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OPTIMAL PORTFOLIO ANALYSIS OF THE PRIMBANK10 INDEX USING THE MARKOWITZ EFFICIENT FRONTIER

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***Abstract**. This study aims to analyze the construction of an optimal portfolio for the PRIMBANK10 index using the Efficient Frontier approach based on Markowitz's portfolio theory. The research employs a quantitative method utilizing secondary data in the form of monthly closing prices of stocks included in the PRIMBANK10 index. The data are processed by calculating returns, risk, and covariance, which are then optimized using the Solver feature in Microsoft Excel to determine efficient asset allocation. The results indicate that the Markowitz model is capable of generating an optimal portfolio that provides the best trade-off between expected return and risk in accordance with investor preferences. These findings confirm the relevance of modern portfolio theory in investment decision-making within the Indonesian capital market, particularly in the banking sector. Nevertheless, the application of this model is subject to limitations due to its reliance on assumptions of market stability and return distribution. Future research is recommended to explore alternative models that are more adaptive to actual market risk conditions.*

Abstrak: Penelitian ini bertujuan menganalisis pembentukan portofolio optimal pada indeks PRIMBANK10 menggunakan pendekatan Efficient Frontier dari teori portofolio Markowitz. Metode yang digunakan adalah analisis kuantitatif berbasis data sekunder berupa harga penutupan bulanan saham-saham yang tergabung dalam indeks PRIMBANK10. Data dianalisis melalui proses perhitungan tingkat pengembalian, risiko, dan kovarians, kemudian dioptimalkan menggunakan fitur Solver pada Microsoft Excel untuk memperoleh kombinasi portofolio yang efisien. Hasil penelitian menunjukkan bahwa pendekatan Markowitz mampu menghasilkan portofolio optimal yang memberikan keseimbangan terbaik antara risiko dan tingkat pengembalian sesuai preferensi investor. Temuan ini mengonfirmasi relevansi teori portofolio modern dalam pengambilan keputusan investasi di pasar modal Indonesia, khususnya pada sektor perbankan. Namun demikian, penerapan model ini masih memiliki keterbatasan karena bergantung pada asumsi stabilitas pasar dan distribusi return. Oleh karena itu, penelitian selanjutnya disarankan untuk mengembangkan pendekatan alternatif yang lebih adaptif terhadap dinamika risiko aktual.

INTRODUCTION

Equity investment has become an increasingly prominent instrument for Indonesian investors aiming to enhance long-term wealth accumulation and financial sustainability. This trend is evidenced by the sustained growth in public engagement within the domestic capital market, as indicated by the rising number of firms listed on the Indonesia Stock Exchange (IDX), which has significantly widened access to equity ownership for both individual and institutional participants (Bangun et al., 2012; Meliala & Sukarno, 2023). Such developments not only reflect a gradual shift toward a more participatory and inclusive economic structure, but also emphasize the necessity of investment strategies grounded in rigorous quantitative analysis to effectively control risk exposure and improve return optimization (Hartono, 2015; Supandi, 2016)

Within the investment decision-making process, the formulation of an optimal stock portfolio constitutes a central pillar of sound financial management. Through appropriate diversification, investors are able to reduce idiosyncratic risk while maintaining exposure to systematic market risk, thereby enhancing portfolio resilience during periods of market uncertainty (Dewi, 2021; Markowitz, 1952). Among the most influential frameworks in modern portfolio theory is the Efficient Frontier model introduced by Markowitz, which is founded on the mean–variance optimization principle. This framework assumes that rational investors seek to maximize expected returns for a given level of risk or, alternatively, minimize risk for a specified expected return. Consequently, the efficient frontier delineates a set of portfolios that are optimal in terms of the risk–return trade-off and cannot be dominated by other feasible investment combinations (Hartono, 2015; Supandi, 2016)

Empirical evidence further supports the applicability of the Markowitz model within the Indonesian equity market. Previous studies demonstrate that variations in asset allocation weights generate substantially different risk and return outcomes, underscoring the importance of optimal weighting schemes in portfolio construction (Supriyadi, 2010). Comparative analyses also reveal that, although the Markowitz approach requires more complex computations than alternative models such as the Single Index Model, it offers a more comprehensive representation of inter-asset relationships by explicitly incorporating covariance structures among securities (Bangun et al., 2012). Consistent findings have been reported across multiple Indonesian stock indices, including IDX30 and other sector-based indices, confirming the robustness of the Markowitz framework in identifying efficient portfolios under diverse market conditions (Dewi, 2021; Oktavianus Yusan & Riyadi, 2024; Tamam Zaidan Rizqullah et al., 2024).

