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COMPARATIVE ANALYSIS OF THE RISK OF THE SPORTS INDEX APPLYING THE SHARPE, SORTINO AND TREYNOR RATIOS

Ivana Putić[1]
Novi Sad School of Business, Novi Sad, Serbia
Suzana Balaban[2]
Alfa BK University, Belgrade, Serbia
Milica Simić[3]
Alfa BK University, Belgrade, Serbia,

ABSTRACT

This paper evaluates the returns and risk of the European Football Clubs Index (EFCI), including Manchester United, Juventus, Benfica, and Celtic, using Sharpe, Sortino, and Treynor ratios. Bivariate portfolios are constructed using the minimum variance approach and optimal weights according to the Kroner and Ng formula. The index is hedged using a selection of precious metals, including gold, silver, platinum, and palladium. The findings indicates that the portfolio with gold achieves the best return-to-risk ratio (Sharpe 0.1186, Sortino 0.0801, Treynor 28.4340), while platinum provides the most effective protection against downside fluctuations (Sortino 0.1049, downside risk 0.4297). Silver and palladium demonstrate comparatively weaker performance, as evidenced by low or negative Sharpe and Sortino ratios, along with an inefficient Treynor ratio (-30.2617 for palladium). The findings confirm that hedging with precious metals significantly reduces the risk of a portfolio in which the European Football Clubs Index (EFCI) is the primary instrument, and that the effectiveness of the strategy depends on the performance measure applied. This paper contributes to the literature through a unique approach to the systematic hedging of sports indices with precious metals, highlighting both the practical applicability and the innovative nature of the methodology. The study is particularly valuable as there are very few existing works that address this topic, making it a novel contribution to research on sports index portfolio risk management.

Key words: portfolio management, European Football Clubs Index, hedging, precious metals, risk, return, safe haven

[1] putic.ivana@gmail.com; https://orcid.org/0009-0004-3294-9736;
[2] suzana.balaban@alfa.edu.rs; https://orcid.org/0000-0001-8132-9120;
[3] milica.simić@alfa.edu.rs ; https://orcid.org/0000-0002-0652-3799

UPOREDNA ANALIZA RIZIKA SPORTSKOG INDEKSA PRIMENOM SHARPE, SORTINO I TREYNOR RATIO

APSTRAKT

Ovaj rad analizira performanse European Football Clubs Index (EFCI), koji uključuje Manchester United, Juventus, Benficu i Celtic, kroz procenu prinosa i rizika. Analiza koristi Sharpe, Sortino i Treynor racio, dok su bivarijantni portfoliji konstruisani primenom minimalne varijanse i optimalnih udela prema Kroner & Ng formuli. Hedžiranje indeksa je sprovedeno sa plemenitim metalima – zlatom, srebrom, platinom i paladijumom. Rezultati pokazuju da portfolij sa zlatom ostvaruje najbolji odnos prinosa i ukupnog rizika (Sharpe 0,1186, Sortino 0,0801, Treynor 28,4340), dok platina pruža najefikasniju zaštitu od negativnih oscilacija (Sortino 0,1049, downside rizik 0,4297). Srebro i paladijum pokazuju slabije performanse, sa niskim ili negativnim Sharpe i Sortino vrednostima i neefikasnim Treynor raciom (-30,2617 za paladijum). Nalazi potvrđuju da hedžiranje sa plemenitim metalima značajno smanjuje rizik portfolija i da efikasnost strategije zavisi od primenjenog pokazatelja performansi. Rad doprinosi literaturi jedinstvenim pristupom sistematskog hedžiranja sportskih indeksa plemenitim metalima, naglašavajući praktičnu primenljivost i inovativnost metodologije.

Ključne reči: portfolio menadžment, European Football Clubs Index, hedžing, plemeniti metali, rizik, prinos, sigurna luka

Introduction

Sport is increasingly treated as a development priority because of its broad benefits, including improvements in public health, stronger social integration, and economic growth, particularly through tourism and the organization of sporting events (Maksimović et al., 2025). Football, the most popular sport in the world, represents a dinamic economic industry with its financial dimension involving the management of substantial capital flows (Ferreira et al., 2017). Global sports sector is showing strong financial expansion, especially in the leading European leagues. The English Premier League today represents one of the most significant economic markets in sport, with high attendance levels, financially stable clubs and a develop sponsorship system, which confirms the strong connection between sports and economy (Zbiljić & Isaković, 2025). The equity markets of European football clubs depend not only on economic factors but also on sporting outcomes and market sentiment (Stracca, 2004). Unexpected match results often trigger significant return fluctuations, posing a challenge for investors seeking to manage risk. Under conditions of heightened market volatility and global economic uncertainty, it's important to examine whether sports indices can function as a sustainable asset class. Additionally, their effective integration into investment portfolios for risk mitigation warrants further investigation.

