OPTIMAL PORTFOLIO FORMATION USING SINGLE INDEX MODEL OF LQ45 STOCKS IN INDONESIA STOCK EXCHANGE FOR 2021-2024 PERIOD

Ida Ayu Artha Widya Sari
Faculty of Economics and Business, Udayana University, Indonesia
(widyasariartha@gmail.com)

I Gusti Ayu Agung Nararatna Mirah Nandini
Faculty of Economics and Business, Udayana University, Indonesia
(nandinimirah@gmail.com)

I Gusti Agung Rai Kristina
Faculty of Economics and Business, Udayana University, Indonesia
(raikristina3@gmail.com)

Ida Bagus Suadmaya
Undiknas Graduate School, Universitas Pendidikan Nasional, Indonesia
(ib_suadmaya@yahoo.com)

I Putu Agus Aditya Pramana Putra
Faculty of Economics and Business, Udayana University, Indonesia
(adityagus7@gmail.com)

Made Mas Ananda Adibaswara
Faculty of Economics and Business, Udayana University, Indonesia
(anandaadibaswara@gmail.com)

I Gusti Agung Bagus Putra Prameswara
Faculty of Economics and Business, Udayana University, Indonesia
(igabagusputra17@gmail.com)

Ni Kadek Adi Astuti
Faculty of Economics and Business, Udayana University, Indonesia
(adiastuti.kd@gmail.com)

Sang Putu Krisnanda Adhitama
Faculty of Economics and Business, Udayana University, Indonesia
(krisnandaadhitama@gmail.com)

ABSTRACT

The research determines the best portfolio composition using the Single Index Model (SIM) on stocks listed in the LQ45 index at the Indonesia Stock Exchange (IDX) for the 2021-2024 period. 45 stocks that are part of the LQ45 index were evaluated, based on their return, risk, and beta. The Single Index Model was used to choose stocks for the best portfolio based on their Excess Return to Beta (ERB) values compared to a cut-off point. The results show that from 45 stocks analyzed, 10 stocks formed the best portfolio with ADRO having the biggest allocation (75.37%), followed by ITMG (7.94%) and PGAS (4.34%). The mining sector was the biggest in the portfolio, showing it had the best risk-return during the study period. The optimal portfolio gave an expected yearly return of 64.84% with a risk level of 9.76%, and a Sharpe ratio of 6.13, showing very good risk-adjusted performance compared to the market. This research adds to the growing literature on portfolio optimization strategies in emerging markets, especially for Indonesian investors who want to maximize returns while managing investment risks in the IDX.

Keywords: single index model, optimal portfolio, lq45, Indonesia stock exchange.

INTRODUCTION

Decision for investing is a very important process for those who want to use their money efficiently in different financial assets. In Indonesian market, as an emerging market, investment offers big growth opportunities but also has big risks. Based on the Indonesia Stock Exchange (IDX), the number of retail investors in Indonesia has increase rapidly, reaching 9.17 million in December 2023, a 30.5% increase from 2022 period (Financial Services Authority of Indonesia [OJK], 2023). This big jump in retail investment participation highlights the importance of making good portfolio strategies for Indonesian investors.

As shown in Figure 1, the performance of the LQ45 index compared to the Jakarta Composite Index (JCI) was very different during the study period. While the JCI had a positive return of +13.57%, the LQ45 index went down by -1.98%, showing that the biggest and most liquid stocks did much worse than the broader market. This big difference in performance shows the challenges for investors who only focus on blue-chip stocks during this time. The underperformance of the LQ45 index happened at the same time as several important events that shaped market dynamics, including the Russia-Ukraine conflict, Bank Indonesia rate hikes, the regional banking crisis, Indonesia's commodity export ban, and the 2024 presidential election.

This difference in performance is both a challenge and an opportunity for portfolio managers. On one hand, it shows that simply investing in the most liquid stocks would have resulted in underperformance compared to the broader market. On the other hand, it shows that sensible stock picking within the LQ45 could potentially give significant returns if guided by a method like the Single Index Model. The negative performance of the LQ45 index makes choosing outperforming stocks within this index especially valuable for investors.

Optimizing a portfolio remains a fundamental challenging task in investment management. Markowitz (1952) introduced Modern Portfolio Theory (MPT), and after that various models have been developed to make an easier portfolio selection process. The Single Index Model by Sharpe (1963), is a more practical approach by reducing the computational complexity of the Markowitz model while maintaining its theoretical principles (Elton et al., 2014).

