Risk Analysis of Single Stocks and Portfolios in LQ45 Index

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Sections Info	ABSTRACT
Article history: Submitted: May 27, 2025 Final Revised: June 10, 2025 Accepted: June 22, 2025 Published: June 29, 2025 *Keywords:* Value at risk Variance-covariance Portfolio LQ45 Investment risk	*Objective:* This study aims to measure and compare the Value at Risk (VaR) between single stocks and a portfolio within the LQ45 index using the Variance-Covariance method. *Method:* Daily closing prices of three companies — PT Bank Rakyat Indonesia (BBRI), PT Bank Central Asia (BBCA), and PT Astra International (ASII) — from January to October 2024 were analyzed. The Kolmogorov-Smirnov test confirmed the normal distribution of returns, validating the use of the Variance-Covariance approach. Risk for individual stocks was calculated using standard deviation, while portfolio risk incorporated covariance between asset returns. *Results:* The results show VaR values of Rp3,057,807 (BBRI), Rp2,243,478 (BBCA), and Rp2,928,485 (ASII) for single stocks, while the combined portfolio had a lower VaR of Rp1,985,061. *Novelty:* These findings indicate that diversification effectively reduces investment risk. The study provides practical insights for investors aiming to manage potential losses through portfolio construction.

INTRODUCTION

Investment can be defined as the activity of investing capital, either directly or indirectly, with the expectation that the capital owner will eventually receive a profit from the investment [1]. Return is a fundamental term in the world of investment that refers to the profit or loss obtained from an investment over a certain period [2]. If the return on shares is positive, then investors will receive a profit because the share price will increase the following month. Conversely, if the stock return is negative, the investor incurs a loss. And the investor neither gains nor loses if the stock return is zero. Risk is the likelihood that certain unfavorable events will occur [3]. Stock risk can be measured by calculating the standard deviation. The profits obtained and the risks faced in an investment are two interrelated factors that must be thoroughly analyzed to ensure optimal investment decisions.

Value at Risk (VaR) is one of the methodologies used to measure the maximum potential loss in investment decisions [4]. VaR can be defined as an estimate of the maximum loss that will be incurred over a certain time period under normal market conditions at a specific confidence level [5]. VaR has become the industry standard for measuring market risk since it was first introduced by JP Morgan in 1994 [6]. This method provides a probabilistic estimate of the maximum potential loss that an investment portfolio may experience over a given period of time with a specified confidence level [7]. The application of the appropriate method and assumptions will result in an accurate VaR calculation that can be used as a measure of risk. VaR is usually calculated for a 1-day period with a confidence level of 95%. This means that with a confidence level of 95% over a 1-day period, there is a 5% chance that the company will experience losses greater

than the VaR value [8]. VaR calculations are usually presented in monetary terms rather than percentages, making VaR very easy to understand [9].

One way to calculate VaR is to use the variance-covariance method. Calculating VaR using the variance-covariance method assumes that exposure is linear and asset risk is normally distributed [10]. To minimize risk, investors can form portfolios. A portfolio is a combination or collection of assets, both real and financial, owned by an investor. The essence of portfolio formation is to reduce risk through diversification, which involves allocating funds to various investment alternatives that are negatively correlated [11]. Based on the portfolio risk concept introduced by Harry M. Markowitz, by assembling assets into a portfolio, the overall portfolio risk becomes smaller than the risk of the individual assets within the portfolio [12].

Therefore, the author conducted a risk analysis of individual assets and stock portfolios with the aim of providing an overview of the Value at Risk (VaR) measurement results using the Variance-Covariance method, which focuses only on stocks listed on the LQ45 index. The LQ45 index is a stock market index on the Indonesia Stock Exchange (IDX) consisting of 45 issuers with high liquidity, selected through several selection criteria. In addition to liquidity assessment, the selection of these issuers also considers market capitalization [13].

