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The Effect of Sectoral Diversification on Return and Risk in Portfolio Management: An Application in Borsa Istanbul

Portföy Yönetiminde Sektörel Çeşitlendirmenin Getiri ve Risk Üzerindeki Etkisi: Borsa İstanbul'da Bir Uygulama

ÖZ

Bu çalışma, Borsa İstanbul içindeki sektörel çeşitlendirmeyi inceleyerek, portföy riski ve getiri dinamikleri üzerindeki etkisini aydınlatmayı amaçlamaktadır. 2020'den 2022'ye kadar olan dönemi kapsayan bu çalışma, bankacılık, enerji ve demir-çelik gibi önemli sektörlerden gelen hisse senetlerini ayrıntılı bir şekilde analiz etmektedir. Sağlam bir metodoloji kullanarak, araştırma, Monte Carlo simülasyonlarını kullanarak birçok hipotetik portföy oluşturur ve ardından bunları Verimli Sınır üzerinde değerlendirerek optimal risk-getiri dengelemelerini belirlemeye çalışır. Sharpe Oranı, Sortino Oranı ve Maksimum Çekilme gibi temel performans ölçütleri, analizi daha da zenginleştirerek portföy davranışlarının ayrıntılı bir görünümünü sunar. Bu çalışmanın önemi, çeşitlendirmenin teorik yapılarını Borsa İstanbul gibi yeni bir pazarın somut gerçekleriyle birleştirmesinde yatmaktadır. Ana bulgularımız, sektörel çeşitlendirmenin potansiyel faydalarını vurgularken, portföy oluşturmanın içerdiği karmaşıklıkları da ortaya koymaktadır. Elde edilen görüşler, yatırımcılar için değerli rehberlik sunar ve çeşitlendirilmiş bir portföyde risk azaltma ve getiri optimize etme arasındaki ince dengeyi vurgular. Ayrıca, bu çalışmanın, yatırım stratejileri geliştiren profesyoneller için önemli bir kaynak olabileceğini belirtmek önemlidir.

Anahtar Kelimeler: Portföy yönetimi, Getiri ve risk, Monte Carlo simülasyonları, Verimli Sınır, Sharpe Oranı, Sortino Oranı, Maksimum Erime

ABSTRACT

This paper investigates sectoral diversification within Borsa Istanbul, aiming to elucidate its impact on portfolio risk and return dynamics. Spanning the timeframe from 2020 to 2022, the study meticulously analyzes stocks from pivotal sectors, including banking, energy, and iron and steel. Employing a robust methodology, the research harnesses Monte Carlo simulations to generate many hypothetical portfolios, subsequently evaluating them on the Efficient Frontier to identify optimal risk-return tradeoffs. Key performance metrics, such as the Sharpe Ratio, Sortino Ratio, and Maximum Drawdown, further enrich the analysis, providing a granular view of portfolio behaviors. The significance of this study lies in its bridging of theoretical constructs of diversification with the tangible realities of an emerging market like Borsa Istanbul. Our main findings underscore the potential benefits of sectoral diversification while highlighting the complexities inherent in portfolio construction. The insights gleaned offer valuable guidance for investors, emphasizing the delicate balance between risk mitigation and return optimization in a diversified portfolio.

Keywords: Portfolio management, Return and Risk, Monte Carlo simulations, Efficient Frontier, Sharpe Ratio, Sortino Ratio, Maximum Drawdown

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Introduction

In the complex domain of financial markets, the search for strategies that would singularly optimize returns and risk reduction must remain constant. Portfolio management is equivalent to the management of investments in order to meet specific organizational objectives (Cameron, 2008). Thereby, resourceful allocation of resources and strategic decision-making must be exercised to balance the seesaw between risk reduction and gain maximization (Brasil and Eggers, 2019). Per portfolio management, diversification has become a base for all strategies and is often referred to as the only "free lunch" in investing (Allan, 2001).

This paper primarily analyses the effect of sectoral diversification among portfolios on risk and returns, mainly from the standpoint of Borsa. Borsa Istanbul, Turkey's foremost stock exchange, features a diverse set of companies across multiple sectors such as banking, energy, and iron and steel, making it a representative microcosm for examination. This factor of diversification among the sectors is chosen to review the efficiency of the capital markets via sectorial categorization. Unique dynamics characterize each sector due to various microeconomic and macroeconomic factors shaping its behavior and performance. It is still need to investigate how these trends interact in a composite portfolio, specifically whether sectoral diversity within Borsa Istanbul improves the risk-return trade-off.

In order to respond to this query, a detailed and deeper analysis of how risk management in portfolio management works is to be incorporated. Risk management is not primarily concerned with the assessment of the different uncertainties of each project. However, it must be able to assess the complementary and conflicting risks of the investments. Risk management looks at the investment task, including the dynamic adaptation of existing risks (Holland and Fathi, 2007). If the risks were known, any project manager could conveniently use narrowly fitted criteria to select projects. However, due to the dynamic of risks in investment tasks, risk management has to apply very flexible mechanisms. For example, it should use criteria based on a contingency perspective (Teller et al., 2014).

This research investigates these characteristics within Borsa Istanbul by analyzing historical data, simulating portfolio scenarios, and evaluating performance metrics to discover both the good and bad aspects of sectorial diversification to allow more precise information for investors, especially in volatile emerging markets such as Turkey.

Following the introduction of the paper, the problem statement is mentioned, indicating the critical inquiries of this research. Furthermore, sections such as the significance of the study are made known in this part; it explicates how much those contributions would affect the investment management literature. The paper concludes with a presentation of systematic findings, an exhaustive discussion, and a summarizing conclusion, providing readers with both theoretical and practical implications of sectoral diversification in portfolio management.

1. Problem Statement

Financial markets constantly evolve, wherein investors pursue methodologies that promise maximized returns at minimized risks. Diversification has emerged as a critical strategy, especially at a sectoral level. It involves spreading investments across diverse industry sectors, offering a unique hedge against sector-specific risks. Borsa Istanbul, characterized by its wide variety of listed companies across sectors like banking, energy, and iron and steel, is an intriguing arena for studying this phenomenon.

Despite the recognized potential of sectoral diversification, several pressing questions and challenges still need to be answered. Predominantly, the issue revolves around the specific impact of sectoral diversification on the risk-return paradigm within the framework of Borsa Istanbul. Does combining companies from different industries result in a portfolio that has a better risk-return ratio? If this holds, the subsequent challenge is deciphering the optimal blend of stocks from these sectors to create a balanced portfolio.

Moreover, there are many operational issues in the risk management portfolio. Resource constraints regarding financial, human ability, and technology limit risk management practices (Elonen and Artto, 2003). Also, the sufficiency of skill, competence, and technique in risk assessment and mitigation has become a significant issue in implementing risk management practices.

