International Journal of Advanced Research in Economics and Finance
e-ISSN: 2682-812X | Vol. 6, No. 5, 15-25, 2024
https://asianscholarsnetwork.com/asnet-journals

Can Shariah-compliant ESG Portfolios Outperform the Market Barometer? Prefatory Evidence from an Emerging Market

Syarifah Nur Samihah Syed Ismail[1], Safwan Mohd Nor[1,2*], Nur Azura Sanusi[1,3]

[1] Faculty of Business, Economics and Social Development, University of Malaysia Terengganu, Kuala Nerus, Malaysia
[2] Victoria Institute of Strategic Economic Studies, Victoria University, Melbourne, Australia
[3] Higher Institution Centre of Excellence (HICoE), Institute of Tropical Aquaculture and Fisheries, University of Malaysia Terengganu, Kuala Nerus, Malaysia

*Corresponding Author: safwan@umt.edu.my

Received: 25 October 2024 | Accepted: 2 December 2024 | Published: 31 December 2024

DOI: https://doi.org/10.55057/ijaref.2024.6.5.2

Abstract: *Environmental, social, and governance (ESG) pillars have been extensively applied by capital market participants in their investment decision-making processes. While the proponents opine that the performance of ESG portfolios outperforms the market in terms of optimal risk-return trade-off, the opponents argue otherwise, which supports the Efficient Market Hypothesis (EMH) theory. In this paper, we construct three variations of Shariah-compliant ESG portfolios, specifically equally diversified stocks (SC ESG 1/N), optimized unconstrained (SC ESG-U), and optimized constrained (SC ESG-C), using ESG scores from the Refinitiv ESG database. Furthermore, the performance of these portfolios is compared against the benchmark market index, the FTSE Bursa Malaysia KLCI (KLCI), by utilizing various risk-adjusted performance metrics for robustness. Using weekly data from January 2016 to December 2022, we find that the optimized SC ESG portfolios generate higher returns and better return-to-risk ratios compared to the market index and the naïve portfolio. Additionally, drawdowns across all portfolios were not homogenous for most of the study period, with the maximum drawdown observed in recent years due to various local and global situations. However, the SC ESG-C portfolio exhibits the most robust risk control, with relatively shallow drawdowns and quicker recoveries. Our findings offer both theoretical and practical implications. The results challenge the EMH, as the market index underperforms the SC ESG portfolios. At the same time, both Muslim and ESG-oriented investors can achieve potential benefits without significantly compromising returns through portfolio optimization strategies. Nevertheless, caution must be exercised when interpreting the empirical results and making inferences, given the relatively small sample size.*

Keywords: ESG investing, portfolio optimization, shariah-compliant stocks, performance analysis

---

1. Introduction

Globally, the significance of the underpinning concept of environmental, social, and governance (ESG) investing is not something new, as it has existed for decades and has gained unprecedented traction in recent years. This shift is largely driven by heightened awareness of climate change, social inequality, and corporate governance failures, which have prompted investors to seek more sustainable and responsible investment strategies. The COVID-19

pandemic further accelerated this trend as stakeholders began to recognize the interconnections between public health, economic stability, and corporate responsibility. As a result, many ethical investors have increasingly incorporated ESG factors alongside traditional financial analysis in their investment decision-making process, supporting the United Nations' Principles for Responsible Investment (UNPRI) global initiative. This rise in ESG investing has spurred large inflows of global sustainable assets, totaling approximately USD 2.8 trillion, primarily driven by the European market, according to Morningstar (2023).

Similarly, there has been a noticeable increase in sustainable investments in Malaysia. The country has made significant strides in integrating ESG principles into its financial landscape. This momentum is driven by national strategies such as the Shared Prosperity Vision 2030 and supportive policy frameworks introduced by the Securities Commission Malaysia (SC). A pivotal development in this regard was the launch of the Capital Market Masterplan 3 (CMP3) in September 2021, which sets a strategic roadmap for the growth and transformation of the Malaysia's capital market. CMP3 emphasizes the importance of sustainable investing and aims to position Malaysia as a leading center for sustainable finance in the region. The plan outlines various initiatives to enhance the adoption of ESG practices among investors and corporations, thereby promoting responsible investment strategies.

