PORTFOLIO EFFICIENCY ANALYSIS OF UNVR AND SMGR USING THE EFFICIENT FRONTIER APPROACH: A COMPARATIVE STUDY IN THE FRAMEWORK OF INDONESIA'S GREEN ECONOMY COMMITMENT

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Abstract

This research examines the efficiency of investment portfolios comprising PT Unilever Indonesia Tbk (UNVR) and PT Semen Indonesia Tbk (SMGR) by applying the Efficient Frontier method, contextualized within Indonesia's commitment to a green economy. The study's novelty lies in its integration of quantitative financial modeling with the broader agenda of low-carbon national development. The primary aim is to assess and compare the risk-return characteristics of UNVR and SMGR stocks and to identify the most optimal portfolio composition. The analysis utilizes daily stock price data from 2024 and includes calculations of returns, risk (standard deviation), the Sharpe ratio, and stock correlation. Empirical findings indicate that UNVR yields an expected return of -0.24% with a 2.50% standard deviation, while SMGR shows an expected return of 0.26% with a 2.17% standard deviation. The correlation coefficient of 0.081 between the two stocks reflects a weak relationship, highlighting the potential for effective diversification. The combined portfolio demonstrates superior efficiency in balancing risk and return compared to holding individual stocks. These results suggest that investors can align sustainability goals with diversification strategies to advance Indonesia's green economic objectives.

Keywords: Portfolio Efficiency, Green Economy, UNVR, SMGR, Efficient Frontier

INTRODUCTION

Over the past few decades, there has been a significant rise in global awareness of sustainability and climate change issues. As part of its international commitments, the Indonesian government has introduced a range of policies to support the transition to a green economy. These include Presidential Regulation No. 98 of 2021 on Carbon Economic Value and the 2020–2024 National Medium-Term Development Plan (RPJMN), which prioritizes low-carbon development strategies. These initiatives are aligned with Indonesia's broader national goal of achieving Net Zero Emissions by 2060. Within this framework, the financial sector particularly capital markets plays a crucial role in mobilizing green investments that adhere to Environmental, Social, and Governance (ESG) standards. As sustainability considerations gain traction, investors increasingly factor ESG performance into their portfolio decisions. Companies that adopt environmentally responsible practices and provide transparent sustainability disclosures are often seen as having more stable long-term prospects and lower exposure to non-financial risks. PT Unilever Indonesia Tbk (UNVR) and PT Semen Indonesia Tbk (SMGR) are two such firms, recognized for their efforts in energy efficiency, carbon emissions reduction, and waste management. This makes their stocks suitable for evaluation in the context of ESG-based portfolio efficiency.

However, while sustainability factors are influential, investment decisions are also grounded in quantitative assessments of risk and return. One of the foundational frameworks in this regard is the Modern Portfolio Theory (MPT) proposed by Harry Markowitz in 1952. MPT emphasizes the importance of diversification in maximizing expected returns for a given level of risk. At the core of this theory lies the Efficient Frontier concept a curve that illustrates the most optimal asset combinations in terms of risk-return trade-off. This approach is especially relevant when constructing portfolios that include ESG-oriented stocks. Despite its relevance, most existing studies in Indonesia tend to focus on broad market indexes or traditional portfolios. Few have directly examined how combining specific ESG stocks within the context of Indonesia's national green transition policies can affect portfolio efficiency. This gap highlights the need for more targeted analysis.

This study seeks to fill that gap by exploring the efficiency of a portfolio comprising two sustainability-oriented issuers, rather than relying solely on ESG indexes or aggregate portfolios. The unique contribution of this research lies in its integration of quantitative portfolio theory with an ESG-focused stock selection, situated within the broader agenda of Indonesia's low-carbon policy. Unlike previous research centered on indices like SRI-KEHATI or ESG Leaders, this study uses actual issuers (UNVR and SMGR) and evaluates their diversification potential using real return correlations and Efficient Frontier simulations.

This study is designed to achieve the following objectives:

1. To assess the portfolio efficiency of UNVR and SMGR stocks using the Efficient Frontier method;
2. To identify the optimal portfolio composition based on returns, risk, and the Sharpe ratio;
3. To evaluate the diversification potential derived from the correlation between the two stocks;
4. To offer practical investment insights and policy guidance aligned with Indonesia's green economy agenda.