Additionally, risk management schemes need to be more focused on portfolio-level efforts. The lack of attention to portfolio analysis and rebalancing could lead to an inaccurate depiction of risk. Making risk perceptions appear riskier than the situation warrants. This could manifest as a concentrated risk that must be diversified across several risks or risks with many more losses than wins. Other risk-related information is scattered across the organization, making risk-related decisions uninformed and potentially more likely to refuse to lend because of a lack of risk disclosure (Elonen and Artto, 2003).

The operational issues are further complicated due to the nature of investment portfolios, which consist of different assets. There needs to be more than an evaluation of risks in individual investments to have a wholesome view; one has to understand how the individual risks overlap, which is captured by covariance or correlation of individual risks (Roman, 2004). The complex issues of investment optimization involve achieving the desired returns at an acceptable level of risk and selecting portfolios that still have expected returns but at a lower risk than initially (Kulian et al., 2020). Again, the risks of portfolio diversification are conditional on factors such as the magnitude of the correlation, the concentration of financial instruments, and the volatility of returns (Aliu et al., 2021)

This study conducts a systematic data collection, builds the portfolio, and analyzes the performance rigorously based on a table utilizing all the pros and cons of sectoral diversification to settle questions, fill in the existing gaps, and resolve the issues. As a result of this study, a variety of investment strategies, particularly in the sectoral portfolios and passive-active investment fund management as well as portfolio management decision-making process, is highly up-to-date information and suggestions are expected to exit.

2. Significance of the Study

In the continuously evolving financial markets, understanding the nuances of diversification, especially on a sectoral level, stands paramount. The necessity of this understanding becomes even more pronounced within the distinctive setting of Borsa Istanbul. Therefore, this study's multi-faceted significance provides profound insights for scholars and practitioners.

Contextual Emphasis: This research provides a detailed analysis focusing on Borsa Istanbul's specific sector diversification possibilities within an emerging market framework. This study takes on uncharted domains by selecting stocks from the banking, energy, and iron and steel sectors that are not sector-specific to previous research conducted. Hence, it contributes to the literature by filling this gap from a sector-specific perspective within such markets.

Robust Methodology: The methodological rigor of this research ensures that its findings are reliable and applicable. Data was obtained from previously established sources such as Yahoo Finance and processed with advanced techniques such as Monte Carlo simulations. The results are not more than theoretically sound used by other prominent firms. However, they are both practically accurate and usable. Additionally, the results are directly relatable for portfolio managers and investors using industry metrics, such as the Sharpe Ratio, Sortino Ratio, and Maximum Drawdown.

Operational Challenges: Research is salient because the paper points out those core challenges in the problem statement section of the paper. Research deepens into resource constraints, portfolio-level activities weaknesses, and fragmented risk-related data information. It suggests solutions to problems and can pave the way for more efficient portfolio management.

Comprehensive Insights: This research paper not only provides the outcome of the impact of sectoral diversification on portfolio performance but is also furnished with results and discussion segments to serve as a thorough guide on handling every aspect of sectoral diversification. One can get complete information from this research paper, from portfolio construction and diversification to the distribution of weights in optimal portfolios.

Addressing Real-world Implications: This research surpasses purely academic purposes; it also has severe contributions and utilities, especially for industry professionals, about challenges and potentials of sector-level diversification in Borsa İstanbul. In this respect, it can provide industry professionals with incremental information that may be used for further informed decision-making in the investment world that may be considered highly volatile and erratic.

The significance of this study lies in its ability to intertwine rigorous academic research with real-world applicability. A detailed examination of sectoral diversification within Borsa Istanbul is a beacon for investors and scholars, guiding them through the intricate intricacies of portfolio management in emerging financial landscapes.

3. Literature Review

Portfolio management has recently evolved significantly from traditional approaches to increasingly integrating advanced technological methods. A comprehensive review of the literature in this domain underscores the shifting paradigms and innovative methodologies that researchers and practitioners have adopted.

The development of new disciplines within project portfolio management (PPM) fosters the integration of artificial intelligence (AI) and machine learning (ML) into traditional PPM processes. Kaiser et al. (2015) pointed to the need for organizational alignment within PPM to implement strategies in complex organizations. To integrate AI/ML in PPM, the structure needs to align with the change and the shift from traditional to data-driven management. Another contribution to this topic was brought by Andrén and Meddeb (2021), who stressed the frame of applying PPM practices to AI projects at Volvo Cars. This demonstrates that AI is, in a way, highly dependent on the very nature of the AI initiative, and bespoke management is required. This exemplifies the specificity that AI brings to Project Management as part of the project management solution portfolio we posted in 2019. Marchinares and Aguilar-Alonso (2020) stated that ML would go from mesmerizing to normal sooner rather than later, just like word processing, which gives great insight into the concept of massive data in project management. Cheng et al. (2022) expanded the AI and ML applications in PPM through a product/market portfolio model that uses these technologies to predict product and market dynamics.

Soni and Kumar (2016) examined using a genetic algorithm (GA) in a more traditional algorithmic approach to predict how the market would act generically. This test showed that a single algorithm might sometimes be best, especially during high market volatility. It showed that hybrid algorithms gave higher prediction accuracy. This study draws attention to the fact that the market is highly unpredictable. Therefore, hybrid algorithms are needed to predict the future accurately. Luo et al. (2017) introduced a new methodology called Combinatorial Fusion Analysis (CFA) that combines multiple algorithms to enhance the performance evaluation of investment portfolios. This widely used trading system shows that traders combine different algorithms to analyze the market.

Network approaches unlock unique possibilities to understand and exploit the intricate web of relationships in financial markets. Zhang and Chen (2017) used a spectral clustering algorithm on stock complex networks for portfolio construction in the Chinese stock market, obtaining more return by investing in stocks with higher centrality measures in the network. Consequently, utilizing centrality in the network when constructing portfolios contributes to a well-performed stock strategy. Similarly, Guindici et al. (2020) used network model applications on a risky asset market, such as the cryptos one, propagating the idea that network approaches should add more value to the classical portfolio allocation model even in very volatile markets.

Recent applications of unsupervised ML techniques, particularly clustering algorithms, have found that unsupervised ML techniques, especially various clustering algorithms, have been employed to distribute market and identify investment opportunities. Rokade et al. (2017) successfully applied K-means clustering to cluster high-growth companies in the Indian stock market. This application of unsupervised learning techniques highlights the capability of unsupervised learning techniques to automatically find patterns and groups within the data that could be very useful for investment decisions. Gupta et al. (2020) designed a framework for K-means clustering to do stock diversification.