Subsequently, in December 2022, the Principles-Based Sustainable and Responsible Investment Taxonomy for the Malaysian Capital Market (SRI Taxonomy) was launched to advance the nation's climate and sustainability goals. This taxonomy provides universal guiding principles for classifying economic activities eligible for sustainable investment, aiming to enhance clarity and consistency in identifying sustainable investments while addressing concerns about greenwashing. The SRI Taxonomy incorporates both environmental and social components, reflecting Malaysia's strong position in Islamic finance and its alignment with sustainability principles. Developed in collaboration with an Industry Working Group, this framework is designed to unlock capital for sustainable development and assist other countries in their transition to socially responsible investments.

These global and national developments underscore the importance of integrating ESG factors into investment strategies, as they not only help mitigate risks but also unlock new opportunities for sustainable growth. ESG investing, or socially responsible investing (SRI), typically employs a screening process to remove assets deemed controversial or not aligned with the moral values outlined in ESG principles. The sustainable practices of companies can also be accessed using ESG scores provided by rating agencies such as Sustainalytics, Refinitiv, MSCI, Bloomberg, and S&P Global. Moreover, the existence of sustainable and ethical-based indices, such as the Dow Jones Sustainability US Index, the MSCI KLD 400 Social Index, the FTSE4Good Index Series, and the FTSE4Good Bursa Malaysia Index, offers additional investment opportunities.

Despite the growing demand for SRI and the increasing availability of investment options, some challenges remain. Bhagat (2022) argues that investing in sustainable funds often sacrifices financial returns, with these funds not showing significant improvements in performance. Additionally, Lee (2023) points out that sustainable markets face major challenges, such as the lack of globally standardized ESG criteria, insufficient transparent ESG data disclosure, and difficulties financing net-zero transitions. Overcoming these obstacles requires global collaboration to ensure long-term sustainability for future generations. From industry research perspectives, the Bank of America Merrill Lynch (2019) thematic study presents favorable outcomes for ESG portfolios. In the US, the top quintile of ESG counterparts

outperform the bottom counterparts by at least 0.3%, based on data from three different rating providers. Similarly, European portfolios with high ESG scores showed better backtested performance from 2007 to 2019. Furthermore, the report highlights that the governance pillar contributes to higher future returns on equity (ROE) for Asian companies.

Alongside these trends, the global investment landscape has witnessed a significant shift toward Islamic finance, particularly within the realm of Shariah investing. In Malaysia, where the majority of the population is Muslim, a significant portion of the investment landscape is governed by Shariah principles. Consequently, the demand for Shariah-compliant investment options has surged, reflecting the growing desire among investors to align their portfolios with Islamic principles. Shariah-compliant investments not only adhere to the prohibitions against interest (riba) and unethical businesses but also promote social justice and equity.

As the momentum for both SRI and Shariah investing continues to build, the alignment of financial performance with ethical considerations is likely to become a central tenet of investment practices worldwide. This evolving landscape further highlights the relevance of this study, which aims to explore the portfolio optimization of maximizing the Sharpe ratio for Shariah-compliant ESG stocks in Malaysia, aligning local investment practices with global sustainability trends. By analyzing the risk-return profiles of these stocks, the research seeks to demonstrate that aligning investments with both Shariah principles and ESG considerations can enhance portfolio performance. This study will contribute to the existing literature by providing empirical evidence on the benefits of integrating ESG factors within the context of Shariah-compliant stock investing, ultimately advocating for a more sustainable and ethical investment strategy in Malaysia.

The rest of the paper is organized as follows: Section 2 provides a discussion of related literature. Section 3 describes the data and methodology, followed by empirical results and discussion in Section 4. Section 5 concludes.

2. Literature Review

This section starts with the introduction to Markowitz theory and discusses some of the extended mean-variance models in the existing literature. It was then followed by the debate on the investment performance of ESG portfolios.

Efficient asset allocation and diversification are the primary keys to both short- and long-term investment success. Modern portfolio theory (MPT), developed by Markowitz (1952), is the most prominent capital allocation technique, and it advocates diversification of assets in a portfolio. Given the practicality of MPT, this mean-variance optimization has been widely explored in the investment literature, but empirical findings remain mixed. For instance, several studies agree that this classical approach and mean-variance-related models are superior to other methods (Amin & Hajjami, 2021; Platanakis et al., 2021; Chen et al., 2022; Kumar & Stauvermann, 2022; Martínez-Nieto et al., 2023), while others assert in another way (Hwang et al., 2018; Branger et al., 2019; Rodríguez et al., 2021).