Combining sports indices with precious metals offer notable advantages in risk management. Sports indices are characterized by high volatility, driven by unexpected match outcomes and investors sentiment, while precious metals tend to exhibit greater stability with low or negative correlations to the broader market. Integrating these assets can reduce overall portfolio volatility, mitigate extreme losses, and enhance return stability, particularly during periods of market or geopolitical uncertainty. In this research, the European Football Clubs Index (EFCI) is developed to capture the performance of four listed European football clubs – Manchester United, Juventus, Celtic, and Benfica. The study focuses on evaluating the effectiveness of hedging strategies by combining the EFCI with precious metals – gold, silver, platinum, and palladium. Portfolio performance is evaluated using the the Sharpe, Sortino, and Treynor ratios with optimal asset weights are determined through minimum variance allocation together and the Kroner & Ng hedging model.

The aim of this study is to quantify the EFCI's risk–return relationship, assess hedging benefits from combining it with precious metals, evaluate the resilience of two-asset portfolios, and explore the investment potential of sports indices. This approach thereby enables the study to contribute to the literature on non-traditional asset classes and portfolio diversification strategies under conditions of heightened market volatility. The existing literature rarely examines the investment efficiency of sports indices, particularly through the quantification of the risk-return relationship using the Sharpe, Sortino, and Treynor ratios, as well as their combination with precious metals for hedging and portfolio diversification purposes. As a result, a significant gap in the research exists, which this study seeks to address. Based on the objectives and motivations presented, this study proposes the following hypotheses:

H_1: The inclusion of precious metals in a portfolio that includes the European football club index (EFCI) significantly reduces overall portfolio risk.

H_2: The effectiveness of hedging a sports index varies depending on the performance measure applied.

The structure of the study, beyond the introduction, encompasses a description of the methodology and data employed, a presentation of the empirical results, and a discussion of the findings. It concludes with recommendations for future research, thereby emphasizing the theoretical and practical significance of the approach.

Literature review

Researchers and investors are showing increasing interest in sports equity markets due to their unique characteristics. The value of investments depends not only on economic factors but also on sporting outcomes and market sentiment. The inherent volatility and downside risk of sports equities make them particularly interesting for a detailed analysis of their risk-return characteristics. Floros (2014) investigates how different match outcomes influence the equity returns of football clubs: Porto, Benfica, Juventus, and Ajax. The study finds that draw results are linked to higher returns for both Benfica and Ajax, while for Juventus, draws and losses are associated with declines in returns. In the case of Porto, the analysis shows no statistically significant reaction in returns to any match outcome. These findings highlight the importance of employing appropriate risk-return assessment tools, thereby supporting the application of the Sharpe, Sortino, and Treynor ratios.
Drawing on the historical evolution of football stock markets, recent studies examine the determinants of investment efficiency and the potential for diversification and risk management in this unique asset class. The professionalization of management and the growth of commercial activities have driven an increase in the market capitalization of football clubs and their public listing (Botoc et al., 2019). As a result, new investment opportunities have emerged for both institutional and individual investors. Research by Renneboog & Vanbrabant (2000) indicates that football club IPOs – initial public offerings of a club's shares – in Europe during the 1980s and 1990s contributed to greater liquidity and investment accessibility, as well as increased stock price volatility. Findings from the study indicate that, by 2000, 22 clubs were listed on European stock exchanges, mostly from the United Kingdom, with only Lazio and Ajax located outside the UK. The study also shows that the stock prices of listed football clubs on the LSE and the AIM respond significantly to weekly sporting results. While wins cause positive abnormal returns, losses and draws result in negative abnormal returns. Based on the Sharpe ratio and Jensen's alpha, the authors found that a long-term equally weighted investment in listed football clubs lags behind the market. This historical analysis indicates that, in addition to economic factors, sporting outcomes significantly influence returns, underpinning the use of sophisticated portfolio performance measures.

The historical analysis of football stock markets highlights their high sensitivity to fluctuations and speculative movements, providing the foundation for contemporary research focused on identifying the factors shaping their market value. Prigge & Tegtmeier (2020, 2022) emphasize the complex risk-return characteristics of football stocks, underlining the influence of various economic, sporting, and psychological factors on their market valuation. In addition to sporting outcomes, football stock markets are exposed to external shocks that

can significantly affect investment values. The COVID-19 pandemic further highlighted the vulnerability of this asset class, as it severely disrupted the financial stability of European clubs (Schreiber & Schiereck, 2025; Bedir et al., 2022). Keshkar & Karegar (2022) also note that the pandemic caused substantial economic losses not only in the football industry but across the entire sports sector. This historical analysis indicates that, in addition to economic factors, sporting outcomes significantly influence returns, thereby providing a rationale for the use of advanced portfolio performance measures.