Figure 1. LQ45 Index Growth Compared to Jakarta Composite Index (JCI), 2021-2024.

The LQ45 index consists of 45 stocks with high market capitalization and liquidity in the Indonesia Stock Exchange. The index is usually an attractive investment target for both institutional and retail investors. These stocks are frequently traded, have substantial market capitalization, and generally have good financial performance (IDX, 2023). However, the index's recent underperformance highlights that even within this elite group, investor discrimination is essential. Even though the index had a negative trend overall, certain stocks in it showed remarkable individual performance, offering opportunities for above-market returns through systematic selection methods.

Several studies have applied the Single Index Model to the Indonesian market (Setiawan & Dewi, 2021; Wibowo, 2014), but most were conducted before or during the COVID-19 pandemic. The post-pandemic economic recovery and changing market dynamics require fresh analysis to guide current investment decisions. Additionally, Indonesia's economic landscape has changed significantly with the Omnibus Law in 2020 and the country's focus on downstream industries, particularly in mining and energy (World Bank, 2023). These structural changes have created new winners and losers even among Indonesia's largest companies, further emphasizing the need for systematic portfolio optimization.

This research addresses the following problems. Firstly, it is to find which stocks from the LQ45 index should be included in an optimal portfolio based on the Single Index Model. Secondly, it is to calculate the optimal proportion of funds invested in each selected stock. And lastly, it is to determine the expected return and risk characteristics of the optimal portfolio. By solving these problems, we aim to provide practical guidance for investors in the Indonesian stock market and contribute to the literature on portfolio optimization in emerging markets.

LITERATURE REVIEW

In 1952 Markowitz introduced the portfolio optimization, known as the introduction of Modern Portfolio Theory (MPT). Since then, this theory revolutionized the investment approach by quantitatively formulating the risk diversification. Markowitz stated that investors should consider how individual securities correlate with each other, not only the risk and return of individual securities. The idea of MPT is that a portfolio's risk can be reduced without reducing expected returns through proper diversification (Bodie et al., 2023). However, in practice the Markowitz model faces challenges due to its complexity when dealing with a large number of securities. Calculation of n(n-1)/2 covariances for n securities is needed, making it difficult for practical implementation (Elton et al., 2014).

To address the limitations of the Markowitz model, Sharpe (1963) developed the Single Index Model (SIM), which simplifies the portfolio optimization process. The SIM assumes that the correlation between stocks comes from their common relationship with the market index rather than direct correlations between individual stocks (Tandelilin, 2017). The SIM describes the return of a security to the return of a market by this relationship

$$R_i = \alpha_i + \beta_i R_M + e_i$$

Where R_i is the return of security i, α_i is the part of security i's return which is independent of market performance, β_i is the sensitivity of security i's return to market returns, R_M is the market return, and e_i is the random error term specific to security i. From this model, the number of estimates is reduced to 3n + 2 compared to n(n+3)/2 in the original Markowitz model (Elton et al., 2014).

Emerging markets, such as Indonesia, present unique challenges and opportunities for portfolio optimization. Angelia et al. (2021) found that portfolio optimization techniques in the Indonesian market require careful consideration of market-specific factors when applying different models like Markowitz and Single Index for LQ45 stocks. Similarly, Prasetyo and Suarjaya (2020) demonstrated that optimal portfolios in Indonesia's stock market can be effectively constructed using the Single Index Model to balance risk and return characteristics appropriate for this emerging market context.

The LQ45 index consists of 45 stocks with high liquidity and market capitalization in the Indonesia Stock Exchange. The index is reviewed and adjusted every period of time to ensure that it represents the most liquid and actively traded stocks in the market (IDX, 2023). Stocks in the LQ45 index are selected based on criteria including trading value, market capitalization, and frequency of trades. Research by Tandelilin (2017) highlighted that the LQ45 index serves as an important benchmark for institutional investors and provides a reliable investment universe for portfolio formation due to the liquidity and fundamental strength of its constituent stocks. Similarly, Khajar (2011) found that stocks in the LQ45 index generally offer better risk-adjusted returns compared to non-LQ45 stocks, making them attractive candidates for portfolio optimization.