Notwithstanding, investors can now formulate an optimal combination of return and risk subject to some ESG criteria or score. There are several approaches to achieving this. The first is in line with the principle of fundamental analysis, which is done by filtering the universe of stocks into those with high (or low) ESG scores. Consequently, optimization can be done in that sample of stock portfolios. This approach is widely used by fund managers and has been

examined by researchers, such as Nor and Zawawi (2018). The second technique is to consider an additional objective of maximizing ESG in addition to the primary investing objectives of maximizing returns and minimizing risks. This can be based on the variety of enhanced models of mean-variance-ESG frameworks that have been developed by some of the recent studies, such as Pedersen et al. (2021), Cesarone et al. (2022), and Steuer and Utz (2023).

Varmaz et al. (2024) develop a multi-index model for extended mean-variance optimization that includes ESG factors, which can improve out-of-sample returns and the Sharpe ratio. Garcia-Bernabeu et al. (2024) apply an efficient multi-objective genetic algorithm based on ε-dominance to generate a three-dimensional Pareto front, and the finding yields a robust solution in the mean-variance-ESG surface for socially responsible investment portfolios aligned with investor preferences. Xidonas and Essner (2024) propose a multi-objective minimax-based portfolio optimization model and validate it through extensive empirical testing on indices such as the EURO STOXX 50, DAX, CAC 40, and DJIA over five years. The results show that the optimal ESG portfolios generated by the model consistently achieve higher risk-adjusted returns compared to their market benchmarks. Empirically, all these models lead to better investment performance and higher utility stock portfolios. The application of numerous models is anticipated to produce pronounced and persuasive outcomes.

In regard to investment performance, some groups of studies discuss the impact of ESG screening on portfolio diversification. To some extent, some academicians argue that this exclusion screening will have a negative impact on return because the broad investment universe is now limited to only ethical-based stocks, hence reducing the diversification opportunities (Trinks & Scholtens, 2017; Wang et al., 2022). On the flip side, Ielasi et al. (2020) suggest that the efficient implementation of ESG screening with smart beta strategies by utilizing the constituents of European and US markets is able to enhance portfolios' sustainability without affecting their effectiveness. Yet, the pros and cons of ESG inclusion in the stock portfolio selection process remain a matter of contention and discussion.

Besides, numerous studies compare the performance of ESG portfolios (individual stocks) with others, including non-ESG, conventional, Shariah-compliant portfolios (stocks), or even market benchmarks. With the utilization of a variety of data and models, these studies observe diverse outcomes. Based on the evaluation of 1,203 US stocks using the MV model, López Prol and Kim (2022) observe that portfolios with high ESG ratings have lower returns and Sharpe ratios. Consistent with previous findings, Wang et al. (2022) find that portfolios with a high ESG exhibit the lowest return, Sharpe ratio, and cumulative wealth when employing risk-weighted models for the CSI 300 composite index from 2012 to 2019. Vu et al. (2025) examine ESG investments in 23 developed markets from 2004 to 2022 and find a weak relationship between ESG ratings and expected returns, with high ESG portfolios sometimes underperforming low ESG portfolios. This suggests that stock prices may already reflect ESG information and traditional asset pricing factors can explain portfolio returns, but the relationship varies with global attention to sustainability.

On the other hand, Pisani and Russo (2021) utilize the 5-year data of 30 ESG funds from the European market, and the results from GARCH models and event study analysis indicate that the performance of the higher ESG funds was better than the others during the COVID-19 outbreak. Similarly, Broadstock et al. (2021) conclude the same finding in China, indicating that ESG can lower the financial risk of portfolios during a pandemic. In a more recent study, Useche et al. (2024) evaluated the performance of investment portfolios based on ESG criteria in companies listed on stock exchanges in Latin America from 2011 to 2019. The findings

highlight the advantages of investing in high-ESG portfolios, reflected in various performance metrics, and emphasize the drawbacks of investing in companies that do not disclose ESG information.

There are also studies that focus on one particular pillar of ESG. For example, Nor and Zawawi (2018) classified the portfolios into strong and weak corporate governance in the UK. Based on the optimization by maximizing the Sharpe ratio, the empirical findings show strong CG companies outperform their weak counterparts. In other works, Qoyum et al. (2021) compare the performance of four different equity portfolios, particularly Islamic SRI (ISRI), SRI, conventional, and Shariah-compliant. The empirical results from CAPM and Fama-French models show superior performance of ISRI than the others, highlighting the flexibility in choosing the stocks. Other than Shariah investing, SRI is also viewed as a safer alternative to traditional investing following the financial crisis, based on the content analysis of an online focus group discussion (FGD) conducted by Hashmi et al. (2022). Overall, these discernible and diverse outcomes, of course, will extend further research opportunities.