Nabli et al. (2025) examine the linkages between leading European football clubs listed on stock exchanges and Bitcoin, employing a quantile-on-quantile methodology and robustness testing through quantile Granger causality. The analysis covers the period from 2014 to 2024. In order to assess portfolio resilience and risk management in periods of market instability, the authors construct optimal portfolios using three strategies: minimum variance portfolios (MVP), minimum correlation portfolios (MCP), and minimum connectedness portfolios (MCoP). The findings indicate strong quantile-on-quantile relationships between football clubs and Bitcoin, with the application of advanced portfolio optimization strategies contributing to enhanced resilience and more effective risk management.

In recent years, research has increasingly focused on the digitalization of sports finance and fan tokens as a new investment class. Esparcia and Díaz (2024) analyze the link between fan tokens and football club equities from November 2021 to March 2023. By applying the GO-GARCH model to model fluctuations in higher-order moments, they find that including equities from multiple leagues alongside fan tokens can provide meaningful portfolio diversification. Although football club equities typically yield superior investment performance, fan tokens offer complementary diversification benefits, driven by their country-specific features such as exclusive content and interactive engagement opportunities with clubs. Similar findings are confirmed by Ersan et al. (2022), who use the TVP-VAR model on the example of four clubs – Juventus, AS Roma, Galatasaray, Trabzonspor – covering the period from December 2020 to January 2022. The authors show that fan tokens transmit a larger share of shocks than stocks, while the overall correlation between tokens and stocks declines over time, suggesting the potential for portfolio diversification. Additionally, Scharnowski et al. (2023) emphasize that fan tokens are collectible utility tokens, extremely volatile and speculative, with returns that are not correlated with the stocks of listed clubs and react to unexpected sports results and increased investor interest.
Although digital assets represent an innovative form of investing in sports, traditional instruments still have a key role in maintaining portfolio stability. Concerning this, precious metals still remain an essential part of investment

strategies due to their protective function in the periods of crisis. Gold, silver, platinum and palladium are key instruments of portfolio diversification due to their low correlation with traditional markets and their role as "safe havens" during the periods of increased market volatility. According to Fassas (2012), precious metals function as safe havens, because their returns are not significantly correlated with the returns of stocks and bonds, contributing to portfolio diversification and protection against inflation and geopolitical risks. The low correlation with traditional capital markets makes them suitable instruments for hedging, which is particularly relevant in the analysis of portfolios that include football club shares and sports indices. Apart from gold and silver, contemporary literature points to the growing importance of platinum and palladium within the framework of hedging and portfolio risk control. Based on evidence from BRICS countries, Shen et al. (2021) find that "white" precious metals, such as silver, platinum and palladium, do not provide a stable hedging effect for stocks. However, silver is effective in hedging bonds, while platinum can significantly reduce the variance of portfolio returns. All three metals contribute to hedging against currency risk.

In the field of financial portfolio management, the Sharpe and Sortino ratios are widely used to assess the performance and risk of investment instruments. Srivastava & Mazhar (2018) analyzed the performance of ten leading mutual funds using Sharpe and Sortino ratio. The authors show that both ratios provide useful insights into fund performance; the Sortino ratio more accurately reflects downside risk, while the Sharpe ratio shows overall risk. They conclude that the combination of both indicators enables a more comprehensive assessment of portfolio efficiency and risk management. Investigating the use of oil, gold, and silver as hedging instruments for the S&P 500, Putić et al. (2025) show that combining the S&P 500 with gold provides the most effective risk reduction. The results are confirmed by the highest value of the Sharpe ratio, while the negative value of the Hedging Efficiency Index (HEI) demonstrates potential for additional risk reduction through alternative instruments.

Although there are significant number of studies that analyze the impact of sports results on stock prices and the diversification properties of fan tokens and precious metals, there is a lack of research that combines sports indices and precious metals in portfolios using the Sharpe, Sortino and Treynor ratios. The paper attempts to fill this gap. Namely, the authors analyze the European Football Clubs Index (EFCI) and its combination with precious metals, to assess the potential of sports indices for risk reduction and portfolio stabilization during the periods of increased market volatility.

Data and Methodology

This paper uses our own developed football club stock index, the European Football Clubs Index (EFCI), which includes four listed clubs: Manchester

United (NYSE), Juventus (Borsa Italiana), Benfica (Euronext Lisbon) and Celtic (London Stock Exchange). The index is constructed on the basis of the daily returns of shares of the mentioned clubs, with equal weights, which eliminates the effect of differences in market capitalization and enables more precise monitoring of the movement of the sports sector as a whole. The annual yield of three-month German government bonds (Bunds) for the period from January 3, 2020 to March 31, 2025 was used as a measure of the risk-free rate (Bundesbank, 2025), while the market yield is defined by the Eurostoxx 50 index.