Research on the Indonesia Stock Exchange has shown promising results using the Single Index Model. Abdilah and Rahayu (2014) analyzed LQ45 stocks from 2008 to 2013 and identified four stocks for the optimal portfolio, primarily from the financial and basic materials sectors. Similarly, Wibowo (2014) looked at LQ45 stocks from 2010 to 2012 and found 14 stocks forming the optimal portfolio, with significant representation from the financial sector. More recently, Setiawan and Dewi (2021) analyzed LQ45 stocks for 2017-2020 and found that six stocks formed the optimal portfolio, with three stocks from basic materials (ANTM, INCO, and SMGR), and one each from financial (BBCA), infrastructure (WIKA), and energy (PGAS). This portfolio yielded an expected return of 2.44% and a portfolio variance of 2.61%. Rae et al. (2021) studied LQ45 stocks during the COVID-19 vaccination period and applied the Single Index Model to banking sector stocks. Their research demonstrated the model's effectiveness in creating optimal portfolios even during a volatile pandemic period, offering investors a methodological approach to select banking stocks within the LQ45 index that could maximize returns while managing risk levels appropriate for the market conditions.

METHOD, DATA, AND ANALYSIS

Data and Sample Selection

This study uses secondary data from the Indonesia Stock Exchange (IDX) covering 3 January 2022, to December 31, 2024. The research population consists of all 45 stocks listed in the LQ45 index in the end of the 2024. The sample includes the daily price and dividend for these 45 stocks over the three-year period that was downloaded from yahoo finance. The risk-free rate (Rf) is set at 5%, based on the average Bank Indonesia (BI) 7-Day Reverse Repo Rate during the study period. The expected market return [E(RM)] is estimated at 12%, derived from the historical performance of the Jakarta Composite Index (JCI) during the same period.

Single Index Model Framework

The Single Index Model relates the return of a security to the return of a market index. The equation for this relationship is:

$$R_i = \alpha_i + \beta_i R_M + e_i$$

In this equation, R_i is the return of security i, α_i is the part of the return that is independent of the market (alpha), β_i is the slope coefficient (beta) that measures the sensitivity of security i's return to market returns, R_M is the market return, and e_i is the random error term.

The expected return of a security is calculated using the following equation:

$$E(R_i) = \alpha_i + \beta_i E(R_M)$$

The total risk of a security (variance of returns) is composed of systematic risk and unsystematic risk. This is shown in the equation:

$$\sigma_i^2 = \beta_i^2 \sigma_M^2 + \sigma_{ei}^2$$

Where σ_i^2 is the total variance of security i, $\beta_i^2 \sigma_M^2$ is the systematic risk component, and σ_{ei}^2 is the unsystematic risk component (residual variance).

Data and Sample Selection

The optimization process using the Single Index Model follows these steps:

First step, for each stock, calculate the alpha (α_i) using the equation $E(R_i) - \beta_i E(R_M)$ and the residual variance (σ_{ei}^2) using the equation $\sigma_i^2 - \beta_i^2 \sigma_M^2$. Second step, calculate the Excess Return to Beta (ERB) for each stock. The ERB measure determines which stocks offer excess returns relative to their systematic risk. It is calculated using the equation $ERB_i = \frac{E(R_i) - R_f}{\beta_i}$, where R_f is the risk-free rate. Third step, arrange the stocks in descending order of their ERB values. Fourth step, for each stock, calculate the values A_i, B_i, and C_i using the equations $A_i = \frac{[E(R_i) - R_f]\beta_i}{\sigma_{ei}^2}$, $B_i = \frac{\beta_i^2}{\sigma_{ei}^2}$, and $C_i = \frac{\sigma_M^2 \sum_{j=1}^{i} A_j}{1 + \sigma_M^2 \sum_{j=1}^{i} B_j}$. The cut-off point (C*) is the highest value of Ci among all calculated values. Fifth, include all stocks with ERB > C* in the optimal portfolio.

For each selected stock, calculate the proportion of funds to be invested (W_i) using the equations $Z_i = \frac{\beta_i}{\sigma_{ei}^2}(ERB_i - C*)$ and $W_i = \frac{Z_i}{\sum Z_j}$. Finally, calculate the portfolio's expected return and risk. The expected return of the portfolio is calculated using the equation $E(R_p) = \sum_{i=1}^{n} W_i E(R_i)$. The portfolio beta is calculated using the equation $\beta_p = \sum_{i=1}^{n} W_i \beta_i$. The portfolio variance is calculated using the equation $\sigma_p^2 = \beta_p^2 \sigma_M^2 + \sum_{i=1}^{n} W_i^2 \sigma_{ei}^2$. The portfolio standard deviation (risk) is the square root of the portfolio variance.