This study concentrates on the PRIMBANK10 index, which comprises major banking and financial sector stocks in Indonesia. Given the critical role of the banking industry in supporting macroeconomic stability and facilitating economic growth, determining an optimal portfolio composition within this index is particularly relevant for both investors and policymakers (Astri Budiarti & Oktofa Yudha Sudrajad, 2024; Meliala & Sukarno, 2023). By employing the Markowitz Efficient Frontier approach, this research builds upon prior empirical evidence regarding portfolio efficiency in the Indonesian capital market (Oktavianus Yusan & Riyadi, 2024; Tamam Zaidan Rizqullah et al., 2024). Accordingly, the explicit objective of this study is to identify and analyze the most efficient stock portfolio within the PRIMBANK10 index by determining the optimal asset allocation that maximizes expected returns at predetermined levels of risk, thereby providing a robust quantitative basis for effective portfolio management in Indonesia's banking sector.

METHOD

This study adopts a quantitative descriptive research design with an analytical approach to systematically examine portfolio optimization in the banking sector. The data utilized in this analysis consist of secondary data obtained from reputable and publicly accessible sources, namely the Indonesia Stock Exchange and the financial information platform www.investing.com. To ensure data consistency and relevance, a screening process was conducted to identify stocks that continuously remained constituents of the PRIMBANK10 Index throughout the observation period from October 2023 to November 2025. Based on this screening procedure, seven stocks were found to satisfy the selection criteria, namely BBCA, BBNI, BBRI, BDMN, BMRI, BRIS, and PNBN. For each of these stocks, monthly historical closing price data were collected over a 26-month observation period, providing the empirical basis for subsequent return and risk calculations.

The construction of the optimal stock portfolio was performed through a series of structured and sequential steps based on the Markowitz Efficient Frontier model. This process involved estimating expected returns, variances, and covariances among the selected assets, which together form the foundation of modern portfolio theory. To facilitate the optimization process, the Solver feature in Microsoft Excel was employed.

This optimization tool enables the determination of optimal investment weights by maximizing or minimizing a specified objective function subject to predefined constraints, thereby allowing investors to obtain the most efficient allocation in line with the principles of risk diversification. Several mathematical formulations underpin the portfolio analysis within the Markowitz Efficient Frontier framework, and the key equations applied in this study are presented as follows:

Return refers to the percentage change in the closing price of stock i included as a sample in this study over a given observation period. It represents the gain or loss experienced by investors as a result of changes in stock prices and serves as a fundamental measure of investment performance. In this analysis, stock returns are calculated based on historical closing prices and are used as the primary input for estimating expected returns, portfolio performance, and risk characteristics within the Markowitz Efficient Frontier framework (Hartono, 2015)

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \tag{1}$$

Where:

R_{it} = return of stock i

P_{it} = closing price of stock i in period t

R_{it-1} = closing price of stock i in period t-1

Expected return refers to the anticipated percentage return of stock i, which is estimated as the average of its historical returns over the observation period included in this study. This measure reflects the expected level of profitability that an investor may obtain from holding the stock under normal market conditions. In the context of this analysis, the expected return serves as a key input in portfolio optimization, as it is used to evaluate individual asset performance and to determine the expected return of the overall (Hartono, 2015):

$$E(R_i) = \frac{\sum_{i=1}^{n} R_{it}}{n} \tag{2}$$

Where:

$E(R_i)$ = expected return of stock i

R_{it} = return of stock i

n = number of observations used in the calculation

Risk refers to the degree of variability or fluctuation of actual returns around the expected return. It reflects the uncertainty faced by investors regarding the realization of anticipated returns. In this study, risk is measured using the standard deviation of returns, which quantifies the dispersion of individual stock returns over the observation period. A higher standard deviation indicates greater volatility and, consequently, a higher level of risk associated with the stock, whereas a lower standard deviation suggests more stable returns (Hartono, 2015):