Therefore, this study fills important gaps in the existing literature on ESG investing, particularly in the Malaysian context. Despite being employed in portfolio optimization, the application of MPT in the context of ESG investments within emerging markets like Malaysia remains underexplored. Besides, there is a lack of empirical evidence comparing the performance of Shariah-compliant ESG portfolios against traditional benchmarks like the KLCI. This absence is significant, as it limits investors' understanding of how Shariah-compliant ESG stocks perform relative to established market indices, particularly in an emerging market setting where investment behaviors and attitudes may differ from developed markets.

The significance of this research lies in its potential to address this gap by providing a comprehensive analysis of ESG portfolio optimization in Malaysia using multiple performance measures. By benchmarking an optimized ESG portfolio against the KLCI, this study aims to offer valuable insights for investors, policymakers, and financial institutions regarding the financial viability of ESG investing. Furthermore, the findings will contribute to the development of tailored investment strategies and promote sustainable investing practices, encouraging a shift towards incorporating ESG criteria in the Malaysian financial landscape.

3. Data and Methods

This section describes the sample data and discusses the portfolio optimization model that is used to construct the optimal portfolio in this study.

3.1 Data

We form investment portfolios comprising 15 Shariah-compliant companies listed in Bursa Malaysia. While a 15-stock portfolio seems small, several studies show it is within sufficient range to diversify away most of the non-systematic risks (for example, Beck et al., 1996; Solnik, 1974). In line with the diversification principle in Markowitz (1952), our portfolio includes companies from diverse industries. Weekly data spans a 7-year period from 01/01/2016 to 31/12/2022. This period includes various events ranging from economics, health, political uncertainty, and war. The historical stock prices and ESG scores are obtained from the Refinitiv ESG database. It is notable that we only select companies with an average ESG score above 50% as an indicator of greater sustainability practices. Table 1 outlines each company based on its average ESG score and its corresponding industry.

Table 1: Shariah-compliant companies for ESG portfolio construction

No.	Company name	Average ESG scores	Industry
1	Nestle (Malaysia) Berhad	88.49	Food & Beverages
2	Petronas Dagangan Berhad	70.54	Retailers
3	MISC Berhad	71.58	Transportation & Logistics Services
4	Axiata Group Berhad	66.97	Telecommunications Service Providers
5	CelcomDigi Berhad	65.44	Telecommunication Service Providers
6	Gamuda Berhad	61.44	Construction
7	Westport Holdings Berhad	61.22	Transportation & Logistics Services
8	IHH Healthcare Berhad	60.79	Health Care Providers
9	Bursa Malaysia Berhad	61.42	Other Financials
10	Telekom Malaysia Berhad	58.64	Telecommunications Service Providers
11	IJM Corporation Berhad	56.29	Construction
12	Sime Darby Berhad	55.57	Automotive
13	Genting Plantations Berhad	54.88	Plantation
14	Malaysia Marine & Heavy Engineering Holdings Berhad	56.55	Energy Infrastructure, Equipment & Services
15	FGV Holdings Berhad	50.77	Plantation

3.2 Portfolio Optimization

Since the main purpose of portfolio diversification is to maximize return given risk (or minimize risk given return), we focus our attention on maximizing the Sharpe ratio, i.e., return-per-risk of the portfolio. This approach is consistent with Nor and Zawawi (2018), where we maximize the Sharpe Ratio (SR) as follows:

$$\max SR = \frac{\mu_p - r_f}{\sigma_p} \quad (1)$$

$$\text{subject to } \sum_{i=1}^{N} w_i = 1 \text{ and } l_i < w_i < u_i \quad (2)$$

In short, μ_p denotes portfolio mean returns, r_f refers to the risk-free rate and σ_p indicates volatility. For weights (w) of stock i, the l_i refers to the lower bound and u_i the upper bound. Our experiment is based on long-only transaction due to short-selling restrictions and uses zero risk-free rate as all funds are fully invested in stock.

We explore three variations of Shariah-compliant ESG portfolios: (1) the naïve diversification where each stock is invested in equally (SC ESG 1/N), (2) optimized unconstrained (without floor and ceiling) (SC ESG-U), and (3) optimized constrained with l_i = 1% and u_i = 25% (SC ESG-C). These constraints are deemed reasonable given portfolio size, but we also test several different weight limits for robustness and find that the outcomes are similar. Results are not reported here for the sake of brevity. For benchmarking purposes, we also compare our SC ESG portfolios against the Malaysian main market barometer, the FTSE Bursa Malaysia KLCI.