Reinforcement learning (RL) has been accepted as an impressive tool for optimizing portfolio management strategies. Liang et al. (2018) found that the policy gradient algorithm outperformed other RL algorithms in the portfolio selection area, representing a significant step in applying RL to financial decision-making. Hu and Lin (2019) discussed that deep reinforcement learning (DRL) can be used to Optimize portfolio management through deep recurrent neural networks, and Peng et al. (2020) reviewed a tutorial regarding applications of RL for portfolio management. Successively, Gao et al. (2019), Ye et al. (2020), and Huang et al. (2020) further demonstrated that RL is a suitable model for portfolio management to address several challenges like data heterogeneity and environmental uncertainty, offering an effective way to determine how to optimize investment decisions by introducing different algorithms or novel mechanisms.

The broader trends in the financial industry indicate a growing recognition of AI's transformative impact. Boschke (2018) discussed AI's potential in banking, emphasizing the importance of balancing technological advancements with human judgment. Gautam et al. (2019) examined AI's role in various financial services, including stock selection and asset allocation, highlighting AI's capacity to revolutionize financial decision-making. Byrum (2022) emphasized the need for integrating AI with human expertise in managing portfolios, especially in the context of market volatility induced by the COVID-19 pandemic. This discussion reflects a consensus on harmonizing AI capabilities with human insights to achieve optimal investment outcomes. This study examines the impact of sectoral diversification on risk and returns within portfolio management, with a particular focus on Borsa Istanbul. It aims to bridge specific knowledge gaps while differentiating itself from existing literature. One of its distinctive features is its choice of

scope and context. While earlier research by Cameron (2008) discussed portfolio management in general terms and Allan (2001) touched on the broad significance of diversification, neither seemed to delve into the unique context of emerging markets like Borsa Istanbul. The study offers a fresh perspective by specifically spotlighting this uncharted territory.

The mechanisms of risk management also receive a detailed exploration in this study. The works of Holland and Fathi (2007) established that risk management is a comprehensive subject that necessitates those who use it to understand the relationship between the investments they make. Teller et al., (2014) have tried to see whether risks have changed over time. In this research paper, we are going to look at the concepts mentioned above concerning Borsa Istanbul; this will help us visualize how the mechanisms of risk management work regarding sector diversity in the market.

The area of operational challenges in portfolio management further builds on the literature. Earlier literature in studies by Elonen and Artto (2003) points out several challenges faced in project risk management, including resource constraints, lack of complete information on the risk event, and sub-optimizing practices. The identified challenges end there without providing tangible solutions. This study mentions these challenges that jeopardize project risk management coupled with practical strategies on how the identified challenges could be curtailed, aiding portfolio managers in practice.

Moreover, this study opens up a new window and perspective on the nature of risk and the different perspectives of risk in portfolios, as discussed by the earlier literature. The realism of individual portfolio risks is that early research by Roman (2004) emphasizes the correlation and tries to understand the individual portfolio risks. This study is like early works by Kulian et al., (2020). Aliu et al. (2021), in examining the complexity of Diversification risk at Borsa Istanbul, which this study consists of, is the differences in sectoral diversification at Borsa Istanbul that neither of these authors has considered.

Lastly, this study's methodological rigor also makes it unique. This study's findings are relevant and actionable, as they leverage widely used data sources like Yahoo Finance and innovative methodologies like Monte Carlo simulations. This study is also uniquely rigorous due to the implementation of metrics, including the Sharpe Ratio, Sortino Ratio, and Maximum Drawdown.

4. Methodology

The methodology section outlines the systematic approach adopted in this study to investigate the impact of sectoral diversification on portfolio performance within the context of Borsa Istanbul. The methodology is structured to ensure rigor, reproducibility, and relevance to the study's objectives.

The study employed Python, a versatile programming language, for data collection, analysis, and visualization. Python's extensive libraries, such as Pandas, NumPy, and Matplotlib, facilitated efficient data handling and analysis.

4.1. Data Analysis

The foundation of any robust financial analysis lies in the judicious selection of data points. For this study, the emphasis was on curating a set of stocks that not only represent the dynamism of Borsa Istanbul but also offer a comprehensive view of the market's risk-return landscape.

4.1.1. Stock Selection

After selecting Borsa Istanbul as the stock exchange to survey, we picked three significant sectors to focus on : Banking, Energy, and Iron&Steel sectors. We did not pick these three sectors for no reason. They were all the determinant sectors in Borsa Istanbul. Many investors will reference these sectors to judge how the market goes; what each sector is performing respectively can generally reflect the market situation, making them three good broad metrics; each sector has its own "personality" so combining them to have a looking now we can give the big picture of via the three sectors.

Once the sectors were identified, the next step was to delve deeper and select individual stocks. Criteria such as market capitalization, liquidity, and availability of historical data were considered for stock selection. Based on market capitalization, stocks with a significant presence in their respective industries were chosen. Liquidity was an important consideration to ensure that the stock prices used for analysis were not subject to the significant volatility that low trading volumes could cause. The availability of historical data was also critical as the study aimed to provide insights based on historical performance. The stock selection led to the following stock names:

Table 1: Sectors and Stocks

Banking	Turkiye Garanti Bankasi, Akbank, Türkiye Is Bankasi
Energy	Petkim Petrokimya Holding, Türkiye Petrol Rafinerileri
Iron and Steel	Kardemir Karabük Demir Çelik, Eregli Demir ve Çelik Fabrikalari

4.1.2. Data Collection

The foundation of any financial analysis lies in the quality and reliability of the data. We have utilized Yahoo Finance to retrieve some real-time historical stock prices. Yahoo Finance is a globally recognized comprehensive financial data-providing website, and the data are accurate and reliable to perform a financial analysis because most financial professionals use it.

The temporal scope of the study was defined from January 2020 to December 2022. This timeframe was chosen to provide a comprehensive view of stock performance, capturing various market phases, including the unprecedented COVID-19 pandemic.

The granularity of data is crucial for in-depth analysis. Therefore, this study chose daily closing prices as the primary data points. This ensured a detailed view of stock performance, allowing for accuracy in the subsequent analytical steps.

4.1.3. Exploring Data

It is essential to acquaint oneself with the available data before diving into complex studies. This section briefly examines the stock data, highlighting its characteristics and patterns. By understanding the foundational attributes of our dataset, we pave the way for more nuanced and informed subsequent analyses.