RESEARCH METHOD
General Background of Research

In financial risk management, especially within capital markets, quantifying potential investment losses is crucial. One of the most widely adopted quantitative tools for this purpose is Value at Rist (VaR), which estimates the maximum expected loss over a given period and confidence level. This research evaluates and compares the VaR of individual stocks and a diversified portfolio listed on the LQ45 index using the variance-covariance method. The method is chosen due to its analytical simplicity and its suitability under the assumption of normally distributed returns, which was verified through normality tests on historical return data. The ultimate goal is to determine whether diversification effectively reduces investment risk.

Type and Source of Data

This study utilizes secondary data in the form of daily closing stock prices of three companies listed on the LQ45 index:
1. PT Bank Rakyat Indonesia (Persero) Tbk (BBRI)
2. PT Bank Central Asia Tbk (BBCA)
3. PT Astra International Tbk (ASII)

The data was obtained from the website www.investing.com, covering the period from January 2, 2024, to October 31, 2024, with a total of 198 daily observations for each stock. A research authorization letter was issued by the Indonesian Stock Exchange Representative Office in Central Java 1, located in Semarang.

Research Procedures

1. Data Collection

    a. Selecting three stocks as the basis of the study based on data availability and completeness.

    b. Collecting daily stock closing prices during the defined period.

2. Data Processing Procedures

    a. Calculating daily returns for each stock using the formula:

$$R_i = \frac{P_t - P_{t-1}}{P_{t-1}}$$

Where:

R_i : Return of stock i

P_t : Closing price of stock i period t

P_{t-1} : Closing price of stock i period $t-1$

    b. Performing normality testing on the return data using the Kolmogorov-Smirnov test via SPSS software to ensure data follows a normal distribution. The Kolmogorov-Smirnov test can be conducted using the following steps [14]:

      1) Hypotheses:

        H_0: The return data is normally distributed

        H_1: The return data is not normally distributed

      2) Significance level:

        $\alpha = 5\% = 0.05$

      3) Rejection criteria:

        If $sig < \alpha$, then H_0 is rejected

        If $sig > \alpha$, then H_0 is accepted

    c. Computing expected return (mean return) for each stock using the formula:

$$E(R_i) = \frac{\Sigma R_i}{n}$$

Where:

$E(R_i)$: Expected return of stock i

n : Number of period

    d. Calculating the variance and standard deviation of stock returns to measure risk using the formula:

$$Var_i = \sum_{i=1}^{n} \frac{\left(R_i - E(R_i)\right)^2}{n-1}$$

$$\sigma_i = \sqrt{Var_i} = \sqrt{\sum_{i=1}^{n} \frac{\left(R_i - E(R_i)\right)^2}{n-1}}$$

    e. Computing covariance between pairs of stocks to assess co-movement in returns using the formula:

$$Cov_{(A,B)} = \sum_{t=1}^{n} [R_{At} - E(R_A)]\,[R_B - E(R_{Bt})]$$

Where:

$Cov_{(A,B)}$: Covariance between stocks A dan B

R_{At} : Return of stock A period t

R_{Bt} : Return of stock B period t

$E(R_A)$: Expected return of stock A

$E(R_B)$: Expected return of stock B

n : Total of the observation period

f. Determining portfolio risk by calculating the portfolio's standard deviation, based on the variances and covariances of the stocks, assuming equal weight allocation using the formula:

$$\sigma_p = \sqrt{Var_p} = \sqrt{\sum W_A^2 \sigma_A^2 + W_B^2 \sigma_B^2 + 2W_A W_B Cov_{(A,B)}}$$

Where:

σ_p : Standard deviation of the portfolio

Var_p : Variance of the portfolio

W_A : Proportion of stock A

W_B : Proportion of stock B

σ_A^2 : Variance of stock A

σ_B^2 : Variance of stock B

g. Calculating Value at Risk (VaR). The Variance-Covariance method assumes that portfolio returns are linear with respect to the returns of individual assets and that returns are normally distributed. This method uses a matrix containing correlation elements, asset weights, and volatility [15]. At a confidence level $(1 - \alpha)$ and over a period of t days, the formula for calculating Value at Risk (VaR) using the Variance-Covariance method for calculating single assets and portfolios is [16]:

a. For individual assets:

$$VaR_i = V_0 \times \sigma_i \times Z_{1-\alpha} \times \sqrt{t}$$

b. For portfolio:

$$VaR_p = V_0 \times \sigma_p \times Z_{1-\alpha} \times \sqrt{t}$$

Where:

V_0 : Initial investment funs

σ_i : Standard deviation of stock return i

σ_p : Standard deviation of portfolio

$Z_{1-\alpha}$: Limit value of standard normal distribution at significance level α

t : Time period

Data Analysis Techniques

Data analysis was carried out by comparing the calculated VaR of each individual stock with the VaR of the portfolio. This comparison aimed to assess whether portfolio diversification effectively reduces investment risk compared to holding a single stock. The interpretation focused on the magnitude of risk exposure associated with each

investment alternative and its implications for making rational and efficient investment decisions.

RESULTS AND DISCUSSION

The data used in this study is visualized in the graph below.
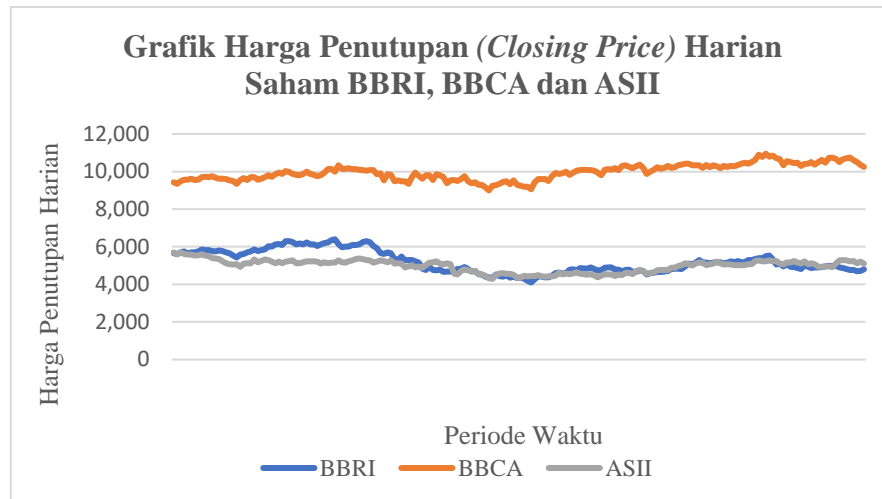
Figure 1. Daily closing price chart of BBRI, BBCA, and ASII stocks.

The daily closing price movements of BBRI, BBCA, and ASII stocks during the period from January 2, 2024, to October 31, 2024, are shown in Figure 4.1. The stock prices appear volatile, experiencing fluctuations over time. The daily closing price of BBRI ranged from IDR 4,100.00 to IDR 6,400.00, with an average of IDR 5,191.00. BBCA's daily closing price ranged from IDR 9,000.00 to IDR 10,950.00, with an average of IDR 9,965.00. ASII's daily closing price ranged from IDR 4,290.00 to IDR 5,700.00, with an average of IDR 4,981.00.