The research used daily data series of the prices of precious metals – gold, silver, platinum and palladium – sourced from the platforms Stooq.com and Investing.com. The data were converted into excess return, which measures how much a portfolio or individual instrument generates excess return over the risk-free interest rate. In this study, the risk-free interest rate is determined by the returned offered on three-month German government bonds for the period from January 3, 2020 to March 31,2025 (Bundesbank, 2025). Return estimates, minimum variance portfolio weightings, and performance estimates were calculated using Sharpe, Sortino, and Treynor ratios. Within Markowitz's theoretical framework, the correlation of instruments in a portfolio is assessed by covariance, which measures the extent to which the returns of two assets move together and how they affect the overall risk of the portfolio (Markowitz, 1991). Volatility is calculated using standard deviation and performance ratios, providing a practical assessment of portfolio stability. The combination of variance and covariance provides an identification of synergies between instruments, assessing the role that individual precious metals play and reduce the systemic risk within the overall investment structure. This measure is used to quantify how much an asset's return exceeds the risk-free rate:

$$r_{i,t}^{excess} = r_{i,t} - r_f \qquad (1)$$

Here, $r_{i,t}$ referse to the observed return to the asset, while r_f stands for the corresponding risk-free benchmark rate.
Providing comparability of heterogeneous instruments the excess return ($r_{i,t}^{excess}$) represents the basis for calculating the Sharpe, Sortino and Treynor ratios, due to the fact that it focuses on the analysis of the realized return in relation to the assumed risk. Its application is particularly significant when combining different asset classes, such as shares of the European Football Clubs Index (EFCI) and precious metals – gold, silver, platinum and palladium – as traditional safe havens.

In order to minimize the overall risk, we use the minimum variance portfolio concept. For a portfolio consisting of two assets, the overall variance can be

determined based on rhe individual asset variances and the correlation between them:

$$\sigma_p^2 = (W_A\,\sigma_A)^2 \;+\; (W_B\,\sigma_B)^2 \;+\; 2(W_A\,\sigma_A)(W_B\,\sigma_B)\,\rho_{AB} \qquad (2)$$

The portfolio variance, denoted as σ_p^2, is determined by the proportional of capital allocated to each asset, represented by the weights W_A and W_B . The standard deviation σ_A and σ_B quantify the volatility of the individual asset returns, while the correlation coefficient ρ_{AB} indicates how strongly the returns of the assets move together or in opposite directions.
The portfolio analysis was done following the portfolio theory of Harry Markowitz (1991), whereby the calculation of the optimal share of each instrument in the minimum variance portfolio was defined according to Kroner & Ng (1998) formula:

$$Ws = \frac{\sigma p^2 - COVp,s}{\sigma p^2 + \sigma s^2 * 2 * COVp,s} \qquad (3)$$

$$W_p = 1 \;-\; W_s \qquad (4)$$

In the observed portfolio, Ws denotes the share of the secondary instrument, while W_p represents the share of the primary instrument. The variance of individual instruments are denoted by σp^2 and σs^2 while COVp, s indicates the covariance between them. This approach makes it possible to combine different asset classes. It is designed to reduce the overall risk, without affecting the expected return. Key concepts of this analysis include minimum variance portfolios and efficient edge.

Sharpe, Sortino and Treynor ratios are applied for the comparative assessment of risk and return of a defined sports index. The study explores how the index interacts with the four selected precious metals, focusing on the outcomes of the hedging strategies. Portfolio performance is evaluated using indicators of modern portfolio theory. The Sharpe ratio is applied as aquantitive measure to evaluate the efficienty with which portfolio generates returns in the relation to the total risk undertaken (Sharpe, 1994). The ratio is definided as:

$$Sharpe\ ratio = \frac{r_p - r_f}{\sigma_p} \qquad (5)$$

In this formula, r_p corresponds to the portfolio's average return over the observed period, r_f is the rate of the return on a risk-free asset, and σ_p indicates the overall volatility of portfolio returns. This measure is widely used for comparing different portfolios or investments strategies in terms of their

effectiveness is generating returns relative to the total variability of outcomes. However, the standard Sharpe ratio can be limited due to the fact that it equally values positive and negative deviations, which can lead to exaggeration or underestimation of the real risk of the portfolio (Živkov et al., 2022). The study extends the analysis beyond the Sharpe ratio by including the Sortino ratio. It ensures a more accurate estimate of downside risk and it is a better basis for comparing portfolio performance (Sortino & Meer, 1991). The Sortino ratio evaluates portfolio performance by focusing specifically on downside risk:

$$Sortino\ ratio = \frac{\bar{r}_{p,t} - r_f}{\sigma_{downside}} \quad (6)$$

where, $\sigma_{downside}$ is the standard deviation of returns below the risk-free rate and is calculated as:

$$\sigma_{downside} = \sqrt{\frac{\sum_{t=1}^{T} \min(0, \bar{r}_{p,t} - r_f)}{T}} \quad (7)$$