The performance of the optimal portfolio is evaluated using the Sharpe ratio, which measures the excess return per unit of total risk. The Sharpe ratio is calculated using the equation $Sharpe\ Ratio = \frac{E(R_p) - R_f}{\sigma_p}$. This ratio provides insight into the risk-adjusted performance of the portfolio, allowing for comparison with the market or other investment strategies.

RESULT AND DISCUSSION

As shown in Figure 2, of the 45 stocks analyzed, 22 stocks had positive ERB values, indicating that they offered returns exceeding the risk-free rate relative to their systematic risk. ADMR had an exceptionally high ERB (1021.10%), significantly outperforming all other stocks. This exceptional ERB value is due to ADMR's high annual return (107.11%) combined with its low beta (0.100), indicating strong performance with minimal market sensitivity. Other stocks with notably high ERB values include AMMN (202.56%), ITMG (97.21%), and MEDC (74.31%).

The cut-off point (C*) was calculated at 0.43%, represented by the red horizontal line in Figure 2. Stocks with ERB values above this threshold qualified for inclusion in the optimal portfolio. The significant gap between the highest ERB values and the cut-off point suggests that these stocks offer substantial excess returns relative to their systematic risk.

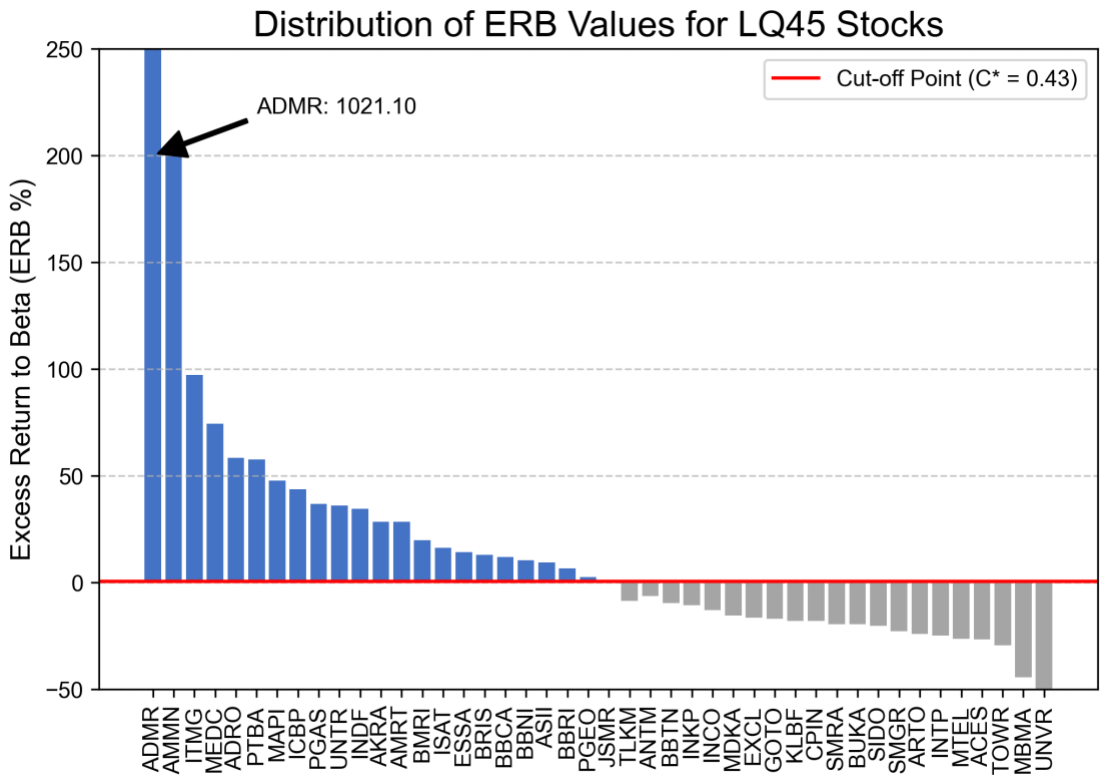

Figure 2. Distribution of ERB values for all 45 LQ45 stocks. Source: Author's calculations based on IDX data (2024)

The analysis of all 45 stocks yielded a cut-off point (C) of 0.430, which was the highest Ci value calculated. This value serves as the threshold for stock selection: stocks with ERB values greater than C are included in the optimal portfolio.