The stock returns of PT Bank Rakyat Indonesia (Persero) Tbk (BBRI), PT Bank Central Asia Tbk (BBCA), and PT Astra International Tbk (ASII) are presented in the following graph.
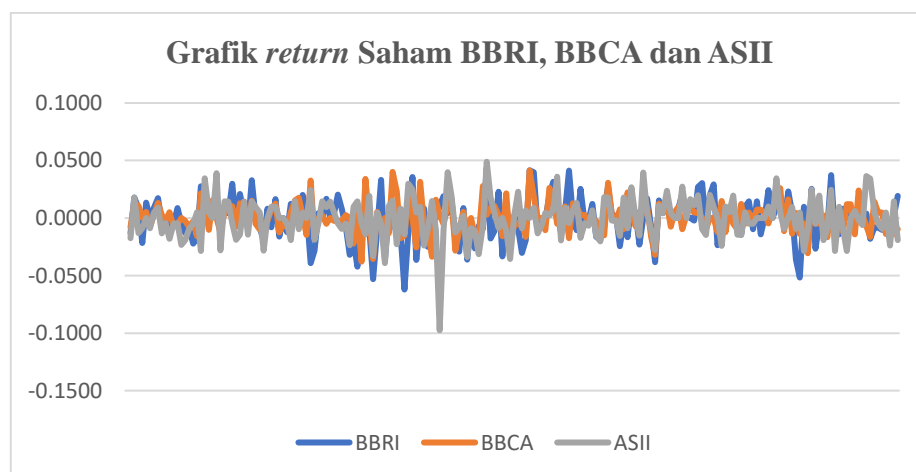
Figure 2. Return chart of BBRI, BBCA, and ASII stocks.

Figure 2 shows the daily return movements of BBRI, BBCA, and ASII stocks during the period from January 2, 2024, to October 31, 2024, which exhibit varying fluctuations

throughout this period. The daily stock returns for BBRI, BBCA, and ASII ranged from -0.0621 to 0.0438, -0.0379 to 0.0414, and -0.0975 to 0.0490, respectively, with average values of -0.0007, 0.0005, and -0.0004.

The average return, referred to as the Expected Return (ER), or the anticipated rate of return, is presented in the following table.

Table 1. Expected returns of BBRI, BBCA, and ASII stocks.

Nama Saham	$E(R_i)$
BBRI	-0,0007
BBCA	0,0006
ASII	-0,0004

Table 1 presents the Expected Return (ER) of three stocks: BBRI, BBCA, and ASII. A`mong the three stocks, only BBCA demonstrates a positive expected return, while BBRI and ASII show negative values, suggesting potential losses during the period.

Before calculating Value at Risk (VaR) using the Variance-Covariance method, it is necessary to ensure that the return data follows a normal distribution. This is tested using the Kolmogorov-Smirnov normality test. The Kolmogorov-Smirnov test was conducted using SPSS software on the return data.

Table 2. Kolmogorov-smirnov normality test for BBRI, BBCA, and ASII.

One-Sample Kolmogorov-Smirnov Test		BBRI
N		197
Normal Parameters[a,b]	Mean	-.000676
	Std. Deviation	.0185875
Most Extreme Differences	Absolute	.058
	Positive	.046
	Negative	-.058
Test Statistic		.058
Asymp. Sig. (2-tailed)		.200[c,d]
a. Test distribution is Normal.		
b. Calculated from data.		
c. Lilliefors Significance Correction.		
d. This is a lower bound of the true significance.		

One-Sample Kolmogorov-Smirnov Test		BBCA
N		197
Normal Parameters[a,b]	Mean	.000518
	Std. Deviation	.0136390
Most Extreme Differences	Absolute	.053
	Positive	.053
	Negative	-.046
Test Statistic		.053
Asymp. Sig. (2-tailed)		.200[c,d]
a. Test distribution is Normal.		
b. Calculated from data.		
c. Lilliefors Significance Correction.		
d. This is a lower bound of the true significance.		

One-Sample Kolmogorov-Smirnov Test		ASII
N		197
Normal Parameters[a,b]	Mean	-.000403
	Std. Deviation	.0178061
Most Extreme Differences	Absolute	.055
	Positive	.052
	Negative	-.055
Test Statistic		.055
Asymp. Sig. (2-tailed)		.200[c,d]
a. Test distribution is Normal.		
b. Calculated from data.		
c. Lilliefors Significance Correction.		
d. This is a lower bound of the true significance.		

Stock risk is measured by calculating the standard deviation. Standard deviation can be obtained as the square root of the variance. The variance and standard deviation of the stock returns of PT Bank Rakyat Indonesia (Persero) Tbk (BBRI), PT Bank Central Asia Tbk (BBCA), and PT Astra International Tbk (ASII) are presented as follows:

Table 3. Variance and standard deviation of stock returns.