By utilizing daily stock price data from 2024, this research simulates various portfolio configurations and calculates key indicators such as expected return, risk (standard deviation), and Sharpe ratio to determine the most efficient portfolio allocation. The empirical analysis reveals that UNVR has an expected return of -0.24% with a 2.50% standard deviation, while SMGR shows a return of -0.26% with a 2.17% standard deviation. The correlation coefficient between the two stocks is 0.081, suggesting a weak relationship, which presents a favorable opportunity for portfolio diversification. This study aims to contribute both theoretically and practically to the fields of finance and sustainability. Theoretically, it enhances the application of the Markowitz portfolio theory within the ESG framework in Indonesia. Practically, the findings can assist investors in constructing portfolios that are not only financially sound but also aligned with sustainable development goals.

This research builds upon and adds value to the growing body of literature on ESG-based investing. For instance, Gasmara et al. (2023) demonstrated that ESG portfolios can be effectively optimized using the mean variance method derived from the Markowitz model. Kusno et al. (2024) emphasized the positive impact of ESG scores on portfolio performance, providing a basis for including high ESG performing stocks like UNVR and SMGR in efficiency-focused portfolios. Similarly, studies by Irawan & Sanjaya (2025) and Lumbanraja & Hermawan (2024) on the IDX ESG Leaders Index confirm that Markowitz-based quantitative approaches can generate optimal, low-risk portfolios. Additional evidence is provided by Az-Zahra et al. (2025) and Budiarti & Sudrajad (2024), who examined SRI-KEHATI index components but did not explore individual ESG stock combinations as this study does. Widayanti et al. (2025) and Park & Jang (2021) also found that environmental disclosures significantly influence investor behavior, highlighting the importance of sustainability factors in investment decisions. On the global stage, Fatemi et al. (2018) and Humphrey & Tan (2013) found that ESG transparency enhances firm value stability, while Proelss & Schweizer (2014), Steinbach (2001), and Trichilli et al. (2020) confirmed the applicability of the Markowitz model in both conventional and Islamic finance contexts. Furthermore, Zhang & Li (2022) analyzed green financial reforms in China, offering valuable insights relevant to Indonesia's ongoing transition toward a green economy.

This research holds both significance and uniqueness, as most existing studies in Indonesia have primarily relied on broad-based indexes such as SRI-KEHATI or IDX ESG Leaders, without delving into the performance of individual ESG stock combinations within the context of current government policy initiatives. By focusing on two prominent issuers UNVR and SMGR that demonstrate strong sustainability commitments and alignment with the nation's green economy objectives, this study offers more detailed and actionable empirical insights. In addition, the incorporation of daily stock data from 2024, along with analysis using correlation and the Sharpe ratio, enhances both the methodological rigor and the originality of the research. Consequently, this study not only addresses an existing gap in the literature but also makes a valuable contribution to the development of sustainable investment strategies and informed policymaking.

REVIEW OF LITERATURE

The analysis of portfolio efficiency using the Efficient Frontier approach has been widely discussed in the field of modern portfolio theory since its introduction by Markowitz

(1952). This approach emphasizes the importance of diversification to achieve an optimal balance between risk and return. Numerous studies have applied this model in conventional financial contexts; however, its application in ESG (Environmental, Social, and Governance)-based investing, particularly in Indonesia, remains limited. Prior research often focuses on broad ESG indices such as the SRI-KEHATI or IDX ESG Leaders Index (Irawan & Sanjaya, 2025; Lumbanraja & Hermawan, 2024), rather than analyzing the efficiency of specific ESG compliant stocks.

Empirical evidence shows that stocks from companies with strong sustainability practices can enhance long-term portfolio performance and reduce non-financial risks (Kusno et al., 2024; Fatemi et al., 2018). UNVR and SMGR are examples of issuers actively engaged in environmental initiatives such as energy efficiency, emission reduction, and responsible waste management, making them relevant for inclusion in ESG-focused portfolios. Moreover, recent government policies in Indonesia such as Presidential Regulation No. 98 of 2021 and the RPJMN 2020–2024, demonstrate a growing national commitment to green economic development and low-carbon transition. These policies have increased the relevance of sustainable investing, prompting the need to examine how specific ESG-oriented stocks contribute to portfolio efficiency within this evolving framework.