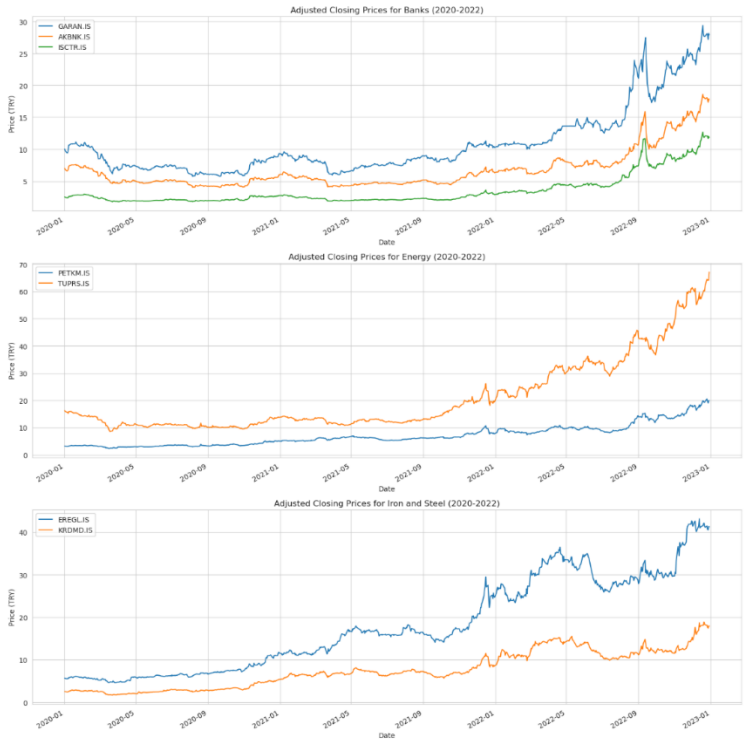

Figure 1: Historical Graphs of Stocks by Sectors

In Figure 1, when observing the Banking sector, the stocks for Garanti Bankası, Akbank, and İş Bankası appear to move in somewhat similar patterns. This suggests that there might be correlations between their price movements. A noticeable decline in their stock prices can be seen around the early 2020 mark, likely due to the worldwide economic effects of the COVID-19 pandemic. However, all these bank stocks show a recovery trend following this decline, albeit with occasional fluctuations.

In Figure 1, turning to the Energy sector, Petkim Petrol Kimya and Türkiye Petrol Rafinerileri exhibit corresponding trends in their stock prices. Among the two, Petkim Petrol Kimya's stock price seems more unpredictable. A significant rise in their stock prices started around the middle of 2020. This upward trend suggests a recovery or growth period for the energy sector within Borsa Istanbul.

In Figure 1, within the Iron and Steel sector, the price movements of Eregli Demir ve Çelik Fabrikalari and Kardemir Karabük Demir Çelik differ noticeably. Eregli Demir ve Çelik Fabrikalari's stock price maintains a more consistent trajectory, whereas Kardemir Karabük Demir Çelik experiences more variability. Around the mid-2021 mark, a sharp surge in Kardemir Karabük Demir Çelik's stock price can be observed, pointing to a potential favorable event or a growth stage for the firm. Descriptive Statistics

We computed and interpreted the basic statistics for each stock, such as mean, median, standard deviation (volatility), skewness, and kurtosis. These statistics provided insights into the distribution and behavior of each stock's returns.

Here are the descriptive statistics for the daily returns of the selected stocks:

Table 2: Descriptive Statistics

Stock	Mean Return	Volatility (Std)	Skewness	Kurtosis
Garanti Bankası	0.0016	0.0268	0.1752	32.073
Akbank	0.0016	0.0268	0.1752	32.073
İş Bankası	0.0024	0.0278	0.2818	30.996
Eregli Demir ve Çelik Fabrikalari	0.0030	0.0261	0.5547	36.747
Petkim Petrol Kimya	0.0028	0.0282	-0.0351	26.245
Türkiye Petrol Rafinerileri	0.0015	0.0255	0.2295	30.249
Kardemir Karabük Demir Çelik	0.0031	0.0310	0.1252	14.196

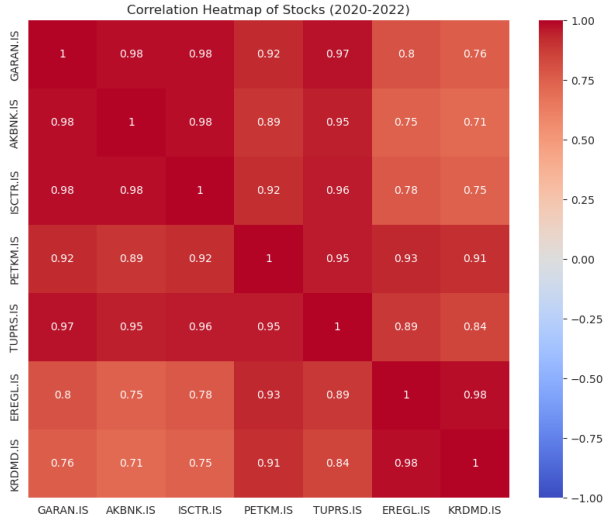

Figure 2: Correlation Heatmap of Stcoks

Correlation values can provide insights into how stocks move relative to one another. When stocks have a high positive correlation, they typically move in the same direction. A value nearing one on the heatmap denotes a robust positive correlation between two stocks. On the other hand, a high negative correlation implies stocks that move in opposite directions, with values approaching -1 indicating a strong negative association. When two stocks have little or no correlation, values are close to 0, showing minimal to no relationship in their price movements.

Examining the heatmap for the Banking sector in Figure 2, it is clear that Garanti Bankası, Akbank, and İş Bankası possess strong positive correlations among themselves. This suggests that their stock prices often trend in the same direction. This alignment is anticipated, given that they operate within the same sector and are likely influenced by shared market dynamics.

Petkim Petrol Kimya and Türkiye Petrol Rafinerileri exhibit a highly positive correlation in the energy sector. This relationship highlights that their stock prices generally showcase similar movement patterns.

Eregli Demir ve Çelik Fabrikalari and Kardemir Karabük Demir Çelik display a moderate positive correlation for the Iron and Steel sector. Even though they are part of the same sector, their price trajectories are not as synchronized as the stock pairs in the banking and energy sectors.

Beyond the confines of individual sectors, the heatmap also reveals moderate positive correlations between stocks from different sectors. A notable example includes the correlation between Garanti Bankası from the Banking sector and Petkim Petrol Kimya from the Energy sector. Such relationships suggest that specific overarching market dynamics might simultaneously affect diverse sectors.

