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Value at Risk (VaR) Analysis using Historical and Monte Carlo Methods in Stock Prices of Bank CIMB Niaga, BSI, BJB, Bank Mega, and Bank Bukopin

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Abstract

In daily life and business, risk is unavoidable. Therefore, various ways can be applied to predict and overcome risks. One type of risk that needs to be anticipated especially in the business world is investment risk. Thus, Value at Risk (VaR) is an important tool to predict and anticipate investment risk. This study aims to determine the results of the Value at Risk (VaR) value in the bank sub-sector stock price using the historical simulation method and Monte Carlo simulation for the period 2020-2023. The data used is secondary data sourced from www.yahoo.finance.com which are companies whose stocks are listed on the Indonesia Stock Exchange (IDX) and included in the Indonesia Stock Exchange (IDX). Sampling was carried out by taking 5 bank companies, namely Bank Umum Koperasi Indonesia (BBKB), Bank Pembangunan Daerah Jawa Barat dan Banten (BJBR), Bank MEGA (MEGA), Bank Syariah Indonesia (BRIS), dan Bank CIMB Niaga (BNGA). From the results of the Value at Risk (VaR) value analysis using the historical simulation method and the Monte Carlo simulation method, it is obtained that the company that has the highest VaR risk level is Bank Syariah Indonesia (BRIS).

Keywords: Value at Risk (VaR), Historical Simulation Method, Monte Carlo Method, Return.

1. Introduction

Humans can always find ways to meet their needs, one of which is by doing economic activities (Jackson, 1999) This economic activity aims to earn money that can be used to meet daily needs. One of the economic activities that can be done is investment (Diener, 2004).

Investment is the activity of allocating financial or other resources to acquire an asset in the present with the aim of gaining profits in the future (Damodaran, 2012). These assets may consist of financial assets such as stocks, deposits, bonds, and other securities, or real assets such as buildings, machinery, land, and other physical objects that have economic value (Kaganova, 2014). In investing, an owner of capital or investor needs a platform to develop his capital, and one of the platform is the capital market (Estrin, 2018).

The capital market is an activity that involves the open contribution and exchange of securities, public organizations that issue securities, and the formation and calls related to securities (Jhamb, 2014). This capital market is a place to invest that connects investors with companies and institutions that sell stocks, bonds and so on.

In investing in stocks in the capital market, it surely can cause profits or losses that must be endured by investors. These gains and losses are called investment risk. With this, risk management is an important aspect of financial analysis related to investment, including the determination of risky assets to be purchased by investors. Investors need

to understand the factors that influence the rise and fall of stock prices, given that stocks are fluctuating. In general, there are external and internal factors that affect stock price movements (In'airat, 2018).

Value at risk (VaR) is a measurement tool used to estimate the risk that may occur in an invested stock. This concept is simple and can be applied with various statistical methods. Value at risk is an estimate of the maximum loss that may occur under normal conditions, within a certain period of time and level of confidence (Stambaugh, 1996).

2. Literature Review

2.1. Return

Return is the result or payoff obtained by an investor after taking the risk of investing in a company's assets. A positive return can be interpreted as the result of an investment that is profitable. Meanwhile, a negative return means that the investment results in a loss. The calculation of the stock return value can be calculated using the following formula:

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

2.2. Risk

Risk is the uncertainty that can affect an investor, either negatively or positively. Risks that must be managed are those that have a negative impact because they can interfere with the achievement of goals or objectives, both in the long and short term. If risk is defined as the extent to which the results obtained can deviate from the desired results, then a measure of dispersion is used to measure the risk.

2.3. Value at Risk

Value at risk is a measure used to evaluate the potential loss that an investor or company may experience on its investment in securities or assets, either individually or in a portfolio, over a certain period of time and with a predetermined level of probability. In value at risk, the probability of loss is calculated based on the chance that the loss will be greater than a predetermined percentage.