4. Results and Discussion

We outline the performance of four portfolios (benchmark KLCI and three SC ESG portfolios) in Table 2. The performance comparison across the portfolios provides several key insights into the risk-return dynamics and portfolio resilience over the study period. The results

highlight distinct patterns in terms of mean returns, risk-adjusted performance, downside risk, and maximum drawdowns (MDD).

The unconstrained ESG portfolio (SC ESG-U) demonstrates the highest mean return, outperforming the others. The superior returns of SC ESG-U align with the idea that unconstrained optimization allows greater flexibility to allocate more weight to high-performing ESG stocks with higher returns, taking advantage of opportunities in sectors that outperform during specific periods. However, the constrained portfolio (SC ESG-C) offers a trade-off by slightly reducing returns in exchange for improved risk control, as evidenced by its lower volatility compared to SC ESG-U. The risk-adjusted performance further supports these observations, as the SC ESG-U portfolio achieves the highest Sharpe, Sortino, and Treynor ratios, underscoring its ability to generate excess returns relative to its risk exposure. In contrast, the FBM KLCI underperforms across all metrics, with negative Sharpe and Sortino ratios, suggesting inefficient risk-return characteristics. The SC ESG-C portfolio provides moderate risk-adjusted performance (e.g., a Sharpe ratio of 0.06), making it suitable for more conservative investors. The higher information ratios of ESG portfolios also indicate their superior risk-adjusted returns over the benchmark. Hence, ESG portfolios offer better investment outcomes compared to the broader market index.

Table 2: Performance of Shariah-compliant ESG portfolios and benchmark KLCI

Performance measures	KLCI	SC ESG portfolios		
		1/N	ESG-U	ESG-C
Mean Returns	-0.02	0.01	0.17	0.08
Volatility	0.017	0.018	0.015	0.014
Sharpe Ratio	-0.01	0.01	0.11	0.06
Sortino Ratio	-0.01	0.01	0.21	0.09
Treynor Ratio	-0.0002	0.001	0.03	0.01
Information Ratio	NA	0.01	0.08	0.07
Value-at-Risk (95%)	-2.35	-2.59	-1.45	-2.06
Conditional VaR (95%)	-3.70	-4.06	-2.68	-3.03
Value-at-Risk (99%)	-4.56	-5.16	-4.59	-3.47
Conditional VaR (99%)	-6.42	-5.85	-5.17	-3.96
Maximum Drawdown	-35.64	-24.93	-15.72	-14.38

Source: Computed and elaborated by the authors.

Downside risk measures, such as Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR), reveal important differences in portfolio stability. At the 95% confidence level, the SC ESG-C portfolio has a lower maximum potential loss than the FBM KLCI and SC ESG 1/N, indicating that the constrained portfolio is relatively safer during extreme market movements. Similarly, at the 99% level, SC ESG-C outperforms both SC ESG 1/N and FBM KLCI. The improved downside protection of SC ESG-C reflects the effectiveness of diversification and allocation constraints in limiting tail risks, which is particularly valuable in periods of heightened market volatility.

The maximum drawdowns (MDD) provide critical insights into the portfolios' resilience during prolonged market downturns. In Figure 1, we illustrate portfolio drawdowns over time. The portfolios are somewhat homogenous during stable periods but diverge sharply during times of market stress and recovery. The FBM KLCI experiences the most severe and prolonged drawdowns, followed by SC ESG 1/N, SC ESG-U, and SC ESG-C. The most significant exposure to risk can be observed in the early 2020s, when maximum drawdowns for all portfolios occurred. Evidently, this peak period exposed international financial markets

to various local and global events, such as the COVID-19 pandemic, the US-China trade war, and the Russia-Ukraine war, while Malaysia also faced political unrest and currency depreciations. These events highlight systematic risk exposure to the portfolios, which cannot be diversified away through a simple ethical investment vehicle. However, the ESG portfolios, particularly SC ESG-C, are proven to be more resilient during the pandemic compared to the FBM KLCI. These portfolios were better positioned to mitigate losses due to their allocation toward sectors with stronger ESG credentials, whereas the FBM KLCI, which is heavily weighted in sectors such as financials and oil & gas, suffered more substantial losses.