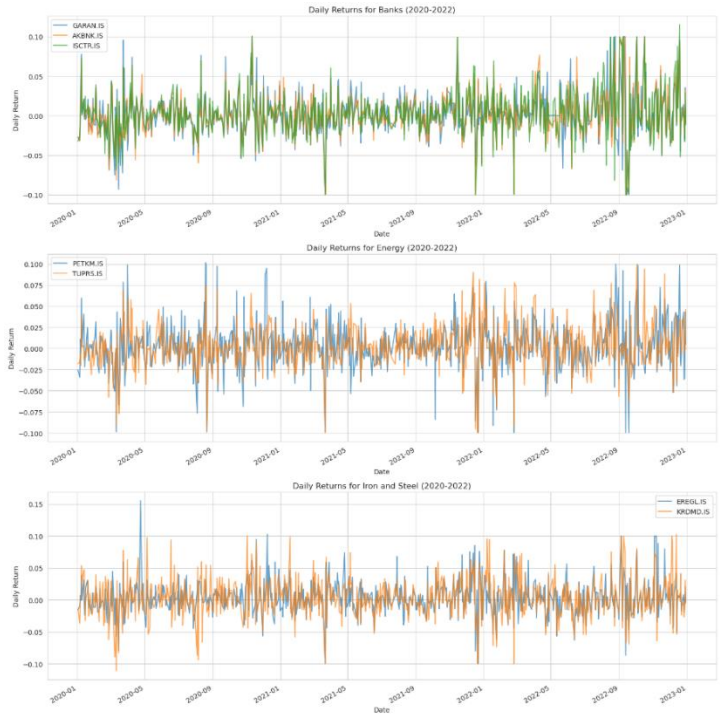

Figure 3: Daily Returns by Sectors

Analyzing the daily returns of the Banking sector in Figure 3 reveals significant volatility for Garanti Bankas, Akbank, and İş bankası, particularly around early 2020 and mid-2021. When the regular pattern of the daily returns displayed in Figure 3 fluctuates more heavily, the stocks of listed banks have experienced a more uncertain and riskier period, e.g., in the January-March periods of 2020 and 2021. The fact that all the stocks of the listed banks show similar patterns in Figure 3 suggests that they have a strong correlation and thus react to the changes in the market in the same way.

When studying the energy sector, Petkim Petrol Kimya and Türkiye Petrol Rafinerileri have a series of different daily returns, with Petkim Petrol Kimya being slightly more volatile. It can be concluded that Petkim Petrol Kimya and Türkiye Petrol Rafinerileri react to similar market signals. However, Petkim Petrol Kimya is more sensitive, or they respond to the market news more quickly and rapidly on average when an unforeseeable event happens.

Eregli Demir ve Çelik Fabrikalari has the most consistent daily returns regarding the Iron and Steel sector. Over time, the company has showcased its relative stability. Meanwhile, Kardemir Karabük Demir Çelik has had a higher likelihood of returns. This firm's volatility grew very high and reached a climax around mid-2021. Some events occurred within this firm, allowing the stock to be affected the way that it did. There were times when there was considerable market instability.

Figure 4: Distribution of Daily Returns by Sectors

Figure 4 also presents the daily returns for Garanti Bankası, Akbank, and İş Bankası in the Banking sector. It can be easily identified that the daily returns for all stocks predominantly cluster around the 0 mark. This implies that most of the days, the price changes experienced by these stocks are essentially nothing or negligible. In terms of the spread of the distributions, while the Garanti Bankası and İş Bankası have molecules of greater volatility when compared with Akbank, the data seem to be suggestive as its portfolio is much more comprehensive.

Observations from the energy sector indicate that the daily returns for Petkim Petrol Kimya and Türkiye Petrol Rafinerileri are chiefly anchored at around 0. However, a subtle differentiation can be noted in their distributions. Petkim Petrol Kimya's returns display a marginally broader spread, alluding to increased volatility relative to Türkiye Petrol Rafinerileri.

Within the Iron and Steel sector, the distribution of daily returns for Eregli Demir ve Çelik Fabrikalari is more constricted than Kardemir Karabük Demir Çelik. This condensed distribution implies that Eregli Demir ve Çelik Fabrikalari experienced more consistent daily returns over the analyzed span. Conversely, Kardemir Karabük Demir Çelik portrays an expanded distribution, signaling heightened volatility in its daily returns.

Complementing these observations, the histograms visually encapsulate each stock's risk and return characteristics. A stock with a broader distribution indicates elevated volatility and, consequently, higher risk. In contrast, a stock displaying a compact distribution indicates steadier returns and is typically associated with reduced risk.

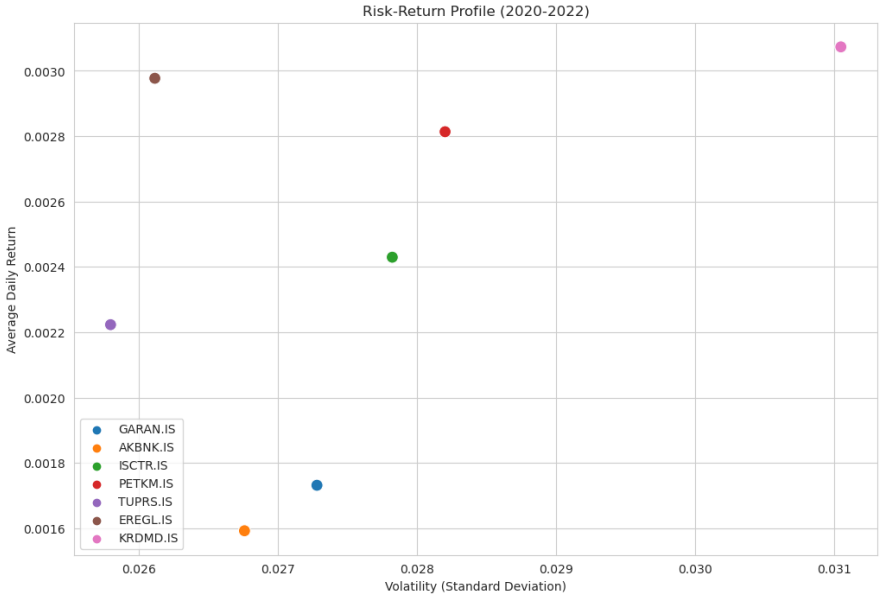

Figure 5: The Risk-Return Profile of Companies

A scatterplot in Figure 5 shows the two essential aspects of stock performance: risk (x-axis) and potential returns (y-axis). The x-axis shows the volatility inherent in the stock identified by the standard deviation of their daily returns. Values higher than the benchmark on this axis are considered more volatile, which means the stock is riskier. On the other hand, the y-axis shows the average daily return of each stock studied over this period. Values higher than the benchmark on this axis can be seen as having superior returns.

Key Observations from the Scatter Plot

"Higher Risk-Higher Return" Segment: Stocks in the zone of high volatility include Kardemir Karabük Demir Çelik and Petkim Petrol Kimya. Nevertheless, the attraction of higher average daily profits is combined with this increased risk. Thus, these equities demonstrate a clear trade-off between risk and return, encapsulating the core of the well-known investing tenet that "higher risks accompany higher potential rewards."

Balanced Risk-Return Segment: The scatter plot indicates that more central positions are held by equities such as İş Bankası and Garanti Bankası. Based on their coordinates, it appears that the risk-return profile is more balanced, with neither extreme.

Stable Investment Segment: Segment of Stable Investment: Eregli Demir ve Çelik Fabrikalari is a perfect example of a stock that typically offers modest profits together with moderate volatility. With its profile, it seems like it could be a more reliable investment option, but with lower potential rewards.