Where T denotes the total number of periods observed. Downside deviation focuses on periods of underperformance, ignoring positive returns.
Finally, the Treynor ratio assesses portfolio performance considering returns in relation to systematic market risk, captured through the portfolio's beta (β_p) (Treynor, 1965). It is calculated as:

$$Treynor\ ratio = \frac{\bar{r}_{p,t} - r_f}{\beta_p} \quad (8)$$

In this context, β_p quantifies the portfolio sensitivity to movements in benchmark market index, such as the Eurostoxx 50. The Treynor ratio ignores the unsystematic components of volatility, emphasizing the portfolio's effectiveness in mitigating market risk. A higher value of the Treynor ratio indicates that the portfolio achieves a higher return premium per unit of systematic risk, which implies the effectiveness of the hedging strategy in managing market exposure. In conditions of low beta value, the Treynor ratio may increase further, which signals the potential effectiveness of the hedging strategy.

Results and discussion

Descriptive statistics of individual assets and constructed portfolios. Table 1 presents the descriptive statistics of excess returns for analyzed instruments, including the European Football Clubs Index (EFCI) and selected precious metals (silver, gold, plazinum and palladium). The table also includes portfolios constructed from these assets, covering the period between the beginning of January, and the end of March 2025.

Table 1. Descriptive statistics of individual assets and constructed portfolios

Instruments	Average value	Min	Max	Skewness	Kurtosis
EFC Index	0.0118	-2.9605	16.6271	-0.5353	8.1744
Gold	0.0412	-5.8609	4.6120	-0.4592	3.0312
Silver	0.0394	-16.0734	8.5078	-0.4997	6.7267
Platinum	-0.0101	-13.2927	10.1707	-0.4546	4.2033
Palladium	-0.0618	-21.9862	19.6726	-0.3596	8.2829
EFCI_gold	0.0237	-2.9605	3.0680	0.2460	8.1256
EFCI_silver	-0.0003	-5.6449	4.1195	-0.3029	10.0025
EFCI_platinum	0.0451	-3.3604	5.1367	1.4237	9.717
EFCI_palladium	0.0153	-5.0309	9.3006	0.9576	16.9467

Source: Author's calculation based on data sourced from the platforms Stooq.com and Investing.com

Table 1 indicates that the EFC Index is 0.0118, corresponding to an additional return of approximately 1.18% per day over the risk-free rate. Precious metals have different returns. Gold records an average excess of 0.0412 and confirms its role as a safe haven, while silver achieves a somewhat lower return (0.0394). Platinum shows a slightly negative excess return (-0.0101), while palladium records the most volatility with an average negative excess of -0.0618. The minimum and maximum return values also illustrate extreme fluctuations, which can be critical for assessing potential risk. The range of returns, from -2.9605 to 16.6271, indicates extreme changes that are characteristic of speculative markets. Gold proves to be a relatively stable instrument, while silver and palladium record wider oscillations and more pronounced negative extremes. Platinum, with a range of -13.2927 to 10.1707, shows moderate volatility, while palladium, with a range of -21.9862 to 19.6726, shows the highest degree of volatility.

The skewness further explained the direction of the return deviation. Negative skewness values indicate more frequent larger negative deviations in the returns of unhedged assets. This behaviour is also reflected in kurtosis, where higher values for the EFC index and palladium imply the presence of fatter tails and potentially increased downside risk.

By combining the EFC index with precious metals, there is a significant reduction in volatility and mitigation of extreme values. The portfolio with gold shows the most stable profile SD - 0.4473; skewness - 0.2460, while silver and platinum provide moderate diversification benefits. Although with the largest oscillations, palladium provides the potential for positive extreme values. The

estimated parameters indicate that the choice of hedging instrument directly affects the risk and return profile of the portfolio. The return distributions of non-hedged assets reveal both negative skewness and high values of kurtosis, especially in the EFC index and palladium, which may indicate the frequency of extreme negative returs and the presence of downside risk. Contrary to that, the combination of EFCI with precious metals, especially with gold and platinum, is characterized by lower skewness values and more moderate extremes, which may suggest a reduction in negative oscillations and a more stable distribution of returns. Although these values do not represent a direct measure of downside risk, they provide preliminary indications of its possible presence and point to the potential stabilizing role of precious metals within a sports portfolio.