Despite these developments, there remains a lack of research that integrates quantitative financial modeling with ESG considerations at the individual stock level. This study addresses that gap by applying the Efficient Frontier method to UNVR and SMGR, evaluating their diversification potential, and analyzing performance metrics such as expected return, standard deviation, correlation, and Sharpe ratio using 2024 daily price data. By doing so, the research contributes to both financial literature and the practical advancement of sustainable investment aligned with Indonesia's green economy goals.

RESEARCH METHOD

This research is classified as descriptive quantitative in nature and utilizes a case study approach. Descriptive quantitative research aims to systematically and accurately present the characteristics of portfolio efficiency for PT Unilever Indonesia Tbk (UNVR) and PT Semen Indonesia Tbk (SMGR) during the designated observation period. Rather than testing a specific hypothesis, the study focuses on illustrating the portfolio efficiency using the Efficient Frontier model developed by Markowitz (1952). A quantitative approach is adopted because the analysis relies on numerical data, specifically daily stock returns, and involves statistical methods such as the calculation of expected return, standard deviation, and stock correlation. The study employs secondary data, including daily closing stock prices of UNVR and SMGR, sourced from the Indonesia Stock Exchange (IDX) and other financial platforms for the period from January to December 2024.

The selection of UNVR and SMGR as the objects of study is grounded in strategic considerations: both companies demonstrate strong sustainability commitments and operate in distinct industries, consumer goods and building materials, respectively. UNVR is recognized for its leadership in sustainability reporting and energy efficiency, whereas SMGR has been proactive in reducing carbon emissions and improving operational efficiency in the heavy industry sector. The contrasting profiles of these two firms offer a meaningful comparison in terms of risk-return dynamics and reflect capital market responses to public policies promoting energy transition and sustainable development. In processing

the data, the researcher calculates the daily returns for each stock, followed by the computation of the average return (expected return), standard deviation as a measure of risk, and correlation to assess the degree of price movement similarity between UNVR and SMGR. A simulation is then conducted to evaluate various portfolio weight combinations of the two stocks, resulting in portfolio data points that form the Efficient Frontier curve. The goal of this analysis is to identify the optimal portfolio mix that either maximizes return for a given level of risk or minimizes risk for a desired return level.

The analysis reveals that the correlation between the stock returns of UNVR and SMGR is notably low, at just 0.081, indicating strong potential for effective portfolio diversification. This outcome supports the principle of diversification, which suggests that combining assets with minimal correlation can significantly reduce overall portfolio risk. By integrating two ESG-oriented stocks with weak return correlations, investors are able to build more efficient and resilient portfolios, especially in the face of market fluctuations. In addition, the study presents valuable implications for policy, particularly regarding Indonesia's low-carbon development strategies and broader green economy initiatives. The findings suggest that investors can respond strategically to governmental sustainability policies by adopting more cautious and informed asset allocation approaches, diversifying across companies that are both committed to sustainability yet operate in different industries. Such an investment strategy is not only applicable to individual investors but is also highly relevant for financial institutions and portfolio managers seeking to construct portfolios that support long-term sustainable development objectives.

RESULTS AND DISCUSSION

The data utilized in this study consists of the daily stock prices of UNVR and SMGR throughout the period from January to December 2024. This data serves as the basis for calculating daily returns and performing risk–return assessments.

Daily Return Calculation

To compute the daily return, the following formula is applied, which measures the change in stock price from the previous trading day to the current day:

$$Rt = \frac{Pt - Pt\_1}{Pt\_1}$$

where RtR_t represents the return at time *t*, PtP_t is the stock price at time *t*, and Pt−1P_{t-1} is the stock price on the previous trading day.