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}[R_{it} - E(R_i)]^2}{n-1}} \quad (3)$$

Where:

σ = risk (standart deviation) of stock i

R_{it} = return of stock i in period t

$E(R_i)$ = expected return of stock i

n = number of observations used in the calculation

Correlation, or the correlation coefficient between two stocks, represents the degree and direction of the relationship between the return of stock A and the return of stock B over a specified period. This measure indicates how closely the returns of the two stocks move together, whether in the same direction, in opposite directions, or independently. In portfolio analysis, correlation plays a crucial role in assessing diversification benefits, as lower or negative correlation between assets can reduce overall portfolio risk without necessarily lowering expected returns (Hartono, 2015):

$$r_{(AB)} = \frac{\sigma(AB)}{\sigma(A) - \sigma(B)} \quad (4)$$

Where:

$r_{(AB)}$ = correlation coefficient between stock A and stock B

$\sigma(AB)$ = covariance between stock A and stock B

$\sigma(A)$ = standart deviation of stock A

$\sigma(B)$ = standart deviation of stock B

Covariance measures the extent to which the returns of two stocks move together over time, indicating whether they tend to increase or decrease in the same direction. A positive covariance suggests that the returns of the two stocks generally move in tandem, while a negative covariance implies that they move in opposite directions. In the context of portfolio analysis, covariance is a key component in evaluating the interaction between assets, as it directly influences the overall risk of a portfolio (Hartono, 2015):

$$\sigma_{RA,RB} = \frac{\sum_{i=1}^{n}[(R_{Ai} - E(R_A).(R_{Bi} - E(R_B)]}{n-1} \quad (5)$$

Where:

$\sigma_{RA,RB}$ = covariance between the return of stock A and the return of stock B

R_{Ai} = return of stock A in period i

R_{Bi} = return of stock B in period i

$E(R_A)$ = expected return of stock A

$E(R_B)$ = expected return of stock B

n = number of observations used in the calculation

The Markowitz portfolio optimization approach is applied to identify optimal asset allocation proportions by explicitly modeling the trade-off between expected return and risk, which represents the fundamental concept underlying modern portfolio theory (Elton & Gruber, 1997; Markowitz, 1952). In this framework, portfolio expected return is derived as the weighted mean of the expected returns of the individual assets, thereby capturing the relative contribution of each asset to the portfolio's overall performance (Bodie et al., 2018). Portfolio risk is quantified using the variance of portfolio returns, a comprehensive measure that accounts for both the standalone risk of each asset and the covariance components that reflect the degree of co-movement among asset returns (Sharpe, 1964). The explicit inclusion of covariance terms allows the Markowitz model to more effectively capture diversification effects and potential risk mitigation benefits compared to analyses that focus on individual assets in isolation (Hartono, 2015). The mathematical expressions employed in this study to compute portfolio expected return and portfolio variance are derived from well-established foundations in modern portfolio theory and are adopted from Khaddafi et al., thereby maintaining methodological alignment with prior empirical studies on portfolio optimization in emerging market contexts.

Return Portfolio:

$$R_p = \sum_{i=1}^{n} w_i E(R_i) \quad (6)$$

Variance (risk) Portfolio:

$$\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{ij} \quad (7)$$

Where:

w_i = proportion of funds allocated to stock i

$E(R_i)$ = expected return of stock i

σ_{ij} = covariance between stock i and stock j

According to Khaddafi et al., the combination of asset weights is systematically analyzed to identify the optimal portfolio located along the efficient frontier, which represents the set of portfolios that provide the highest attainable expected return for each corresponding level of risk. Through this analysis, portfolios that are inefficient or dominated by others are excluded, ensuring that the selected portfolio reflects the most favorable trade-off between return and risk within the given investment universe.