Figure 1 shows the dynamics of the daily returns of the EFC index, precious metals and related portfolios, highlighting the differences in performance. Gold and palladium portfolios achieve more stable and higher excess returns compared to silver and platinum portfolios. During the initial shock of the pandemic in 2020, the gold portfolio recorded an excess return of 3.8%, while the palladium portfolio achieved 2.9%. Silver and platinum portfolios had a lower excess of 2.5% and 3.2%. Over the following years, gold and palladium portfolios maintained excess returns between 2.5% and 3.4%, while silver and platinum portfolios oscillated between 1.8% and 2.8%.

Changes in excess returns correspond strongly with the results of football matches at the European level, including the Champions League and the Europa League. The positive outcomes of the key matches of the clubs included in the EFC index accompanied by the increases in the portfolio daily excess returns whereas weaker or unexcected results led to temporary declines. For instance, a favorite's victory in the Champion League often corresponds with an increase of up to 3.2% in gold portfolios, while surprising defeats caused drops of 1.8-2.0% in silver and platinum portfolios. This dynamic points to the importance of football performance as a volatility factor in the sports equity market, with gold and palladium providing a stabilizing effect in moments of heightened sports and market uncertainty.

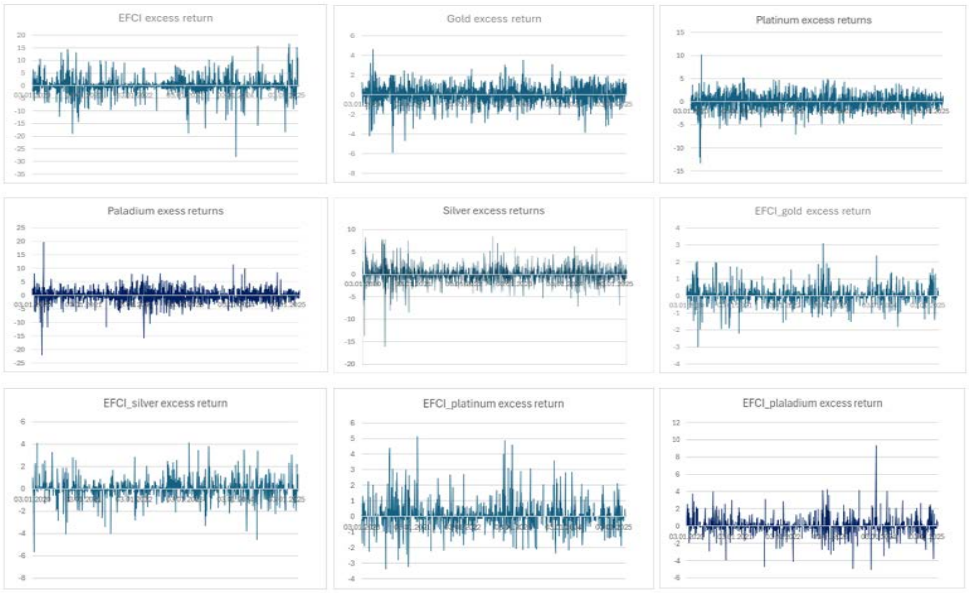

Figure 1. Excess returns of EFC index, precious metals and created portfolios – daily data

Source: Author's calculation based on data sourced from the platforms Stooq.com and Investing.com

Minimum variance of constructed portfolios. Table 2 shows the minimum variance portfolio weightings that combine the EFCI index as the primary asset and precious metals as the secondary asset. Based on the data, the share of the primary instrument, the EFC index, ranges from 38.90% in portfolios with gold to 56.98% in portfolios with palladium. This shows that the portfolio weights are adjusted to minimize total risk, in accordance with the principles of Markowitz's portfolio theory. In particular, portfolios with more stable assets like gold account for a smaller portion of the EFC index, whereas those including more volatile components, such as palladium, occupy a larger share due to their higher volatility and limited risk-reduction potencial. Secondary instruments, i.e. precious metals, have a share in the portfolio from 43.02% to 61.10%. Gold has the largest share in the portfolio, 61.10%, which confirms its ability to reduce the overall risk of the portfolio. However, palladium, with a share of 43.02%, has a smaller contribution to hedging, which is in line with the results of the analysis of returns and risks.

Table 2. Asset shares in the portfolio

Portfolio	Primary instrument EFC Index (%)	Secundary instrument precious metals (%)	Total (%)
EFCI_gold	38.90	61.10	100
ECI_silver	51.45	48.55	100
EFCI_platinum	52.72	47.28	100
EFCI_palladium	56.98	43.02	100

Source: Author's calculation based on data sourced from the platforms Stooq.com and Investing.com

Analysis of portfolio performance. Table 3 shows quantitative indicators of risk and return of the EFCI precious metals hedged index portfolio, including standard and negative deviation, Sharpe and Sortino ratios, beta and Treynor ratios.