The risk-return duality for each stock is skillfully visualized by the scatter plot. Investors can use this representation to gain important insights that will help them customize their investment strategies to fit their risk tolerance and financial objectives.

4.2. Portfolio Construction

Efficient frontier is a critical tool in portfolio management, as it represents the set of portfolios that provide investors with the maximum expected return for a given level of risk or, conversely, the minimum level of risk that investors would be exposed to for a given level of expected return

(Solimanpur et al., 2015). This concept assists in determining the optimal combination of efficient assets for investors with various levels of appetite for risk and returns.

Using Monte Carlo Simulation, we generated hypothetical portfolios by randomly selecting stocks from each sector. The idea was to see the impact of sectoral diversification on overall portfolio risk and return. We ran simulations to create thousands of portfolios using randomly generated weights for each stock. We then visualized the risk-return tradeoff for these portfolios.

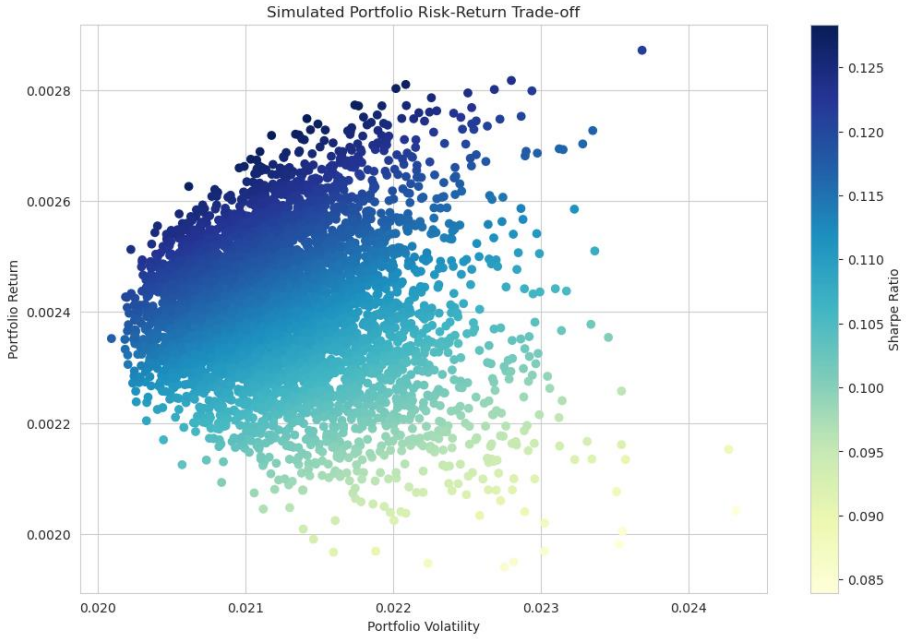

Figure 6: Simulated Portfolio Risk-Return Tradeoff

The scatter plot presented in Figure 6 visually represents various hypothetical portfolios, each embodying a distinct mix of stock allocations.

Risk Dimension (Portfolio Volatility): The x-axis shows risk, measured using the volatility measure. The higher a portfolio's volatility measure, the higher the portfolio's risk. Return Dimension (Portfolio Return): The y-axis shows the expected return of each portfolio, where portfolios with higher expected returns are shown higher up on the axis.

Each dot's hue on the plot is indicative of its Sharpe Ratio. This ratio serves as a benchmark for risk-adjusted returns. Essentially, a more intense shade of blue (or a higher Sharpe Ratio) symbolizes a portfolio that delivers superior returns for its level of risk. Conversely, a lighter blue hue indicates a sub-optimal risk-return balance.

One can discern a pronounced upward-trending curve within the scatter, termed the "Efficient Frontier." This curve is pivotal in portfolio management. Portfolios residing on this curve epitomize efficiency as they promise the maximum potential return for any given level of risk. In other words, for any point on the Efficient Frontier, no other portfolio provides higher returns for the same risk or lower risk for the same returns.

4.3. Portfolio Optimization

Using the Efficient Frontier methodology, we identified the optimal portfolio that offers the highest return for a given level of risk. We used the Sharpe Ratio to determine the optimal

portfolio, as it considers both the return and volatility of a portfolio. The portfolio with the highest Sharpe Ratio is considered the most desirable.

Figure 7: Optimal Portfolio Risk-Return Tradeoff

In Figure 7, our attention is drawn to a prominent red star. This symbol denotes the "optimal portfolio," which is a portfolio that stands out with its superior Sharpe Ratio relative to all other simulated portfolios. This portfolio delivers the most impressive risk-adjusted return among its peers.

The exact location of the optimal portfolio on the scatter plot is revealing. Its coordinates on the x and y axes indicate inherent risk (measured by volatility) and projected return, respectively. The portfolio containing the best profit-return balance in the chart may only be ideal for some investors. By measuring the position, investors can quickly understand this portfolio's risk and return dynamics and verify that this portfolio is the most effective option to achieve the best possible return for a given level of risk.

Table 3: Optimal Portfolio Weights by Stocks

Stock	**Weight (%)**
Akbank	1,82
Kardemir Karabük Demir Çelik	41,65
Türkiye Petrol Rafinerileri	3,09
Petkim Petrol Kimya	13,56
İş Bankası	0,56
Ereğli Demir ve Çelik Fabrikaları	4,03
Garanti Bankası	35,3

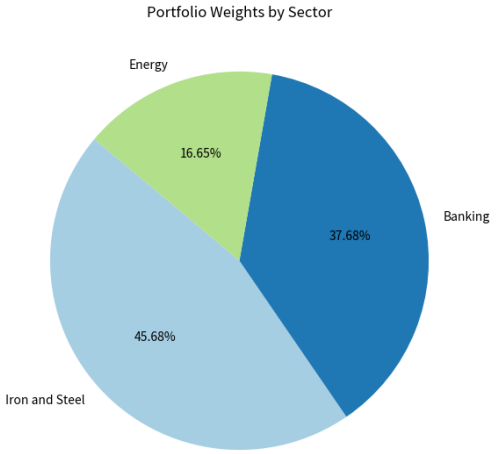

Figure 8: Optimal Portfolio Weights by Sector

4.4. Performance Evaluation

The Sharpe Ratio (ShR) constitutes a critical metric in investment analysis, designed to assess the performance of a selected portfolio relative to its risk. This ratio is calculated by subtracting the risk-free rate (Rf) of the investment from the expected return of the portfolio (Rx) and then dividing the result by the standard deviation of the portfolio's return (StdDev Rx), which represents the risk or volatility of the portfolio return (Sharpe, 1966).

$$\mathrm{ShR} = \frac{\mathrm{Rx} - \mathrm{Rf}}{\mathrm{StdDev\ Rx}}$$

The Sharpe ratio, sometimes called the reward-to-variability ratio, quantifies the average return above the risk-free rate per volatility unit of an asset. A heightened Sharpe ratio indicates a superior return earned for each risk unit. However, its constraint lies in measuring an asset's total volatility. Contrarily, risk-averse investors typically focus on the downside risk of an asset, viewing the asset's upside volatility as favorable (Sendi, 2020). Furthermore, when two portfolios exhibit proximate Sharpe ratios, investors tend to favor the one with a diminished estimation risk within the Sharpe ratio, as suggested (Martínez, 2023).