The steps undertaken in this study are as follows:

1. Collecting the required data.
2. Calculating the expected return and risk of each stock.
3. Constructing the correlation matrix and the variance-covariance of the stocks.
4. Determining the portfolio's expected return and risk.
5. Developing the Markowitz efficient frontier curve.
6. Identifying and assigning the optimal portfolio investment weights

RESULTS AND DISCUSSION

Calculating the expected return and risk of each stock

Table 1 Expected Return and Risk of the Candidate Portfolio Stocks

No	Stock	Expected Return	Risk
1	BBCA	-0.029%	4.933%
2	BBNI	-0.016%	7.883%
3	BBRI	-0.449%	9.885%
4	BDMN	-0.231%	3.518%
5	BMRI	-0.340%	8.500%
6	BRIS	2.534%	11.332%
7	PNBN	0.452%	11.920%

Source: Processed data, 2025

After calculating the expected return and risk of each candidate stock included in the portfolio, as summarized in the table above, it can be observed that BRIS demonstrates the highest expected return, amounting to 2.534%, accompanied by a risk level of 11.332%. This indicates that BRIS offers relatively higher potential returns, albeit with a higher degree of volatility. In contrast, BBRI records the lowest expected return at –0.449%, with a corresponding risk of 9.885%, suggesting that despite its moderate level of risk, the stock underperformed during the observation period.

Correlation Coefficient Matrix

From the Table 2, a total of 28 correlation coefficients are identified among the candidate stocks included in the portfolio. These values indicate varying degrees of relationships between stock returns, including the presence of several negative correlations. A negative correlation implies that the returns of the paired stocks tend to move in opposite directions, thereby offering potential diversification benefits. Conversely, a positive correlation indicates that the stock returns generally move in the same direction, which may reduce diversification effectiveness when the assets are combined within a portfolio.

Table 2 Correlation Coefficient Matrix

	BBCA	BBNI	BBRI	BDMN	BMRI	BRIS	PNBN
BBCA	1						
BBNI	0.685491	1					
BBRI	0.623532	0.812815	1				
BDMN	0.236465	0.522235	0.411205	1			
BMRI	0.717406	0.881445	0.84718	0.329648	1		
BRIS	0.544441	0.564444	0.341506	0.37915	0.48524	1	
PNBN	0.131198	0.196275	0.36412	-0.05487	0.37244	-0.01321	1

Source: Processed data, 2025

Stock Covariance Matrix

Table 3 Covariance Matrix of the Candidate Portfolio Stocks

	BBCA	BBNI	BBRI	BDMN	BMRI	BRIS	PNBN
BBCA	0.002434						
BBNI	0.002666	0.006214					
BBRI	0.003041	0.006334	0.009771				
BDMN	0.000281	0.000992	0.00098	0.000581			
BMRI	0.003008	0.005906	0.007117	0.000675	0.007224		
BRIS	0.003044	0.005042	0.00383	0.001035	0.004677	0.012814	
PNBN	0.000772	0.001844	0.004291	-0.00016	0.003774	-0.00018	0.014207

Source: Processed data, 2025

Based on the covariance data presented in the table above, it can be observed that several pairs of stocks exhibit negative covariance values, indicating that their returns tend to move in opposite directions over the observation period. The highest covariance value is recorded for PNBN at 0.014207, suggesting a relatively stronger co-movement with other assets. In contrast, the lowest covariance value is identified between BRIS and PNBN at –0.00018, reflecting a weak inverse relationship between the returns of these two stocks, which may contribute to risk reduction when combined within a portfolio.

Portfolio Expected Return and Risk

In this study, 50 portfolio points are generated within the range bounded by the minimum and maximum expected returns of the selected assets. Each portfolio point reflects a unique configuration of asset weights, resulting in a specific combination of expected return and associated risk. The systematic construction of these portfolios allows for an extensive evaluation of feasible investment alternatives and facilitates a detailed examination of the inherent trade-offs between return and risk across the investment universe (Best & Grauer, 1991; Fabozzi et al., 2002).

