$$

and

$$\beta_i = \rho_{i,M} \times \frac{\sigma_i}{\sigma_M} \tag{4}$$

where:

r_{CAPM} = Expected return according to the Capital Asset Pricing Model
r_f = Risk-free rate
r_M = Market Return
β_i = Beta (systematic risk)
$\rho_{i,M}$ = Correlation between the returns of the asset and the market
σ_i = Volatility of the asset's returns
σ_M = Volatility of market returns.

Secondly, we use a Relative Strength Index (RSI) strategy on commodities to test whether this procedure leads to better results than CAPM. The RSI is calculated as follows:

$$\boldsymbol{RSI_{i,t} = 100 - \left(\frac{100}{\left[1 + \frac{\frac{1}{n}\sum_1^n max(P_t - P_{t-1}; 0)}{\frac{1}{n}\sum_1^n min(P_t - P_{t-1}; 0)}\right]}\right)} \tag{5}$$

For comparability reasons, the quarterly prices of aluminium, zinc, nickel, lead, tin, copper, gold, Brent oil and natural gas are calculated for a period of four quarters as part of the RSI. The signal of the RSI is adjusted individually for the intervals (0.1; 0.9), (0.2; 0.8), (0.3; 0.7), and (0.4; 0.6) and tested against the SML. If the upper quantile is exceeded, the metal is considered overbought, and we go short, i.e., sell the commodity for one quarter. In case of breaching the lower quantile, the commodity is considered oversold, and we buy it for one quarter. No trading is carried out within the interval limits. The value is then set to zero for comparison purposes and tested against the SML strategy.

Results

As a part of the empirical analysis, the SML strategy is reviewed for its suitability as a hedging instrument compared to the RSI, which is regularly used to hedge metals and commodities. We used IBM SPSS software to calculate statistics and conducted a paired sample T-test for four pairs presented in the following table.

Tab. 2 Portfolio returns – Paired Samples T-test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	RSI (0.1;0.9) - SML	22.962	3003.952	132.628	-237.600	283.523	0.173	512	0.863
Pair 2	RSI (0.2;0.8) - SML	17.393	3168.495	139.892	-257.441	292.226	0.124	512	0.901
Pair 3	RSI (0.3;0.7) - SML	-19.539	3748.420	165.497	-344.676	305.597	-0.118	512	0.906
Pair 4	RSI (0.4;0.6) - SML	6.147	3750.421	165.585	-319.163	331.457	0.037	512	0.970

Source: author's calculation in SPSS

We tested the following hypothesis set at the beginning of our working paper. H0: SML strategy does not lead to better hedging results than the RSI strategy.

As the previous table presents, three out of four tested pairs showed outperformance of the RSI strategy over the SML strategy. In the case of the first pair RSI on the interval 0.1 and 0.9 outperformed SML by 22.96 points on average. However, the *p*-value of 0.863 was above 0.05, suggesting that this result has no statistical significance. Only pair 3, which tested the difference in returns of RSI (0.3;0.7) and SML, resulted in the outperformance of the SML strategy over RSI. Here, on average, the SML was performing 19.54 points better than RSI, although in this case, the result was statistically not significant (p-value 0.906).

After the first part of our analysis, we can conclude that the differences between all analysed pairs did not show any statistical significance according to our data. Therefore, hypothesis H0 cannot be rejected and must be retained, meaning that the SML strategy does not lead to better hedging results than the RSI strategy for the analysed data sample.

As the next step, we conducted paired sample T-test using SPSS software to compare differences between RSI and SML for nine individual commodities on four different intervals of RSI. The following table presents the results of the analysis for 36 pairs:

Tab. 3 Paired Sample T-test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	RSI Aluminium 3-Month-Officials (0.1;0.9) - SML Aluminium 3-Month-Officials	-6.895	478.882	63.429	-133.959	120.170	-0.109	56	0.914
Pair 2	RSI Zinc 3-Month-Officials (0.1;0.9) - SML Zinc 3-Month-Officials	-81.088	547.123	72.468	-226.259	64.084	-1.119	56	0.268
Pair 3	RSI Nickel 3-Month-Officials (0.1;0.9) - SML Nickel 3-Month-Officials	50.281	6115.325	809.995	-1572.333	1672.895	0.062	56	0.951
Pair 4	RSI Lead 3-Month-Officials (0.1;0.9) - SML Lead 3-Month-Officials	-0.281	373.972	49.534	-99.509	98.948	-0.006	56	0.995
Pair 5	RSI Tin 3-Month-Officials (0.1;0.9) - SML Tin 3-Month-Officials	91.877	6486.460	859.153	-1629.212	1812.967	0.107	56	0.915
Pair 6	RSI Copper 3-Month-Officials (0.1;0.9) - SML Copper 3-Month-Officials	120.947	1501.320	198.855	-277.406	519.301	0.608	56	0.546
Pair 7	RSI Gold Fixing London (0.1;0.9) - SML Gold Fixing London	32.512	281.819	37.328	-42.264	107.289	0.871	56	0.387
Pair 8	RSI Oil Brent (0.1;0.9) - SML Oil Brent	-0.845	17.833	2.362	-5.577	3.887	-0.358	56	0.722
Pair 9	RSI Natural Gas (0.1;0.9) - SML Natural Gas	0.146	1.323	0.175	-0.205	0.497	0.832	56	0.409
Pair 10	RSI Aluminium 3-Month-Officials (0.2;0.8) - SML Aluminium 3-Month-Officials	-7.807	492.577	65.243	-138.505	122.891	-0.120	56	0.905

Pair 11	RSI Zinc 3-Month-Officials (0.2;0.8) - SML Zinc 3-Month-Officials	-110.298	567.741	75.199	-260.940	40.344	-1.467	56	0.148
Pair 12	RSI Nickel 3-Month-Officials (0.2;0.8) - SML Nickel 3-Month-Officials	218.246	6424.309	850.921	-1486.353	1922.844	0.256	56	0.799
Pair 13	RSI Lead 3-Month-Officials (0.2;0.8) - SML Lead 3-Month-Officials	15.632	402.371	53.295	-91.132	122.395	0.293	56	0.770
Pair 14	RSI Tin 3-Month-Officials (0.2;0.8) - SML Tin 3-Month-Officials	-88.930	6868.095	909.701	-1911.281	1733.421	-0.098	56	0.922
Pair 15	RSI Copper 3-Month-Officials (0.2;0.8) - SML Copper 3-Month-Officials	104.947	1567.580	207.631	-310.988	520.882	0.505	56	0.615
Pair 16	RSI Gold Fixing London (0.2;0.8) - SML Gold Fixing London	26.973	287.633	38.098	-49.346	103.292	0.708	56	0.482
Pair 17	RSI Oil Brent (0.2;0.8) - SML Oil Brent	-2.356	25.676	3.401	-9.168	4.457	-0.693	56	0.491
Pair 18	RSI Natural Gas (0.2;0.8) - SML Natural Gas	0.127	1.362	0.180	-0.235	0.488	0.703	56	0.485
Pair 19	RSI Aluminium 3-Month-Officials (0.3;0.7) - SML Aluminium 3-Month-Officials	-0.886	493.456	65.360	-131.817	130.045	-0.014	56	0.989
Pair 20	RSI Zinc 3-Month-Officials (0.3;0.7) - SML Zinc 3-Month-Officials	-160.035	872.348	115.545	-391.500	71.430	-1.385	56	0.172
Pair 21	RSI Nickel 3-Month-Officials (0.3;0.7) - SML Nickel 3-Month-Officials	206.737	6622.280	877.142	-1550.391	1963.864	0.236	56	0.815
Pair 22	RSI Lead 3-Month-Officials (0.3;0.7) - SML Lead 3-Month-Officials	51.605	421.864	55.877	-60.330	163.541	0.924	56	0.360
Pair 23	RSI Tin 3-Month-Officials (0.3;0.7) - SML Tin 3-Month-Officials	-441.474	8968.687	1187.932	-2821.187	1938.239	-0.372	56	0.712
Pair 24	RSI Copper 3-Month-Officials (0.3;0.7) - SML Copper 3-Month-Officials	151.219	1613.509	213.715	-276.902	579.341	0.708	56	0.482
Pair 25	RSI Gold Fixing London (0.3;0.7) - SML Gold Fixing London	18.651	306.224	40.560	-62.601	99.903	0.460	56	0.647
Pair 26	RSI Oil Brent (0.3;0.7) - SML Oil Brent	-1.717	26.664	3.532	-8.792	5.358	-0.486	56	0.629
Pair 27	RSI Natural Gas (0.3;0.7) - SML Natural Gas	0.045	1.519	0.201	-0.358	0.448	0.224	56	0.824
Pair 28	RSI Aluminium 3-Month-Officials (0.4;0.6) - SML Aluminium 3-Month-Officials	5.263	507.537	67.225	-129.404	139.931	0.078	56	0.938
Pair 29	RSI Zinc 3-Month-Officials (0.4;0.6) - SML Zinc 3-Month-Officials	-131.447	888.706	117.712	-367.253	104.358	-1.117	56	0.269
Pair 30	RSI Nickel 3-Month-Officials (0.4;0.6) - SML Nickel 3-Month-Officials	323.912	6591.589	873.077	-1425.072	2072.896	0.371	56	0.712
Pair 31	RSI Lead 3-Month-Officials (0.4;0.6) - SML Lead 3-Month-Officials	40.368	432.662	57.307	-74.432	155.169	0.704	56	0.484
Pair 32	RSI Tin 3-Month-Officials (0.4;0.6) - SML Tin 3-Month-Officials	-365.684	8982.459	1189.756	-2749.051	2017.683	-0.307	56	0.760
Pair 33	RSI Copper 3-Month-Officials (0.4;0.6) - SML Copper 3-Month-Officials	160.272	1687.200	223.475	-287.403	607.946	0.717	56	0.476
Pair 34	RSI Gold Fixing London (0.4;0.6) - SML Gold Fixing London	23.118	310.028	41.064	-59.143	105.380	0.563	56	0.576