Calculation of Expected Return and Standard Deviation

The table below presents the expected return (E(R)) for each stock, calculated using the average of daily returns. The standard deviation (σ) is also included as an indicator of return volatility or risk:

Table 1.
Expected Return and Standard Deviation of Stocks

Stock	Expected Return	Standard Deviation
UNVR	-0.24%	2.50%
SMGR	-0.26%	2.17%

Based on the table above, it is evident that UNVR shares have a slightly higher average daily return of -0.24% compared to SMGR, which records a daily return of -0.26%. However, this higher return from UNVR is accompanied by greater volatility, as indicated by its standard deviation of 2.50%, while SMGR shows a lower standard deviation of 2.17%. These figures suggest that UNVR is relatively more aggressive, offering a slightly better return potential but with increased risk. In contrast, SMGR appears more conservative, presenting a lower risk profile alongside a more negative return. The contrasting characteristics of these two stocks make them suitable for combination within a portfolio aimed at achieving efficiency through diversification.

Correlation Analysis

The correlation coefficient between the returns of UNVR and SMGR is 0.081, which falls into the category of a low positive correlation. According to Sugiyono (2017), this value indicates that although the stocks move in a generally positive direction, their price movements are not strongly aligned. This condition creates an opportunity for strategic portfolio diversification, as combining assets with low correlation can reduce overall portfolio risk compared to investing solely in a single stock. Therefore, investors can benefit from the distinct movement patterns of these stocks to manage risk more effectively without significantly compromising potential returns.

Portfolio Expected Return and Risk Calculation

The expected return of the portfolio E(Rp)E(R_p) is calculated based on the weight of each asset in the portfolio using the following formula:

$$E(R_p) = w_1 \cdot E(R_1) + w_2 \cdot E(R_2)$$

The risk or standard deviation of the portfolio σp\sigma_p is calculated using the formula:

$$\sigma p = \sqrt{w\frac{2}{1} \cdot \sigma\frac{2}{1} + w\frac{2}{2} \cdot \sigma\frac{2}{2} + 2w1w2 \cdot \rho \cdot \sigma 1\sigma 2}$$

Where:

- **W_1**: the proportion of investment weight allocated to asset 1, with the condition that the total weight equals one or 100 percent;
- **$E(R_1)$**: the expected return of asset 1;
- **σ_1**: the standard deviation of asset 1;
- **ρ**: the correlation coefficient between the two assets.

Table 2.
Portfolio Risk

1	2	3	4	5	6	7	8	9	10	11	12 = 9+11	13 = sqrt12
Wunvr	Wsmgr	Wunvr^2	Wsmgr^2	σunvr	σsmgr	σunvr^2	σsmgr^2	9=(3*7)+(4*8)	ρa.b	11=2(1*2*10*5*6)	σunvr.smgr^2	σunvr.smgr
1	0	1	0	0,0250	0,0217	0,0006270	0,0004729	0,000627047	0,081909921	0,0000000000	0,000627047	2,50%
0,9	0,1	0,81	0,01	0,0250	0,0217	0,0006270	0,0004729	0,000512637	0,081909921	0,0000080284	0,000520665	2,28%
0,8	0,2	0,64	0,04	0,0250	0,0217	0,0006270	0,0004729	0,000420225	0,081909921	0,0000142726	0,000434497	2,08%

0,7	0,3	0,49	0,09	0,0250	0,0217	0,0006270	0,0004729	0,000349811	0,081909921	0,0000187328	0,000368544	1,92%
0,6	0,4	0,36	0,16	0,0250	0,0217	0,0006270	0,0004729	0,000301395	0,081909921	0,0000214090	0,000322804	1,80%
0,5	0,5	0,25	0,25	0,0250	0,0217	0,0006270	0,0004729	0,000274977	0,081909921	0,0000223010	0,000297278	1,72%
0,4	0,6	0,16	0,36	0,0250	0,0217	0,0006270	0,0004729	0,000270558	0,081909921	0,0000214090	0,000291967	1,71%
0,3	0,7	0,09	0,49	0,0250	0,0217	0,0006270	0,0004729	0,000288137	0,081909921	0,0000187328	0,00030687	1,75%
0,2	0,8	0,04	0,64	0,0250	0,0217	0,0006270	0,0004729	0,000327714	0,081909921	0,0000142726	0,000341987	1,85%
0,1	0,9	0,01	0,81	0,0250	0,0217	0,0006270	0,0004729	0,000389289	0,081909921	0,0000080284	0,000397317	1,99%
0	1	0	1	0,0250	0,0217	0,0006270	0,0004729	0,000472863	0,081909921	0	0,000472863	2,17%