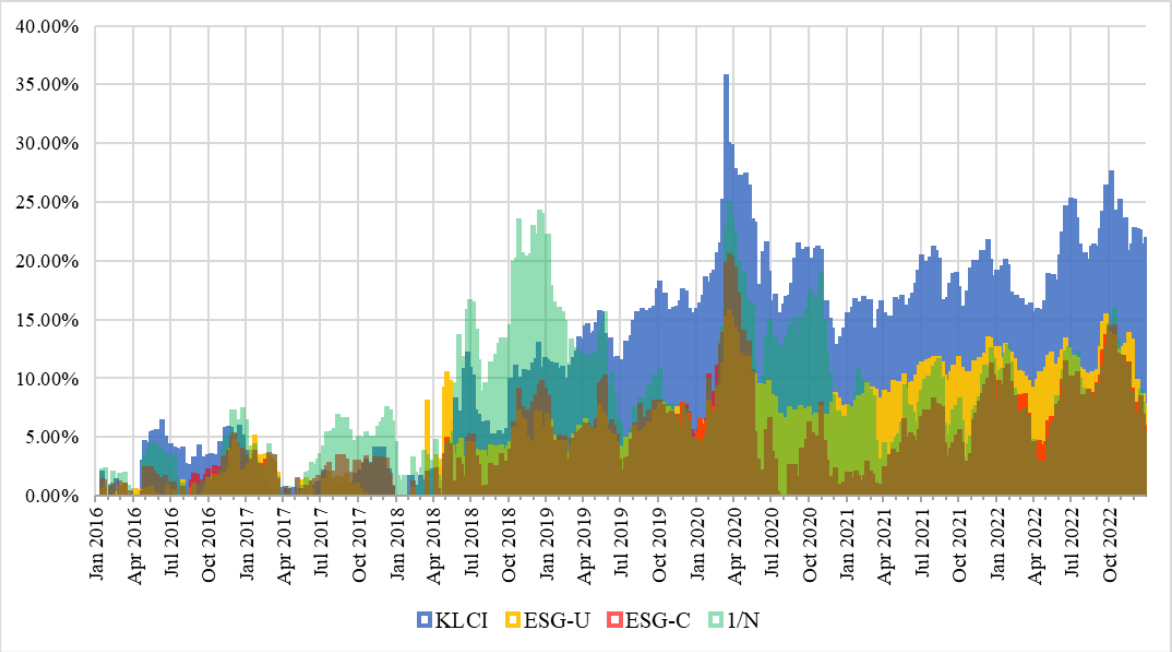

Figure 1: ESG portfolio drawdowns for the period 01/01/2016 to 31/12/2022

Overall, the constrained portfolio emerges as a well-balanced approach, offering competitive returns, lower risk, and reasonable ESG performance. It presents a compelling option for investors prioritizing risk management and sustainability. Meanwhile, the unconstrained portfolio may appeal to investors willing to accept higher risks for superior returns and better ESG alignment. These insights demonstrate the importance of tailoring portfolio strategies to specific investment goals and risk tolerances.

5. Conclusion

In this paper, we investigate the performance of three constructed Shariah-compliant ESG portfolios (in-sample) that are equally weighted and optimized under both unconstrained and constrained scenarios, comparing them against the FTSE Bursa Malaysia KLCI Index. Overall, the optimized ESG portfolios outperform both naïve diversification ESG and the market barometer portfolios. Despite this, the risk-return trade-off for the unconstrained portfolio is superior to that of the constrained portfolio due to the limitations of in-sample data, which result in concentrated risk and reduced diversification. Furthermore, an analysis of drawdowns highlights the impact of global and local market conditions. The maximum drawdowns occurred during the COVID-19 pandemic and other crises, which severely affected market performance. Among the portfolios, SC ESG-C demonstrated the most robust risk control, underscoring the importance of applying constraints to enhance portfolio resilience during periods of heightened uncertainty.

Our findings contribute to the existing literature on investment theory and the empirical practice of ESG investing. While previous studies evaluated the performance of ESG portfolios against traditional investments, this study adopts a more specific and centralized approach by constructing portfolios entirely from similar Shariah-compliant ESG stocks without price variations in the market. The distinction lies in the comparative asset allocation models and constraints applied. Thus, our results provide deeper insights for academicians and practitioners. Theoretically, according to the Efficient Market Hypothesis (EMH), the market index should perform better since all available information is reflected in prices. Additionally, higher returns are generally associated with higher risk. However, our results deviate from the EMH, potentially because market players may not adequately account for certain risks. This aligns with findings by Lee et al. (2021), which show that high-ESG-rated portfolios outperform the market.