Pair 35	RSI Oil Brent (0.4;0.6) - SML Oil Brent	-0.525	28.434	3.766	-8.069	7.020	-0.139	56	0.890
Pair 36	RSI Natural Gas (0.4;0.6) - SML Natural Gas	0.046	1.496	0.198	-0.351	0.443	0.230	56	0.819

Source: author's calculation in SPSS

We tested a similar hypothesis as in the previous part on the pairs containing RSI and SML approach of individual commodities to find out whether the SML strategy outperforms RSI. The null hypothesis was formulated as follows – H0: SML strategy does not lead to better hedging results than the RSI strategy. Using paired sample T-test in SPSS software, we calculated differences in returns of 36 pairs, and this test brought us results presented in the previous table. Overall, the SML strategy beats the RSI in performance only in 15 out of 36 cases. The rest 21 pairs showed outperformance of the RSI strategy. Commodities performed individually, resulting in different outcomes. For instance, in the case of Aluminium SML strategy outperformed the RSI strategy in three of four cases; only in RSI (0.4;0.6) was the result reversed, and the RSI approach outperformed the SML strategy by 5.2 points. However, in all four pairs, the *p*-value was higher than 0.05, meaning that these results are not statistically significant. Other tested commodities were Zinc and Oil brent which in all four analysed pairs showed outperformance of SML strategy over RSI. For example, the SML of Zinc outperformed RSI (0.3;0.7) by 160 points. Also, the differences in these pairs of Zinc and Oil brent were not statistically significant. On the other hand, the RSI of Nickel, Copper, Gold and Natural Gas outperformed the SML strategy on all four tested pairs with different RSI intervals. Lead showed outperformance of SML strategy against RSI only on the interval (0.1;0.9) with an average outperformance of 0.281.

However, the p-value is in all tested pairs above 0.05, which means that these results are not statistically significant on the 5% level of significance. There was no *p*-value below 0,1, meaning that even on a 10% level of significance, none of the pairs was tested as statistically significant, suggesting that differences in returns are not systematic. Thus, we do not reject the null hypothesis, and we can summarise that, on average, the SML strategy did not lead to better results than the RSI strategy during the selected period.