Table 1. Optimal Portfolio Composition

Stock	ERB (%)	ERB-C* (%)	Zi	Wi (%)	Sector
ADRO	58.38	57.95	65.623	75.37	Mining
ITMG	97.21	96.78	6.913	7.94	Mining
PGAS	36.68	36.25	3.784	4.34	Energy
ADMR	1021.10	1020.67	2.415	2.77	Mining
MAPI	47.66	47.23	2.258	2.59	Retail
AMMN	202.56	202.13	1.933	2.22	Mining
ICBP	43.55	43.12	1.850	2.13	Consumer
PTBA	57.71	57.28	1.781	2.04	Mining
MEDC	74.31	73.88	1.589	1.83	Energy
UNTR	35.94	35.51	1.277	1.46	Industrial
			Total	100.00	

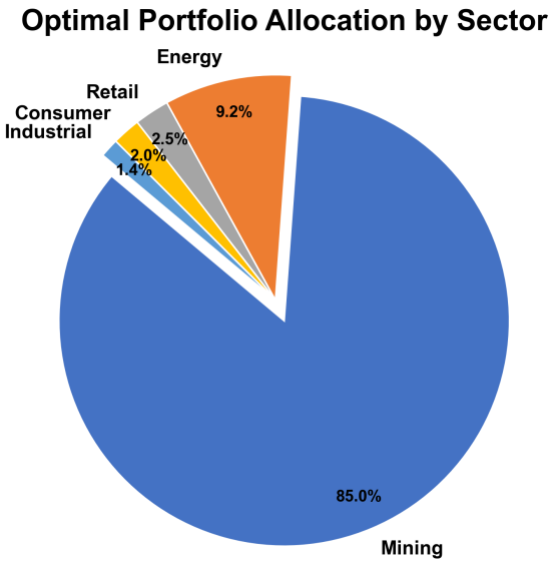

Figure 3. Sector allocation in the optimal portfolio. Source: Author's calculations (2024)

As shown in Figure 3 and Table 1, the optimal portfolio is heavily dominated by the mining sector, which accounts for 85.0% of the total allocation. The energy sector follows with 9.2%, while retail (2.5%), consumer (2.1%), and industrial (1.5%) sectors have minor representations. This sector concentration reflects the superior risk-return characteristics of mining stocks during the study period, particularly following Indonesia's implementation of mineral export restrictions that benefited domestic mining companies.

Interestingly, while ADMR had the highest ERB by a substantial margin, it received only 2.77% allocation in the optimal portfolio. This is due to its relatively high residual variance (0.04227), which reduces its attractiveness in the portfolio optimization process. Conversely, ADRO, with its lower ERB but extremely low residual variance (0.00094), secured the dominant position in the portfolio with a 75.37% allocation.

Table 2: Portfolio Return and Risk Calculation

Stock	Wi (%)	E(Ri) (%)	Beta	σei²	Wi×E(Ri)	Wi×Beta	Wi²×σei²
ADRO	75.37	67.41	1.069	0.0009	50.80	0.8057	0.000536
ITMG	7.94	64.01	0.607	0.0085	5.08	0.0482	0.000054
PGAS	4.34	23.49	0.504	0.0048	1.02	0.0219	0.000009
ADMR	2.77	107.11	0.100	0.0423	2.97	0.0028	0.000032
MAPI	2.59	27.64	0.475	0.0099	0.72	0.0123	0.000007
AMMN	2.22	69.01	0.316	0.0331	1.53	0.0070	0.000016
ICBP	2.13	13.84	0.203	0.0047	0.29	0.0043	0.000002
PTBA	2.04	52.73	0.827	0.0027	1.08	0.0169	0.000001
MEDC	1.83	44.46	0.531	0.0247	0.81	0.0097	0.000008
UNTR	1.46	36.84	0.886	0.0025	0.54	0.0129	0.000001
				Total	64.84	0.9417	0.000666