The Sortino Ratio (SoR) is an advanced financial metric that refines the concept of the Sharpe Ratio by focusing specifically on downside risk, offering a more nuanced view of a portfolio's risk-adjusted performance. This ratio is calculated by taking the difference between the expected return of the selected portfolio (Rx) and the risk-free rate of the investment (Rf) and then dividing this result by the standard deviation of the portfolio's downside risk (StdDev Rxd) (Sortino & van der Meer, 1991).

$$\mathrm{SoR} = \frac{\mathrm{Rx} - \mathrm{Rf}}{\mathrm{StdDev\ Rxd}}$$

The sortino ratio targets this very limitation of the Sharpe ratio. The Sortino ratio is an enhancement of the Sharpe ratio, focusing solely on the downside risk when assessing the risk-return attributes of an asset (Sendi, 2020). Stefanus and Robiyanto (2020) elaborate that the Sortino ratio differentiates between overall and perilous volatility. It achieves this by computing the standard deviation of negative return rates, otherwise recognized as downside deviation. A superior Sortino ratio indicates a preferable investment, as assets are penalized based on their associated bad risk (Sendi, 2020).

The maximum drawdown stands out in risk measurements, especially among money management experts. Defined as the paramount cumulative loss from a peak to the ensuing trough, its significance is underscored when contemplating the risk-free return after the previous peak. Yu et al. (2014) posit that the maximum drawdown tests clients' financial endurance, and large drawdowns frequently culminate in fund redemptions.

We evaluated the performance of the optimal portfolio using various metrics like Sharpe Ratio, Sortino Ratio, and Maximum Drawdown. These metrics provided insights into the portfolio's risk-adjusted performance and potential downside risk.

Here are the performance metrics for the optimal portfolio:

Table 4: Performance Metrics for The Optimal Portfolio

Metric	Value
Sharpe Ratio	-0.30098
Sortino Ratio	-0.393141
Maximum Drawdown	-0.34142

The Sharpe ratio measures the returns on investment per return of risk taken. In other words, the Sharpe ratio measures the return on investment per point of risk. A positive Sharpe ratio value would mean the portfolio delivered returns above the risk-free rate for the risk taken. On the other hand, a negative value would mean the portfolio is delivered at a risk-free rate after accounting for volatility. Noted, -0.30098 is a negative value, and it implies that the portfolio failed to deliver any excellent or satisfactory performance because, when adjusted for risk, the performance was not as expected.

The Sortino Ratio is a variation of the Sharpe ratio but only penalizes the returns when falling below the target. Its use will only be helpful with confident investors whose concern is only on the downside or negative volatility. A high positive Sortino Ratio is better for this investor. The negative 0.393141 implies that our portfolio is underperforming at the risk-free rate when only looking at unfavorable returns.

Performance measures for this optimal portfolio suggest that while this may provide diversification, it may not be the best-performing portfolio. Considering the risk taken, it may have performed differently than it should have and experienced a high level of downside risk. These metrics should be considered in relation to investors' risk tolerance and objectives.

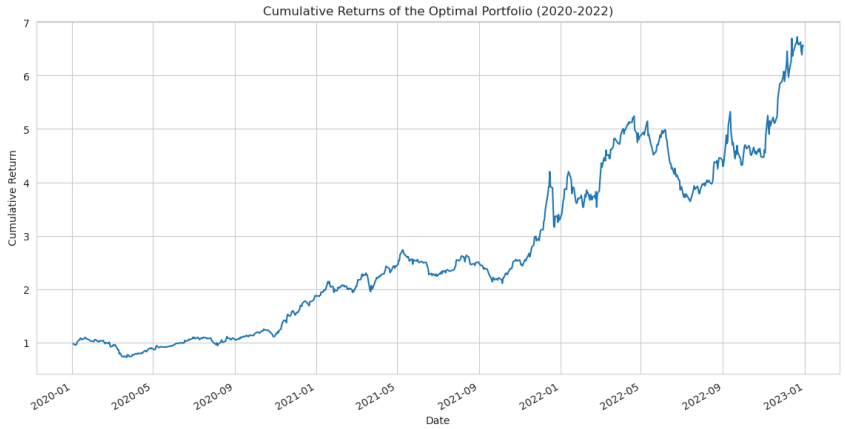

Figure 9: Cumulative Returns of The Optimal Portfolio

Figure 9, shows the relatively dynamic returns for the optimal portfolio over the next three years. The line graph demonstrates the cumulative returns of the strategy, giving us an idea of how the portfolio has performed over the 36 months.

The periods that the line is rising on the graph signify times that the strategy was yielding positive returns. Conversely, the line is declining for periods when the strategy yielded negative returns. The negative returns would have been caused by many things, including sudden stock fluctuations or current events occurring to any individual stocks that comprise the portfolio.

Confidently pronounced descents in the trajectory are discernible. These declines could be a reflection of substantial market downturns or particular incidents that had an adverse effect on the stocks incorporated in the portfolio. Such downturns play a role in determining the maximum drawdown value we previously delved into, indicating the magnitude of potential losses an investor might face during these downturns.

Table 5: Overall Performance of the Optimal Portfolio

Stock	**Weight (%)**	**Return**
Akbank	1,82	139%
Kardemir Karabük Demir Çelik	41,65	557%
Türkiye Petrol Rafinerileri	3,09	314%
Petkim Petrol Kimya	13,56	514%
İş Bankası	0,56	348%
Ereğli Demir ve Çelik Fabrikaları	4,03	353%
Garanti Bankası	35,3	167%
Weighted Portfolio Return		389%

The portfolio used in this study did not make for a completely safe investment but showed a significant return of 389 percent. This large return was achieved because we were attempting to make as much money as possible while still keeping our risk level low; in the end, our strategy was successful and showed that investing in increasingly less risky sectors, even if it does not outperform the completely safe investment can oust a sizable return highlighting the impact of adequately constructing a portfolio and diversifying that investment across different sectors.

Maximum drawdown is a metric that provides insights into the most significant decrease in the portfolio's value over a given period without witnessing a new high. The figure of -0.34142 indicates that the most substantial drop in the portfolio's value was 34.142%. This showcases the potential level of downside risk the portfolio has faced.