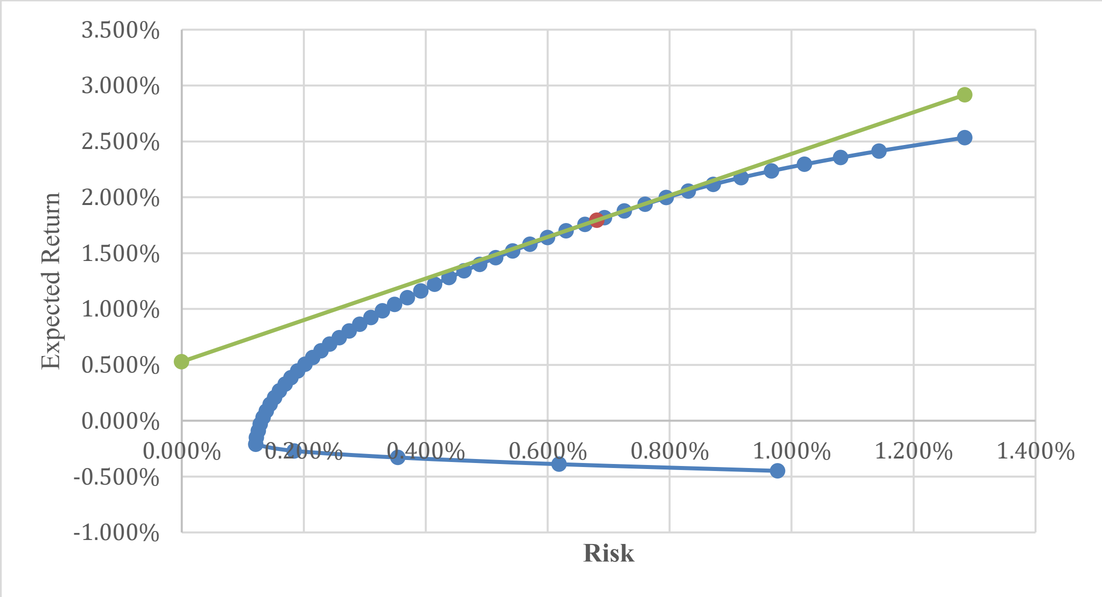
Table 4 Portfolio Expected Return and Risk

Portofolio	**Risiko**	***Expected Return***	**Portofolio**	**Risiko**	***Expected Return***
1	0.977%	-0.449%	26	0.349%	1.042%
2	0.619%	-0.389%	27	0.370%	1.102%
3	0.354%	-0.330%	28	0.392%	1.162%
4	0.184%	-0.270%	29	0.415%	1.221%
5	0.122%	-0.210%	30	0.439%	1.281%
6	0.123%	-0.151%	31	0.463%	1.341%
7	0.125%	-0.091%	32	0.489%	1.400%
8	0.129%	-0.031%	33	0.515%	1.460%
9	0.134%	0.028%	34	0.543%	1.520%
10	0.139%	0.088%	35	0.571%	1.579%
11	0.145%	0.148%	36	0.600%	1.639%
12	0.152%	0.207%	37	0.630%	1.698%
13	0.160%	0.267%	38	0.661%	1.758%
14	0.170%	0.327%	39	0.693%	1.818%
15	0.179%	0.386%	40	0.726%	1.877%
16	0.190%	0.446%	41	0.760%	1.937%
17	0.202%	0.506%	42	0.795%	1.997%
18	0.215%	0.565%	43	0.831%	2.056%
19	0.228%	0.625%	44	0.872%	2.116%
20	0.243%	0.684%	45	0.917%	2.176%
21	0.258%	0.744%	46	0.967%	2.235%
22	0.275%	0.804%	47	1.022%	2.295%
23	0.292%	0.863%	48	1.080%	2.355%
24	0.310%	0.923%	49	1.144%	2.414%
25	0.329%	0.983%	50	1.284%	2.534%

Source: Processed data, 2025

These portfolio points are subsequently employed to form the Markowitz efficient frontier, which visually represents the set of portfolios that achieve the highest expected return for each corresponding level of risk, or alternatively, the lowest level of risk for a given expected return. The efficient frontier functions as a central analytical tool in portfolio optimization, enabling the identification of portfolios that dominate others in terms of efficiency. By analyzing the structure and curvature of the efficient frontier, investors and researchers can better understand the diversification benefits and risk–return characteristics of the market, thereby establishing a rational basis for optimal portfolio selection aligned with investor risk preferences (DeMiguel et al., 2009; Michaud, 1989).