Nama Saham	Variansi	Standar Deviasi
BBRI	0,0003	0,0186
BBCA	0,0002	0,0136
ASII	0,0003	0,0178

Table 3 shows that BBRI has the highest volatility among the three stocks, indicated by its standard deviation of 0.0186. BBCA has the lowest risk, as it has the smallest variance and standard deviation values. This suggests that BBCA is relatively more stable with lower volatility. Although ASII has the same variance as BBRI, which is 0.0003, its standard deviation of 0.0178 is slightly lower than BBRI's. This indicates that ASII carries slightly less risk than BBRI but still more than BBCA. The order of stock risk from lowest to highest is: BBCA, ASII, BBRI.

Before calculating portfolio risk, the covariance between each pair of stocks must first be determined. Covariance indicates the extent to which two stocks tend to move together in terms of returns. The covariance values between each pair of stocks are presented in the following table:

Table 4. Covariance between pairs of stocks.

Saham A	Saham B	Cov(a,b)
BBRI	BBCA	0,0000992
BBRI	ASII	0,0001003
BBCA	ASII	0,0000449

The table shows that all covariance values are positive, indicating that the stocks tend to move in the same direction. When the price of one stock rises, the others are also likely to rise, and vice versa. This suggests a similar movement pattern over the observed period.

Tables 3 and 4 show the variance of each individual stock and the covariance between each pair of stocks, respectively. In this portfolio, the three stocks are assigned equal weights of 33% each. The calculated portfolio variance and standard deviation are presented in the following table:

Table 5. Portfolio variance and standard deviation.

Variansi Portofolio (Var_p)	Standar Deviasi Portofolio (σ_p)
0,000145644	0,012068316

Table 5 shows that the portfolio variance is 0.000145644, a relatively low value indicating lower volatility compared to the individual stock variances. The portfolio's standard deviation of 0.012068316 is also smaller than the standard deviations of the individual stocks. This suggests that the portfolio carries less risk than holding any single stock alone.

The Value at Risk (VaR) was calculated at a 95% confidence level using the Variance-Covariance method. By using Microsoft Excel, the Z-score for $Z_{1-\alpha} = 1,64$ was obtained. Assuming an initial investment of Rp100,000,000 and a one-day holding period, and using the standard deviation values from Table 3 for each individual stock and from Table 5 for portfolio, the VaR values are presented below.

Table 6. Value at Risk (VaR) of single assets and portfolio.

Saham	Nilai VaR
BBRI	Rp3.057.807,00
BBCA	Rp2.243.478,00
ASII	Rp2.928.485,00
Portofolio	Rp1.985.061,00

Based on Table 6, the portfolio VaR is IDR 1,985,061.00. Meanwhile, the single-asset VaRs are IDR 3,057,807.00 for BBRI, IDR 2,243,478.00 for BBCA, and IDR 2,928,485.00 for ASII. This shows that the daily loss risk at a 95% confidence level is lower for the portfolio investment than for individual stocks.

CONCLUSION

Fundamental Finding : This study finds that portfolio diversification significantly reduces investment risk compared to individual assets. Using the Value at Risk (VaR) approach with the Variance-Covariance method, it was found that the potential loss of a diversified portfolio (Rp1,985,061) is lower than the losses from investing in single stocks such as BBRI, BBCA, and ASII, which had higher individual VaR values. **Implication :** The result emphasizes the practical benefit of diversification in investment strategy. Investors are encouraged to construct portfolios rather than rely on single stocks to minimize risk exposure and ensure more stable returns, especially during uncertain market conditions. **Limitation :** This research is limited by the assumption of normal distribution inherent in the Variance-Covariance method. Additionally, the analysis only includes three stocks within a specific time period, which may not reflect broader market behavior or conditions. **Future Research :** Further research is recommended to apply alternative VaR methods such as Historical Simulation or Monte Carlo Simulation to compare accuracy and robustness. Future studies should also consider larger, more varied portfolios and longer observation periods to improve generalizability.

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