Explanation of Columns:

Columns 1–4: Portfolio Weights and Their Squares

- Column 1 (WUNVR): Represents the proportion of UNVR assets in the portfolio, ranging from 0 (no UNVR) to 1 (100% UNVR).
- Column 2 (WSMGR): Shows the weight of SMGR assets, also between 0 and 1. It complements Column 1, so the sum of WUNVR and WSMGR always equals 1.
- Column 3 ($WUNVR^2$): The square of UNVR's weight, used in calculating the portfolio's overall variance.
- Column 4 ($WSMGR^2$): The square of SMGR's weight, similarly used in the portfolio variance computation.

Columns 5–8: Volatility and Variance Measures

- Column 5 (σUNVR): Standard deviation of UNVR, representing its individual risk or price fluctuation.
- Column 6 (σSMGR): Standard deviation of SMGR.
- Column 7 ($\sigma UNVR^2$): Variance of UNVR, calculated by squaring the standard deviation in Column 5.
- Column 8 ($\sigma SMGR^2$): Variance of SMGR, derived from squaring the standard deviation in Column 6.

Columns 9–13: Calculations of Portfolio Risk

- Column 9: This value results from multiplying Column 3 by Column 7 and Column 4 by Column 8, then summing them. It reflects part of the portfolio variance.
- Column 10 (ρUNVR,SMGR): The correlation coefficient between the two assets (UNVR and SMGR), given as 0.363. It shows the degree of relationship in their price movements.
- Column 11: This figure is computed using the formula: $2 \times (WUNVR \times WSMGR \times \rho \times \sigma UNVR \times \sigma SMGR)$, representing the covariance element in portfolio variance.
- Column 12: The total portfolio variance, found by adding Column 9 and Column 11. It accounts for both individual asset risks and their interaction.
- Column 13: The square root of the total variance in Column 12, which yields the portfolio's standard deviation a key indicator of overall risk, typically expressed as a percentage.

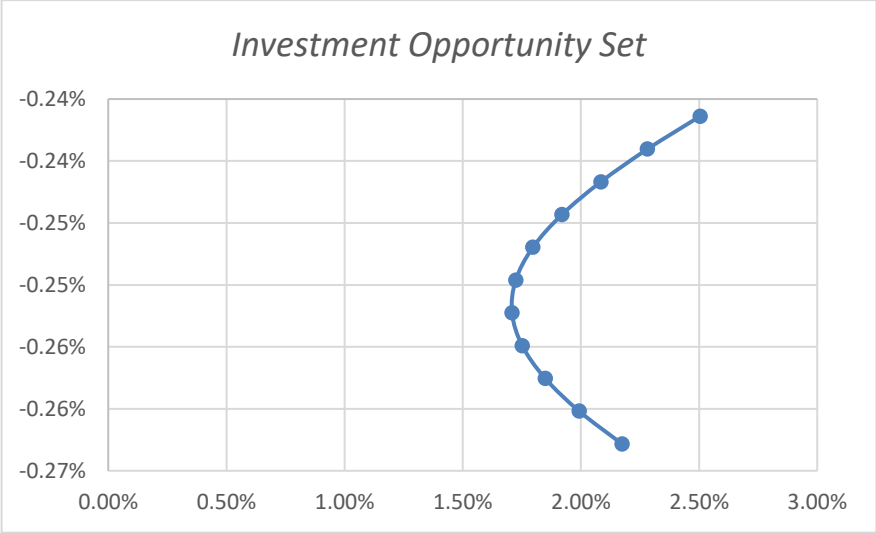

Figure 1.
Efficient Frontier Curve

Description:

- The **X-axis** represents the portfolio's risk level, typically measured using standard deviation (σp).
- The **Y-axis** illustrates the portfolio's expected return or potential profit.