Conclusion

Hedging is a proactive risk management measure aiming to avoid the drawdown risk of the portfolio and loss on investment. We can successfully complete this task by incorporating assets which move in the opposite direction as the market. Commodities are standardly used as a hedge against inflation. Using a pair trading hedging strategy, we tested two approaches – CAPM vs RSI on nine commodities: Aluminium, Zinc, Nickel, Lead, Tin, Copper, Gold, Brent Oil and Natural Gas on shifted quarter basis on an event window 2008-2023.

The study tested the hypothesis that the SML strategy does not lead to better hedging results than the RSI strategy. After analysing the data for four different intervals of RSI, it was found that in three out of four tested pairs, the RSI strategy outperformed the SML strategy, but the differences were not statistically significant (p-value > 0.05). The paired sample T-test results for 36 pairs of individually selected commodities showed that the SML strategy outperformed the RSI strategy in 15 cases, while the RSI strategy outperformed the SML strategy in 21 cases, but again, these differences were not statistically significant. Therefore, based on the data analysed, it can be concluded that the SML strategy did not lead to better hedging results than the RSI strategy on average during the selected period.

Within our paper, we used the methodology as stated above with data on a quarterly basis. A problem with no statistical significance has occurred. This could be eventually solved by switching to weekly or daily data, which will result in a changed SML strategy. Also, signal adjustment for quantiles can change the results. The RSI strategy has an advantage because it does not do anything in the interval outside the active area, whereas SML will always be either positive or negative. Alternatively, days, weeks, and months can be tested instead of quarters to calculate the RSI. Secondly, instead of using zero values in the RSI strategy, the sample could be reduced and a comparison made only in cases where numbers are also present in the RSI.

The main limitations of the RSI indicator are false buy/sell signals, as momentum is sometimes ahead of price, and it is not clear up, or a downtrend can produce multiple false signals in sideways markets. RSI is also dependent on standard 14 periods; changing this can lead to signal changes. Lastly, this indicator is usually used as a supplement to another indicator of technical analysis for validation of signals and improvement of success rate. Therefore, the implementation of, for instance, MACD to this strategy could be a viable extension. MACD is a powerful indicator producing buy and sell signals and can be used to assess potential market movements and make hedging decisions. This approach is not typically used; therefore, it is worth analysing its potential in future studies.

On the other hand, SML / CAPM also have limitations, mainly the choice of a correct market portfolio as well as a risk-free rate. Additionally, this approach describes a linear relationship, which is not always correctly

describing returns and systematic risk in reality. It could also be questioned whether all information is priced in current asset prices, which is the main assumption of efficient market theory.

All of these comments can lead to different results when taken into consideration. Further scientific work is encouraged to change and check these sensitivities and methodologies.

References

Adekoya, O. B., Oliyide, J. A., Olubiyi, E. A., and Adedeji, A. O. (2023). The inflation-hedging performance of industrial metals in the world's most industrialized countries. Resources Policy, 81, 103364. https://doi.org/10.1016/j.resourpol.2023.103364

Ahmad, M., Ahmed, Z., Gavurova, B., and Oláh, J. (2022). Financial risk, renewable energy technology budgets, and environmental sustainability: Is going green possible? Frontiers in Environmental Science, 10, 909190. https://doi.org/10.3389/fenvs.2022.909190

Ayadi, A., Gana, M., Goutte, S., and Guesmi, K. (2021). Equity-commodity contagion during four recent crises: Evidence from the USA, Europe and the BRICS. International Review of Economics & Finance, 76, 376–423. https://doi.org/10.1016/j.iref.2021.06.013

Bedoui, R., Guesmi, K., Kalai, S., and Porcher, T. (2020). Diamonds versus precious metals: What gleams most against USD exchange rates? Finance Research Letters, 34, 101253. https://doi.org/10.1016/j.frl.2019.08.001

Bhatia, V., Das, D., and Kumar, S. B. (2020). Hedging effectiveness of precious metals across frequencies: Evidence from wavelet based dynamic conditional correlation analysis. Physica A: Statistical Mechanics and Its Applications, 541, 123631. https://doi.org/10.1016/j.physa.2019.123631