The optimal portfolio generated an expected annual return [E(Rp)] of 64.84%, with a portfolio beta (βp) of 0.9417 (Table 2). The portfolio risk (σp) was calculated as 9.76%. This value was derived using the following equation:

$$\sigma_p^2 = \beta_p^2 \sigma_M^2 + \sum_{i=1}^{n} W_i^2 \sigma_{ei}^2 = (0.9417)^2 \times 0.00975 + 0.000666 = 0.00953$$

$$\sigma_p = \sqrt{0.00953} = 9.76\%$$

The Sharpe ratio, calculated as [E(Rp) - Rf] / σp = (64.84 - 5.00) / 9.76 = 6.13, indicates exceptional risk-adjusted performance. This high ratio suggests that the portfolio offers substantial excess returns relative to its risk.

As shown in Figure 4, the optimal portfolio (blue star) achieves a superior risk-return profile compared to individual stocks and the market index. It plots well above the Capital Market Line (CML), indicating that it offers higher returns per unit of risk than what would be achieved by combining the risk-free asset with the market portfolio. The efficient frontier (curved blue line) represents the set of portfolios that offer the highest expected return for a given level of risk. The optimal portfolio sits on this frontier, confirming its efficiency.

Individual stocks exhibit varying risk-return characteristics, with ADMR showing the highest return but also high risk, while ADRO and ITMG offer a better balance between return and risk. The market index (yellow square) delivers a lower expected return (12%) with moderate risk, highlighting the potential benefits of active portfolio management using the Single Index Model.

The dominance of the mining sector in the optimal portfolio (85.0% allocation) reflects its superior risk-return profile during the 2021-2024 period. This finding aligns with Indonesia's economic focus on resource optimization and value addition in the mining sector, as outlined in the country's downstream industry development policy (Ministry of Energy and Mineral Resources, 2023).

The strong performance of mining stocks, particularly ADRO and ITMG, can be attributed to several factors. First, global commodity prices experienced significant appreciation during the post-pandemic recovery period (World Bank, 2023). Second, Indonesia's ban on raw mineral exports, as highlighted in Figure 1 as a key market event, encouraged domestic processing, benefiting integrated mining companies

(PWC Indonesia, 2023). Third, the global energy transition increased demand for certain minerals, such as nickel and copper, which are abundant in Indonesia (IEA, 2022).

The energy sector, represented by PGAS and MEDC, secured a combined allocation of 6.17%. This modest but significant presence reflects the sector's strategic importance in Indonesia's economic landscape and its relatively stable performance amid global energy market volatility.

The consumer, retail, and industrial sectors received smaller allocations, suggesting that while these sectors offer diversification benefits, their risk-return profiles were less attractive compared to the mining and energy sectors during the study period.

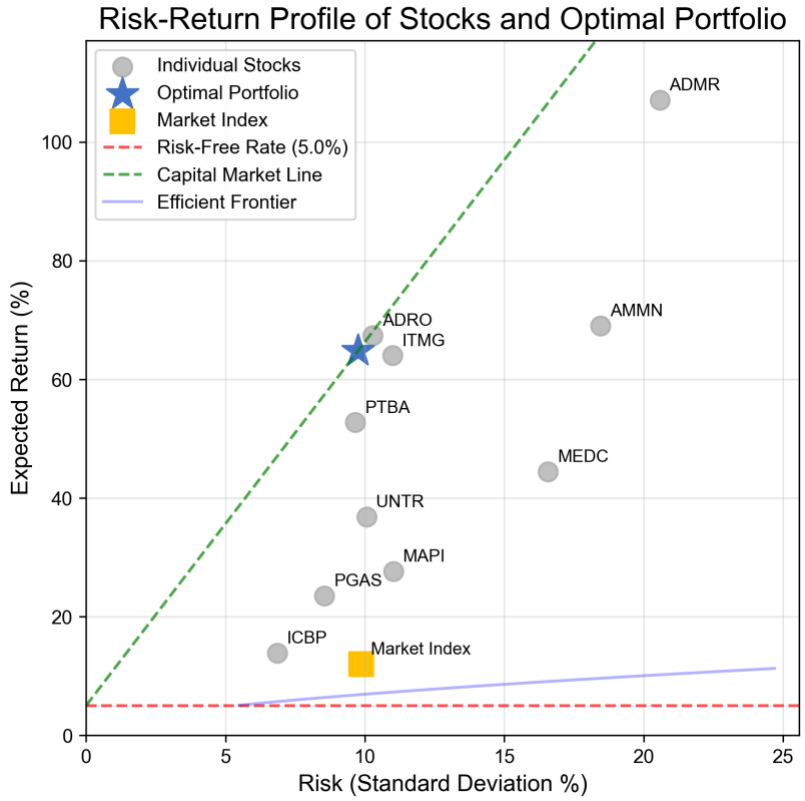

Figure 4. Risk-return profile of optimal portfolio compared to individual stocks and market index. Source: Author's illustration based on research findings (2024)