Construction of the Efficient Frontier Curve



Source: Processed data, 2025

Figure 1 Efficient Frontier Curve

As depicted by the efficient frontier shown above, a set of 50 portfolio solutions is generated and visualized, with the detailed results summarized in Table 4. Each solution corresponds to a distinct combination of asset weights that achieves the maximum attainable expected return for a specific level of portfolio risk within the predetermined investment universe. Drawing on the framework proposed by Bayumashudi and Agul (2006), the optimal portfolio is identified as the portfolio that yields the steepest Capital Allocation Line (CAL), representing the most favorable balance between excess return and overall risk once a risk-free asset is incorporated into the analysis.

Conceptually, the slope of the CAL is derived from the ratio between the portfolio's excess return and its total risk, calculated as the difference between the expected portfolio return and the risk-free rate divided by portfolio risk. In this research, a risk-free rate of 0.53% is employed, producing a CAL slope of 186.025%. Such a magnitude indicates that the selected portfolio delivers a relatively high excess return for each unit of risk undertaken, thereby underscoring its superiority from a risk–return efficiency standpoint. The graphical representation of the efficient frontier further highlights the tangency point between the CAL and the frontier, which corresponds to the portfolio with the maximum Sharpe ratio and, consequently, the most efficient allocation.

Once this tangency portfolio is established, the analysis proceeds to the determination of the exact asset allocation proportions that form the optimal portfolio. This stage is implemented through the use of the Solver add-in in Microsoft Excel, which facilitates the optimization of the objective function under a set of predefined constraints. By applying this optimization procedure, the theoretical insights obtained from the efficient frontier are translated into concrete investment weights, enabling the formulation of a portfolio strategy that is both analytically sound and practically applicable.

Optimal Portfolio Investment Weight Allocation

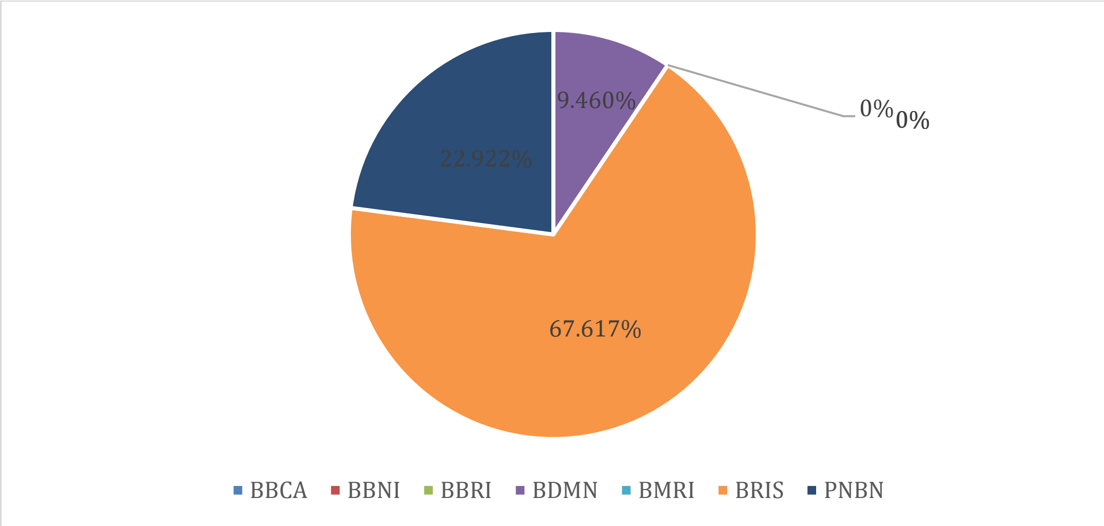
Table 5 Optimal Portfolio Investment Weight Allocation

Kode Saham	Bobot	*Expected Return*	Risiko
BBCA	0.000%	1.795%	0.681%
BBNI	0.000%		
BBRI	0.000%		
BDMN	9.460%		
BMRI	0.000%		
BRIS	67.617%		
PNBN	22.922%		

Source: Processed data, 2025

The information presented in the table allows for a comprehensive interpretation of the investment weight allocation in the optimal portfolio. From the seven stocks initially analyzed as potential portfolio members, only three securities are ultimately assigned positive weights. Specifically, BDMN contributes 9.460% of the total portfolio, BRIS dominates the allocation with 67.617%, and PNBN accounts for the remaining 22.922%. In contrast, the other stocks receive zero allocations, indicating that, within the applied optimization constraints, their inclusion fails to enhance the portfolio's overall performance. This outcome suggests that these assets either exhibit less favorable return-to-risk characteristics or do not offer sufficient diversification advantages when combined with the selected securities.