The standard deviation of unhedged assets, EFC index, is 3.5311, which indicates a relatively high level of volatility characteristic of markets with increased risk. Hedging the index with precious metals significantly reduces overall volatility, with gold showing the highest efficiency, SD - 0.4473, while palladium contributes the least risk reduction, SD - 0.8560. This confirms H_1, showing that the combination of the EFCI index with precious metals leads to a statistically significant reduction in portfolio risk. Similarly, the negative deviation, which measures downside risk, confirms the superiority of gold (0.2962) over palladium (0.5636).

Table 3. Quantitative indicators of portfolio performance

Portfolio	SD without hedge	SD with hedge	Downside risk	Sharpe ratio	Sortino	Beta	Treynor ratio
EFCI gold	3.5311	0.4473	0.2962	0.1186	0.0801	0.0008	28.4340
EFCI silver	3.5311	0.7511	0.5392	-0.0006	-0.0006	-0.0001	2.0378
EFCI platinum	3.5311	0.7310	0.4297	0.0848	0.1049	0.0118	3.8229
EFCI palladium	3.5311	0.8560	0.5636	0.0209	0.0271	-0.0005	-30.2617

Source: Author's calculation based on data sourced from the platforms Stooq.com and Investing.com

The risk-return analysis shows the different performances of individual precious metals. Our results indicate that gold and platinum provide the most effective portfolio hedging in terms of total and downside risk, while palladium shows limited effectiveness. and other Research confirms that precious metals retain or increase in value during periods of market instability and achieve returns opposite to reference assets, providing protection even in the event of extreme losses (Będowska-Sójka & Kliber, 2021; Kazak et al., 2025; Rana & O'Connor, 2023).

Our findings partially confirm the results of Shen et al. (2021) who show that, while platinum continues to be effective in reducing downside risk, palladium exerts only a limited influence on both overall and downside portfolio risk, whereas silver has a minimal impact. This differentiation in hedging efficiency is clearly visible through the values of the Sharpe and Sortino ratios, which confirms H_2 and emphasizes that the success of the hedging strategy depends on the selected performance indicator.

The Sharpe ratio indicates how effectively a portfolio converts risk into return by showing the extra return an investor receives per unit of total volatility above the risk-free rate. Our results indicate that the portfolio combined with gold reaches a Sharpe ratio of 0.1186, reflecting the most favorable balance of return relative to risk. These findings align with the Putić et al., (2025), who highlight the prominent role of gold in enchasing the balance between risk and return. The Sortino ratio enables a precise assessment of portfolio performance in crisis conditions, when investors most want to avoid losses. In our case, the portfolio with platinum achieves the best Sortino ratio (0.1049), which indicates that this combination most effectively reduces downside risk. Combinations with silver record negative values of both ratios, which suggests that silver has a limited ability to reduce overall and downside risk. Palladium also shows relatively weak performance, especially the Treynor ratio, which indicates increased volatility and weaker portfolio protection.

These results confirm that the effectiveness of sports index hedging varies depending on the applied performance indicator. The choice of precious metal in the hedging strategy must be adapted to the specific goal of the investor – whether it is to focus on total return or on protection against losses. Our findings are consistent with Tuna (2019) and Shen et al. (2021), which indicate the selective safe haven role of precious metals and support the analysis of their integration into portfolios with non-standard asset classes, such as the European Football Clubs Index (EFCI). This further confirms the relevance of precious metals as instruments of diversification and risk management in specific investment contexts.

By examing the Treynor ratio, one can asses how the portfolio's return exceed's the risk free rate in relation to systematic risk, measured by beta. The lowest market exposure was recorded in the portfolio with gold, β – 0.015, while the portfolio with platinum β -0.022, also shows a very low beta value. In contrast, portfolios with palladium β – 0.084 and silver, β – 0.051, show neutral beta, indicating weaker protection against systemic risk. Low values of β are reflected in the highest values which indicates that the gold portfolio achieves the nost favorable ratio between excess return and systematic risk, with a Treynor ratio of 28.4340. In comparison, the palladium portfolio achieves a Treynor ratio of -30.2617, highlighting lower efficiency due to its higher exposure to market movements. Although the gold portfolio does not have the highest mean return, its low beta and high Treynor ratio show that it is an optimal choice when the goal is to minimize systemic risk and maintain a favorable risk-return ratio.

The obtained results indicate that portfolio hedging with precious metals significantly reduces overall and downside risk, improves performance and increases the portfolio's resistance to external market volatility. hedging the EFCI index with precious metals significantly reduces portfolio risk and shows different efficiency depending on the selected performance indicator, thus confirming both hypotheses of this research (H_1 and H_2).