Carter, C. A., and Revoredo-Giha, C. (2023). Financialization and speculators risk premia in Commodity Futures Markets. International Review of Financial Analysis, 88, 102691. https://doi.org/10.1016/j.irfa.2023.102691

Cheng, S., Zhang, Z., and Cao, Y. (2022). Can precious metals hedge geopolitical risk? fresh sight using wavelet coherence analysis. Resources Policy, 79, 102972. https://doi.org/10.1016/j.resourpol.2022.102972

Gil, C. (2022). Intraday trading of Precious Metals Futures using algorithmic systems. Chaos, Solitons & Fractals, 154, 111676. https://doi.org/10.1016/j.chaos.2021.111676

Debru, P. and Shah, N. (2021). Building Stronger Portfolios: The Case for Investing in Broad Commodities. WisdomTree 2021. Available at: https://www.wisdomtree.eu/-/media/eu-media-files/other-documents/research/market-insights/the-case-for-investing-in--broad-commodities.pdf

Ewald, C.-O., Haugom, E., Lien, G., Størdal, S., and Wu, Y. (2022). Trading time seasonality in commodity futures: An opportunity for arbitrage in the natural gas and crude oil markets? Energy Economics, 115, 106324. https://doi.org/10.1016/j.eneco.2022.106324

Gustafsson, R., Dutta, A., and Bouri, E. (2022). Are energy metals hedges or safe havens for Clean Energy Stock Returns? Energy, 244, 122708. https://doi.org/10.1016/j.energy.2021.122708

Kelemen, M., and Jevcak, J. (2018). Security Management Education and training of critical infrastructure sectors' experts. 2018 XIII International Scientific Conference - New Trends in Aviation Development (NTAD). https://doi.org/10.1109/ntad.2018.8551687

Kelemen, M., Szabo, S., and Vajdová, I. (2018). Security management in the air transport: Example of an interdisciplinary investigation of special security questions. Challenges to National Defence in Contemporary Geopolitical Situation, 105–108. https://doi.org/10.47459/cndcgs.2018.15

Masood, O., Aktan, B., Gavurova, B., Fakhry, B., Tvaronaviciene, M., and Martinkute-Kauliene, R. (2017). The impact of regime-switching behaviour of price volatility on efficiency of the US sovereign debt market. Economic Research-Ekonomska Istrazivanja, 30(1), 1865–1881. https://doi.org/10.1080/1331677x.2017.1394896

Psaradellis, I., Laws, J., Pantelous, A. A., and Sermpinis, G. (2023). Technical analysis, spread trading, and data snooping control. International Journal of Forecasting, 39(1), 178–191. https://doi.org/10.1016/j.ijforecast.2021.10.002

Rehman, M. U., Shahzad, S. J., Uddin, G. S., and Hedström, A. (2018). Precious Metal returns and oil shocks: A time varying connectedness approach. Resources Policy, 58, 77–89. https://doi.org/10.1016/j.resourpol.2018.03.014

Salisu, A., Vo, X., and Lawal, A. (2021). Hedging oil price risk with gold during COVID-19 pandemic. Resources Policy, 70, 101897. https://doi.org/10.1016/j.resourpol.2020.101897

Sinicakova, M., and Gavurova, B. (2017). Single Monetary Policy versus Macroeconomic Fundamentals in Slovakia. Ekonomicky casopis, 65(2), 158–172.

Teall, J. (2023). Financial Trading and Investing (Third Edition). ISBN 9780323909556

Uzik M., Block S., (2023). The Roling SML-based Portfolio Strategy. Conference Paper, 8th International Scientific Conference Economics, Management & Business 2023, Working Paper 2023.

Yu, X., Shen, X., Li, Y., and Gong, X. (2023). Selective hedging strategies for crude oil futures based on Market State Expectations. Global Finance Journal, 57, 100845. https://doi.org/10.1016/j.gfj.2023.100845

Zioło, M., Kluza, K., Kozuba, J., Kelemen, M., Niedzielski, P., and Zinczak, P. (2020). Patterns of interdependence between financial development, fiscal instruments, and environmental degradation in developed and converging EU countries. International Journal of Environmental Research and Public Health, 17(12), 4425. https://doi.org/10.3390/ijerph17124425