The resulting portfolio produces an expected return of 1.795%, while the associated portfolio risk is estimated at 0.681%. These results indicate that the constructed portfolio achieves an optimal balance between return and risk and occupies a position along the efficient frontier. Consequently, the optimal allocation demonstrates the effectiveness of the Markowitz portfolio optimization approach in determining asset combinations that efficiently manage risk while maximizing expected returns, thereby providing a sound quantitative basis for rational investment decision-making.



Source: Processed data, 2025

Figure 2 Pie Chart of Optimal Portfolio Investment Weight Allocation

After the optimal investment weights have been obtained, investors may apply the proposed allocation scheme in practice by distributing funds according to these proportions, while simultaneously considering their own risk preferences, investment goals, and financial limitations. In real-world applications, the optimal weights generated by the model function primarily as a quantitative benchmark rather than an absolute rule. Consequently, investors often need to make adjustments to accommodate personal considerations such as liquidity requirements, regulatory constraints, or specific portfolio objectives. Therefore, the optimal portfolio should be regarded as a strategic guideline that informs decision-making, rather than a fixed and inflexible allocation.

Nevertheless, as highlighted by Assof et al., the application of the Markowitz Efficient Frontier approach in constructing an optimal stock portfolio is accompanied by several methodological constraints. One of the principal limitations lies in the assumption of a single investment period, which does not adequately reflect the dynamic and multi-period characteristics of actual financial markets, where risk and return parameters change over time. Moreover, the model assesses the risk–return relationship based exclusively on linear correlations, thereby overlooking potential nonlinear interactions and extreme risk events that commonly emerge during periods of financial turbulence. In addition, transaction costs, taxation, and other market frictions are not explicitly incorporated into the framework, despite their significant impact on realized portfolio performance and the practicality of portfolio rebalancing. These considerations imply that although the Markowitz model remains a cornerstone of modern portfolio theory, its outcomes should be interpreted prudently and ideally supplemented with alternative analytical methods when employed in practical investment contexts.

CONCLUSION

Based on the analysis and discussion conducted, it can be concluded that the optimal portfolio for the PRIMBANK10 index during the period from October 2023 to November 2025—constructed using the Markowitz Efficient Frontier approach—results in a diversified investment allocation consisting of 9.460% in BDMN, 67.617% in BRIS, and 22.922% in PNBN. This allocation reflects the optimal trade-off between expected return and risk within the feasible investment set, as identified by the efficient frontier. Under this composition, the portfolio is expected to generate an average return of 1.795% with an estimated risk level of 0.681%, indicating a relatively favorable risk–return profile for investors seeking exposure to the banking sector represented by the PRIMBANK10 index.

Assuming a total investment value of IDR 100,000,000, the recommended allocation corresponds to an investment of IDR 9,460,355.00 in BDMN, IDR 67,617,149.43 in BRIS, and IDR 22,922,495.57 in PNBN. Based on these allocations, the estimated monetary return of the portfolio amounts to IDR 1,794,960.98, while the associated risk, expressed in nominal terms, is approximately IDR 680,891.70. These figures provide a concrete illustration of how the theoretical results of the Markowitz model can be translated into practical investment decisions, offering investors a clear benchmark for expected performance under the specified assumptions.

Nevertheless, it is important to recognize that actual market dynamics are shaped by a wide range of unpredictable external factors, including macroeconomic conditions, regulatory changes, and investor sentiment, which may not be fully captured by the Markowitz framework. Moreover, the model's reliance on assumptions such as normally distributed returns, stable correlations, and rational investor behavior represents an inherent limitation when applied to real-world financial markets. Therefore, future research is encouraged to incorporate alternative portfolio optimization approaches—such as downside risk measures, robust optimization, or multifactor models—that are better suited to capturing complex risk structures, thereby producing results that are more resilient and applicable under varying market conditions.

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