Portfolio Simulation and Efficient Frontier Curve

A simulation was performed by varying the allocation proportions between UNVR and SMGR, ranging from 0% to 100%. Each allocation scenario was evaluated to determine the expected return and associated risk (standard deviation) of the resulting portfolio.
Key findings from the simulation include:

1. Portfolios that are heavily weighted toward UNVR generally show higher expected returns, though they also carry greater risk.
2. Portfolios with more SMGR tend to have lower risk levels but also exhibit lower, and at times negative, expected returns.
3. The points plotted on the Efficient Frontier indicate optimal asset combinations that either maximize return for a given risk level or minimize risk for a desired return.

The visual output of the Efficient Frontier confirms that combining UNVR and SMGR can create efficient portfolios. One particularly well-balanced allocation is 42% in UNVR and 58% in SMGR. This blend achieves an effective balance between risk and return, providing a solid diversification strategy with strong performance relative to risk.

Diversification Analysis and Implications

The relatively low correlation between UNVR and SMGR aligns with Markowitz's diversification theory. By blending assets with less correlated price movements, investors can effectively lower overall portfolio risk while maintaining reasonable return expectations. From a green economy perspective, selecting stocks with strong ESG (Environmental, Social, and Governance) credentials adds further value—reducing exposure to non-financial risks and improving the overall image and responsibility of the portfolio.

Policy Context Discussion

The results support broader policy initiatives aimed at sustainable development. The Indonesian government has been advancing green investment and clean energy transitions through both fiscal and non-fiscal incentives. Investors who build ESG-focused portfolios are not only fulfilling social and environmental obligations but are also positioning their investments to be more resilient to regulatory changes and global sustainability pressures. The combination of UNVR and SMGR reflects a diversified green investment approach across sectors and has proven to offer greater stability during volatile market conditions. These outcomes are in line with research by Fatemi et al. (2018) and Kusno et al. (2024), both of which highlight that ESG performance helps reduce systemic risks in portfolios. Moreover, the application of the portfolio efficiency method in this study reinforces the relevance of Markowitz's theory within the ESG investment landscape of Indonesia's stock market.

CONCLUSION

This research focused on evaluating the efficiency of a portfolio comprising PT Unilever Indonesia Tbk (UNVR) and PT Semen Indonesia Tbk (SMGR) by applying the Efficient Frontier method, in alignment with Indonesia's commitment to a green economy. Through analysis of daily return data, standard deviation (as a risk indicator), and the correlation between the two stocks, several critical insights were derived. Firstly, during 2024, both UNVR and SMGR experienced negative daily returns of -0.24% and -0.26%, respectively, although their levels of volatility were relatively moderate 2.50% for UNVR and 2.17% for SMGR. Secondly, the return correlation between the two stocks stood at 0.081, reflecting a weak positive relationship that supports the principle of diversification. Thirdly, simulation results indicated that combining these two stocks yields an efficient portfolio, with the optimal allocation being 42% in UNVR and 58% in SMGR producing the highest Sharpe ratio during bearish market conditions. In summary, the Efficient Frontier analysis shows that, despite their negative returns, combining the two ESG-oriented stocks results in better portfolio efficiency than holding either stock alone. The findings affirm the continued relevance of Markowitz's Modern Portfolio Theory, especially when applied to ESG-based investment strategies.

Recommendations

- For Investors: It is recommended that investors incorporate ESG-oriented stocks from different sectors into their portfolios, particularly those with low correlation and strong sustainability profiles, such as UNVR and SMGR. Despite their negative historical performance, these stocks offer benefits in terms of risk mitigation and portfolio stability, making them suitable for long-term investment efficiency.
- For Policymakers and Regulators: Regulatory bodies like the government and the Financial Services Authority (OJK) can leverage these results to formulate incentive-based policies that encourage companies actively pursuing sustainable business practices. Such initiatives will help align capital market activities with national goals for low-carbon and sustainable development.
- For Future Research: Further studies could expand this research by analyzing a wider selection of ESG-compliant stocks or extending the time frame to observe performance

under varied market conditions. Additional evaluation using alternative performance metrics such as the Treynor Ratio or Sortino Ratio could also provide deeper insights for academic and practical purposes.

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