From a practical perspective, the results offer valuable insights for Muslim and ESG-focused investors. The superior performance of SC ESG portfolios compared to the FBM KLCI suggests that integrating ESG factors into Shariah-compliant portfolios can deliver substantial benefits without sacrificing returns. This finding is consistent with prior research, such as Qoyum et al. (2021), which observed the outperformance of Islamic SRI portfolio relative to others. Additionally, consistent with Pedersen et al. (2021), our study shows that multiple objective optimizations outperform naïve diversification. ESG investors can achieve beneficial returns tailored to their risk appetite by optimizing portfolios rather than dividing investment capital equally or focusing solely on the market index. This is particularly significant given the growing demand for sustainable and ethical investment products, as institutional and retail investors increasingly incorporate ESG factors into their decision-making processes. However, investors must bear in mind that market risk is cannot be eliminated through a simple ethical investment instrument, emphasizing the need to monitor various macroeconomic indicators related to the financial market.

Nevertheless, several limitations of this study must be acknowledged. While the findings are robust across multiple performance metrics, the relatively small sample size and the focus on a single emerging market, Malaysia, restrict the generalizability of the results. Emerging markets may exhibit different dynamics than those developed markets, where ESG investing is more mature. As a result, our findings might not be applicable to other companies, optimization models, stock markets, or time horizons. Since this study focuses exclusively on in-sample data, further research could extend it by employing walk-forward optimization analysis to better reflect real-time trading environments. Moreover, incorporating additional constraints, such as transaction costs, into optimal portfolios and utilizing enhanced Modern Portfolio Theory (MPT) or more sophisticated optimization methods could further improve the robustness and applicability of the results.

References

Amin, G. R., & Hajjami, M. (2021). Improving DEA Cross-efficiency Optimization in Portfolio Selection. Expert Systems with Applications, 168. https://doi.org/10.1016/j.eswa.2020.114280

Bank of America Merrill Lynch. (2019). ESG from A to Z: A Global Primer. https://www.wlrk.com/docs/ESG_A_to_Z.pdf

Beck, K. L., Sieven, B. P., & Pamela, P. P. (1996). The Role of Alternative Methodology on the Relation Between Portfolio Size and Diversification. The Financial Review, 31, 381–406. https://doi.org/10.1111/j.1540-6288.1996.tb00878.x

Bhagat, S. (2022). An Inconvenient Truth about ESG Investing. Harvard Business Review. https://hbr.org/2022/03/an-inconvenient-truth-about-esg-investing

Branger, N., Lučivjanská, K., & Weissensteiner, A. (2019). Optimal Granularity for Portfolio Choice. Journal of Empirical Finance, 50, 125–146. https://doi.org/10.1016/j.jempfin.2019.01.005

Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X. (2021). The Role of ESG Performance During Times of Financial Crisis: Evidence from COVID-19 in China. Finance Research Letters, 38. https://doi.org/10.1016/j.frl.2020.101716

Cesarone, F., Martino, M. L., & Carleo, A. (2022). Does ESG Impact Really Enhance Portfolio Profitability? Sustainability (Switzerland), 14(4). https://doi.org/10.3390/su14042050

Chen, W., Zhang, H., & Jia, L. (2022). A Novel Two-stage Method for Well-diversified Portfolio Construction Based on Stock Return Prediction Using Machine Learning. North American Journal of Economics and Finance, 63. https://doi.org/10.1016/j.najef.2022.101818

Garcia-Bernabeu, A., Hilario-Caballero, A., Tardella, F., & Pla-Santamaria, D. (2024). ESG Integration in Portfolio Selection: A Robust Preference-based Multicriteria Approach. Operations Research Perspectives, 12, 100305. https://doi.org/10.1016/j.orp.2024.100305

Hashmi, W. H., Ellahi, N., Ehsan, S., & Waheed, A. (2022). Islamic Equity Indices: A Focus Group Discussion. Journal of Islamic Accounting and Business Research, 13(6), 881–901. https://doi.org/10.1108/JIABR-09-2021-0241

Hwang, I., Xu, S., & In, F. (2018). Naive versus Optimal Diversification: Tail Risk and Performance. European Journal of Operational Research, 265(1), 372–388. https://doi.org/10.1016/j.ejor.2017.07.066

Ielasi, F., Ceccherini, P., & Zito, P. (2020). Integrating ESG Analysis into Smart Beta Strategies. Sustainability (Switzerland), 12(22), 1–22. https://doi.org/10.3390/su12229351

Kumar, R. R., & Stauvermann, P. J. (2022). Portfolios under Different Methods and Scenarios: A Case of Fiji's South Pacific Stock Exchange. Journal of Risk and Financial Management, 15(12), 549. https://doi.org/10.3390/jrfm15120549

Lee, D. (2023). Key 3 Challenges for ESG Investing: What's next? GRC Insights. https://insights.grcglobalgroup.com/key-3-challenges-for-esg-investing-whats-next/

López Prol, J., & Kim, K. (2022). Risk-return Performance of Optimized ESG Equity Portfolios in the NYSE. Finance Research Letters, 50, 103312. https://doi.org/10.1016/j.frl.2022.103312

Markowitz H. (1952). Portfolio Selection. Journal of Finance, Vol. 7, 77–91.