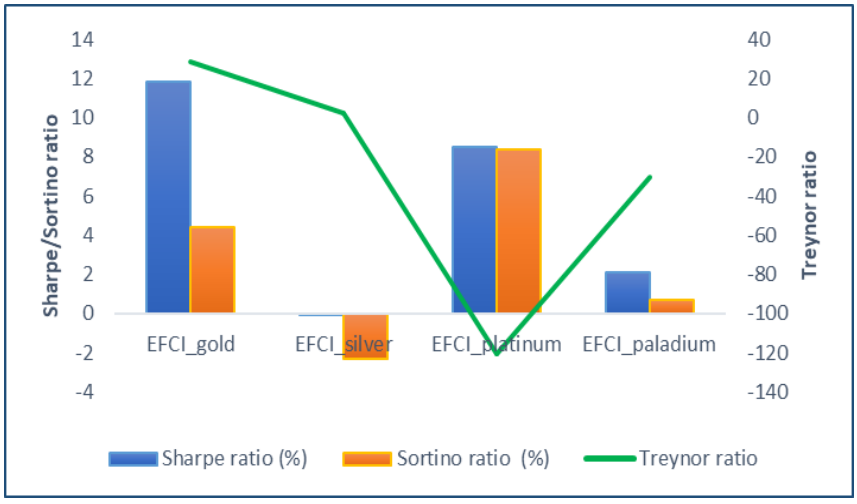

Figure 2. Portfolio performance indicators
Source: Author's calculation based on data sourced from the platforms Stooq.com and Investing.com

Figure 2 shows a comparative analysis of Sharpe, Sortino and Treynor ratios for the examined portfolios. The portfolio with gold (EFCI_gold) achieves the best performance, with Sharpe 11.5%, Sortino 4.0% and Treynor 27.5, while

portfolios combined with silver and platinum achieve moderate values. The palladium portfolio has the highest volatility, with a Sharpe of 2.0%, a Sortino of 0.5% and a Treynor of -40, indicating a relatively lower return to risk ratio compared to gold. The presented results suggest that gold provides the most effective portfolio protection in terms of return and risk ratio, while other metals represent less stable alternatives.

Conclusion

In this paper, a comparative analysis of the European Football Clubs Index (EFCI) portfolio in combination with precious metals was conducted, using standard deviation, downside risk, beta values, as well as Sharpe, Sortino and Treynor ratios. Hedging with gold and platinum significantly reduces overall and downside risk compared to the underlying portfolio. The standard deviation decreased from 3.5311 to 0.4473 for gold and 0.7310 for platinum, and the downside risk to 0.2962 and 0.4297, respectively, consequently confirming the hypothesis H1 about a statistically significant reduction in portfolio risk.

A comparison of Sharpe, Sortino and Treynor ratios shows the differentiation of performance. Gold achieves the best ratio of return to total risk (Sharpe 0.1186; Treynor 28.4340; β -0.015), while platinum provides the best downside risk control (Sortino 0.1049). Silver and palladium show limited efficiency, with low or negative Sharpe and Sortino values (-0.0006 and 0.0271) and an unfavorable Treynor ratio (-30.2617 for palladium). This confirms hypothesis H2 that the effectiveness of the hedging strategy depends on the selected performance indicator. By comparing the indicators, it is clear that gold optimizes the overall balance of returns and volatility, platinum provides the best protection against negative trends, while silver and palladium have a minimal contribution to stability. These findings highlight the practical value of selectively hedging sports indices with precious metals, as they enable diversification and increase portfolio resilience to market turbulence. Gold provides the highest return relative to total risk, with a Sharpe ratio of 0.1186, a Treynor ratio of 28.4340, and a beta of -0.015. In contrast, platinum excels at managing downside risk, as shown by its Sortino ratio of 0.1049. The results emphasize the selective hedging role of precious metals, showing that the choice of metals in a hedging strategy directly affects the effectiveness of risk reduction and portfolio stability. The use of gold and platinum allows for diversification and increases the portfolio's resilience to market turbulence, thereby improving the overall stability of returns.

However, this study has several limitations. This analysis is based on a relatively small number of publicly listed European football clubs, which may constrain the generalizability of the findings to the broader sports industry.

Additionally, focus is solely on precious metals as hedging instruments, without considering other alternative assets that could further enhance diversification. Future research should include a wider range of sports indices and long periods, as well as employ more advanced risk assessment methodologies, to deepen the understanding of the strategic role of sports investments with portfolio management.

The work contributes to the academic community by opening a new research field, since systematic studies on the hedging of sports indices with precious metals do not exist so far. At the same time, it provides a basis for further empirical research and practical application in risk management strategies.

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