Here is a visualization of the drawdowns of the optimal portfolio from 2020 to 2022:

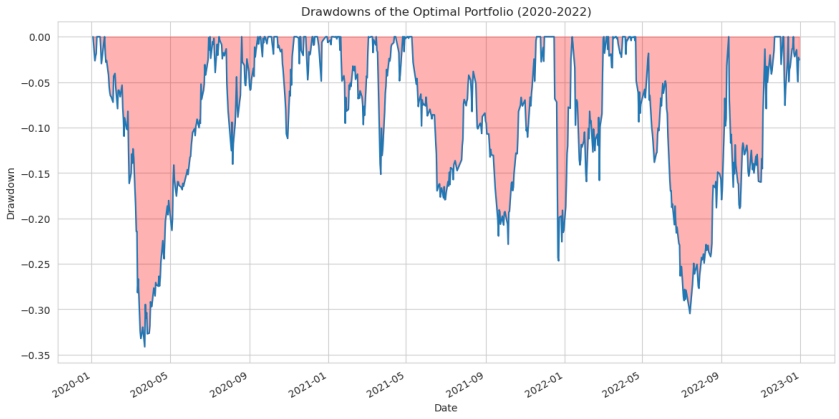

Figure 10: Max. Drawdowns of The Optimal Portfolio

The graph visually presents the drawdowns experienced by the optimal portfolio. Drawdowns are defined as the reductions in the portfolio's value, spanning from its peak value to its subsequent trough.

The red-shaded sections on the chart depict the depth and duration of each drawdown. A shaded, broader, and more profound region signifies a drawdown that persisted for a more extended period and had a more significant decline in value.

The most pronounced red-shaded area, which stands out due to its size, corresponds to the maximum drawdown metric we previously analyzed. This specific drawdown exemplifies the portfolio's steepest dip throughout the observed period.

Repeated occurrences of profound drawdowns can raise concerns among investors, particularly those who lean towards a more conservative investment approach with a preference for lower risk. Evaluating these drawdowns in light of the broader investment goals and strategy is crucial for informed decision-making.

Discussion

Investigation of the impact of sectoral diversification within Borsa Istanbul from 2020 to 2022 reveals interestingly coded nuanced insights for portfolio management and diversification strategies in sharp contrast to and concurrence with related literature and a more abundant window into portfolio performance optimization in an emerging market setting that can be achieved by employing a variety of research methods such as the Monte Carlo simulation along with performance metrics such as the Sharpe ratio, Sortino ratio, and maximum drawdown.

The efficiency of Sectoral Diversification: Consistently with the general literature that advocates diversification as a tool to mitigate risk (Allan, 2001; Brasil and Eggers, 2019), the results of this study endorse spreading investments across several sectors as a risk management strategy. However, unlike some optimistic views in the present literature, our results highlight the challenges associated with achieving an optimal balance between risk and return. This is particularly the case in an emerging market like Borsa İstanbul, where the behavior-specific dynamics of the sectors and macroeconomic influences are significant.

Methodological Rigor and Real-world Application: Our approach agrees with recent calls for more methodological rigor in portfolio analysis by employing modern analytical techniques (Cheng et al., 2022; Marchinares and Aguilar-Alonso, 2020). By utilizing Monte Carlo simulations and evaluating portfolios on the Efficient Frontier, our group demonstrates the

importance of using sophisticated analytical tools to find the most optimal risk-return tradeoff. This methodological rigor allows for a stronger tie between theoretical constructs and the tangibles of managing a portfolio of stocks, similar to how Kaiser et al. (2015) and Andrén and Meddeb (2021) leveraged technology such as AI and ML in PPM to face the realities of financial markets.

Performance Metric Findings: The pioneer's use of performance metrics like the Sharpe Ratio, Sortino Ratio, and Maximum Draw Down gives a micro view into the behavior of portfolios, something that was agreed upon in the literature, where more nuanced analysis was recommended (Sendi, 2020; Martínez, 2023). The results further challenge the idea that diversification is guaranteed to improve portfolio performance and raise questions on the validity of the diversification models in use today. Such concerns are not only scary but require a re-look into the dominance of diversification, especially in emerging markets where more volatile and sector-specific forces dilute the powerful effect of diversifying across several asset classes.

Conclusion

In conclusion, we conduct a rigorous study researching the impact of sector diversification on portfolio performance, clarifying diversified portfolio performance, and analyzing the mutual effect between risk and return with a diversified portfolio between industries. In characteristics of an emerging market, the Istanbul Stock Exchange has been selected as the research object. Through Monte Carlo simulation and some combination of performance metrics, including the Sharpe Ratio, Sortino Ratio, and Maximum Drawdown, the empirical research presents a comprehensive evaluation of diversified portfolio strategy underlying driving forces under the background of emerging market countries.

The significance of this research is twofold. For the academic domain, it enriches the existing corpus of knowledge by intensely monitoring sector-specific diversification and its results on portfolio performance within an emerging market landscape. For practitioners, the study underscores the imperative for a strategic diversification approach, highlighting the criticality of careful sector selection and resource allocation to achieve an optimal risk-return juxtaposition in volatile environments.

The statistics provided a clear portrayal. The best combination of stocks from banks, energy, and iron and steel industries exhibited the perspective of varied business setups. Conversely, the numbers indicated an alternate story. However, the portfolio's reward-adjusted performance gained attention with 389% profit; a Sharpe Ratio of -0.30098 and a Sortino Ratio of -0.393141 show that the portfolio lacks risk-free asset returns.

When comparing a diversified portfolio to a concentrated portfolio in one sector, we can see the strengths and weaknesses each offers. A diversified portfolio is a tremendous safeguard against downtrends specific to one sector; however, it mirrors numerous adversities typically found throughout those sectors.

Acknowledging the limitations of our study, which include the small sample size of the three sectors of Borsa Istanbul and a limited time frame. Nonetheless, these limitations also provide a road map for future scholarly studies. Future studies could analyze the effects of sectoral diversification across emerging markets and compare them with those of developed ones. Research could help identify unique patterns or commonalities in how diversification impacts portfolio performance across varying market conditions and stages of economic development.

Another exciting research direction could be incorporating the latest machine learning and AI technologies to predict sector performance and optimize portfolios. With advancements in machine learning and artificial intelligence, researchers in the finance field can tackle these tasks with a boost in explanatory power.

Including behavioral finance perspectives could help us understand investors' behaviors affecting each sector's performance. By doing so, we can investigate how cognitive bias and emotional sentiment affect sector selection and an individual's overall portfolio.

Moreover, it might be interesting to explore alternative ways of diversification, such as factor-based or diversification across different asset classes (e.g., stocks, bonds, real estate, commodities), as alternative ways and to reassess the risk-return tradeoff in emerging markets relative to traditional industry diversification approaches.

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