The optimal portfolio demonstrates an impressive expected return of 64.84% with a moderate risk level of 9.76%. This translates to a Sharpe ratio of 6.13, indicating exceptional risk-adjusted performance. For context, the Jakarta Composite Index (JCI) historically delivers Sharpe ratios between 0.3 and 1.5 (IDX Annual Report, 2023).

The portfolio's beta of 0.9417 suggests that it is slightly less volatile than the market, while still capturing substantial returns. This favorable risk-return profile is particularly relevant for Indonesian investors, who often face limited access to global markets and rely heavily on domestic investment opportunities.

The concentration of the portfolio in the mining sector, particularly the 75.37% allocation to ADRO, raises concerns about diversification. While this concentration maximizes expected returns based on

historical data, it also introduces sector-specific risks. Investors implementing this portfolio might consider adjusting the weights to improve diversification, even if this results in a theoretically sub-optimal portfolio from a pure mathematical perspective.

Our findings both align with and differ from previous research on the Indonesian market. Similar to Setiawan and Dewi (2021), we found that the basic materials sector (which includes mining) plays a significant role in forming optimal portfolios. However, while they identified BBCA (a financial sector stock) as a major component, our study found minimal representation from the financial sector.

The preponderance of mining stocks in our optimal portfolio contrasts with Wibowo's (2014) findings, where the financial sector dominated the portfolio allocation. This shift reflects the changing economic landscape in Indonesia, particularly the government's focus on developing downstream industries in the mining sector.

Firdaus (2020) noted that portfolios formed using the SIM tend to have higher returns but also higher risks. Our findings partially support this observation, as our portfolio offers a high expected return (64.84%). However, our portfolio's risk level (9.76%) is relatively moderate, suggesting that the post-pandemic market conditions may have altered the risk-return dynamics of LQ45 stocks.

CONCLUSION

This study implemented the Single Index Model to determine the optimal portfolio composition using stocks from the LQ45 index on the Indonesia Stock Exchange for the 2021-2024 period. The analysis produced an optimal portfolio comprising 10 stocks, with ADRO (75.37%), ITMG (7.94%), and PGAS (4.34%) receiving the highest allocations. The portfolio was predominantly weighted toward the mining sector, showing its superior risk-return ratio during the research period. The optimal portfolio demonstrated exceptional performance metrics, with an expected annual return of 64.84%, a risk level of 9.76%, and a Sharpe ratio of 6.13. These results highlight the potential for achieving substantial returns through systematic portfolio optimization in the Indonesian market, especially the LQ45 index.

The dominance of mining sector in the optimal portfolio reflects Indonesia's economic focus on resource optimization and value addition in the mining sector, as well as favorable global commodity market conditions during the post-pandemic recovery period. This finding underscores the importance of considering macroeconomic trends and government policies when constructing investment portfolios in emerging markets.

IMPLICATION/LIMITATION AND SUGGESTIONS

The analysis relies on historical data for the 2021-2024 period, which includes the post-pandemic recovery phase and was significantly influenced by specific events like the Russia-Ukraine conflict and Indonesia's commodity export ban, as shown in Figure 1. Future market conditions may differ significantly. The study focuses solely on stocks from the LQ45 index, excluding potential investment opportunities in smaller-cap stocks or other asset classes. Transaction costs, taxes, and liquidity constraints were not incorporated into the optimization model, which could affect the practical implementation of the portfolio. Despite these limitations, this research provides valuable insights into portfolio optimization strategies for the Indonesian stock market and contributes to the growing literature on investment decision-making in emerging markets.

We propose several recommendations for future research. Extend the analysis to compare the performance of SIM-based portfolios with other optimization techniques, such as the Treynor-Black Model or Black-Litterman Model. Investigate the impact of different market regimes (bull vs. bear markets) on the stability of optimal portfolios in the Indonesian context.

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