Martínez-Nieto, L., Fernández-Navarro, F., Montero-Romero, T., & Carbonero-Ruz, M. (2023). COVID-19 impact on the Spanish Stock Exchange with Mean-variance and Diversification-based Portfolios. Applied Economics Letters, 30(4), 416–422. https://doi.org/10.1080/13504851.2021.1990203

Morningstar. (2023). Global Sustainable Fund Flows: Q2 2023 in Review. https://www.morningstar.com/lp/global-esg-flows

Nor, S. M., & Zawawi, N. H. M. (2018). Optimal Portfolios vis-à-vis Corporate Governance Ratings: Some UK Evidence. Economic Annals-XXI, 170(3–4), 57–63. https://doi.org/10.21003/ea.V170-10

Pedersen, L. H., Fitzgibbons, S., & Pomorski, L. (2021). Responsible Investing: The ESG-Efficient Frontier. Journal of Financial Economics, 142(2), 572–597. https://doi.org/10.1016/j.jfineco.2020.11.001

Pisani, F., & Russo, G. (2021). Sustainable Finance and COVID-19: The Reaction of ESG Funds to the 2020 Crisis. Sustainability (Switzerland), 13(23). https://doi.org/10.3390/su132313253

Platanakis, E., Sutcliffe, C., & Ye, X. (2021). Horses for Courses: Mean-variance for Asset Allocation and 1/N for Stock Selection. European Journal of Operational Research, 288(1), 302–317. https://doi.org/10.1016/j.ejor.2020.05.043

Qoyum, A., Al Hashfi, R. U., Zusryn, A. S., Kusuma, H., & Qizam, I. (2021). Does an Islamic-SRI Portfolio Really Matter? Empirical Application of Valuation Models in Indonesia. Borsa Istanbul Review, 21(2), 105–124. https://doi.org/10.1016/j.bir.2020.08.002

Rodríguez, Y. E., Gómez, J. M., & Contreras, J. (2021). Diversified Behavioral Portfolio as an Alternative to Modern Portfolio Theory. North American Journal of Economics and Finance, 58. https://doi.org/10.1016/j.najef.2021.101508

Solnik, B. H. (1974). Why Not Diversify Internationally Rather Than Domestically? Financial Analysts Journal, 30, 48–54. https://doi.org/10.2469/faj.v30.n4.48

Steuer, R. E., & Utz, S. (2023). Non-contour Efficient Fronts for Identifying Most Preferred Portfolios in Sustainability Investing. European Journal of Operational Research, 306(2), 742–753. https://doi.org/10.1016/j.ejor.2022.08.007

Trinks, P. J., & Scholtens, B. (2017). The Opportunity Cost of Negative Screening in Socially Responsible Investing. Journal of Business Ethics, 140(2), 193–208. https://doi.org/10.1007/s10551-015-2684-3

Useche, A. J., Martínez-Ferrero, J., & Alayón-Gonzales, J. L. (2024). Socially Responsible Portfolios, Environmental, Social, Corporate Governance (ESG) Efficient Frontiers, and Psychic Dividends. Corporate Social Responsibility and Environmental Management, 31(2), 1323–1339. https://doi.org/10.1002/csr.2635

Varmaz, A., Fieberg, C., & Poddig, T. (2024). Portfolio Optimization for Sustainable Investments. Annals of Operations Research, 341(2–3), 1151–1176. https://doi.org/10.1007/s10479-024-06189-w

Vu, T. N., Lehkonen, H., Junttila, J.-P., & Lucey, B. (2025). ESG Investment Performance and Global Attention to Sustainability. The North American Journal of Economics and Finance, 75, 102287. https://doi.org/10.1016/j.najef.2024.102287

Wang, Z., Liao, K., & Zhang, Y. (2022). Does ESG Screening Enhance or Destroy Stock Portfolio Value? Evidence from China. Emerging Markets Finance and Trade, 58(10), 2927–2941. https://doi.org/10.1080/1540496X.2021.2014317

Xidonas, P., & Essner, E. (2024). On ESG Portfolio Construction: A Multi-Objective Optimization Approach. Computational Economics, 63(1), 21–45. https://doi.org/10.1007/s10614-022-10327-6.