3. Materials and Methods

3.1. Materials

In this research, value at risk (VaR) analysis is carried out using historical simulation and Monte Carlo simulation methods in the stock prices of bank companies with the sub-sectors of Bank Umum Koperasi Indonesia (BBKB), Bank Pembangunan Daerah Jawa Barat dan Banten (BJBR), Bank MEGA (MEGA), Bank Syariah Indonesia (BRIS), dan Bank CIMB Niaga (BNGA). The data used is closing stock of banks from January 1, 2020 to December 31, 2023 taken from www.finance.yahoo.com.

In the analysis, several calculations were carried out using Microsoft Excel software, including calculating the return and average return, standard deviation, percentile, and value at risk. The VaR value shows the maximum loss rate experienced by investors when investing in a bank.

3.2. Methods

According to Mostafa et al. (2017) in (Astuti and Gunarsih 2021), the three most commonly used methods for measuring Value at Risk (VaR) are the historical simulation method, the Monte Carlo simulation method, and the variance-covariance method. In this study, only two of these methods are used.

1. Historical Simulation Method

It is a non-parametric approach that is based solely on historical market data and does not rely on any particular statistical distribution of ideas. It is the simplest and most user-friendly approach to defining variables as only

historical data is used directly. This approach assumes that the distribution of past drawdowns is a good and perfect reference for expected future returns (Butler, 1997).

2. Monte Carlo Simulation Method

This method uses a semi-parametric approach to calculate variables. This method is almost the same as historical simulation, but the difference is that the data collection algorithm uses a random number generator to create stock price hypotheses instead of just historical data. In addition, these hypothesis changes are used to estimate hypothesis returns or gains and losses from hypotheses, which are much more accurate because they are based on multiple measurements made on the same data set (Butler, 1997).

3.2.1. Structure

This research article is divided into several main sections, namely Introduction, Literature Review, Materials and Methods, Results and Discussion, Conclusion, and References.

3.2.2 Formula

This research article is divided into several main sections, namely Introduction, Literature Review, Materials and Methods, Results and Discussion, Conclusion, and References.

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

Description:

R_t : Specific time closing price return
P_t : Today's closing price value
P_{t-1}: The closing price value at the time of the previous day -1
t : Time

Value at Risk calculation using Historical Simulation method:

$$VaR\ 1-\alpha = \mu(R) - R\alpha$$

Description:

$VaR\ 1-\alpha$: The possibility of the highest loss
$\mu(R)$: Average value of return
$R\alpha$: The highest loss α

Value at Risk calculation using Monte Carlo Simulation method

$$VaR = \mu - (Z \times \sigma)$$

Description:

VaR : Probability of the highest loss
μ : Average value of return
Z : Confidence level
σ : Standard deviation

4. Results and Discussion

This research was conducted on several stocks listed on the Indonesia Stock Exchange (IDX) in the 2020-2023 period, with the objects of the research being 5 stocks, namely BBKP, BJBR, MEGA, BRIS and BNGA. This study uses secondary data obtained through www.finance.yahoo.com and processed using historical and monte carlo methods. Return data is calculated because volatility is influenced by these characteristics and returns. Return data is continuous time series data so that to find out the daily return results can be calculated based on the price ratio, Statistical description of BBKP, BJBR, MEGA, BRIS and BNGA stocks can be seen in the following Table 1:

Table 1: Statistical Description of Return January 1, 2020 to December 31, 2023

	BBKP	**BJBR**	**MEGA**	**BRIS**	**BNGA**
$\mu(R)$	-0.000060453352	0.000194172213	0.000727139557	0.002532981776	0.000785468972
Standard Deviation	0.03928283932	0.02076038372	0.02814610151	0.04142099933	0.02049758211
Highest Return	0.3401012953	0.1368424978	0.2000001572	0.2499994304	0.183908046
Lowest Return	-0.1280000517	-0.1010100417	-0.1428569847	-0.1439999311	-0.07638888889
Number of Observation	973	973	973	973	973

Table 1 shows the average stock return value for each bank in the 2020-2023 period for bank Bukopin is -0.000060453352, bank BJB 0.000194172213, Bank Mega 0.000727139557, bank BSI is 0.002532981776, and bank CIMB Niaga is 0.000785468972. Meanwhile, the highest value of the highest return is at bank Bukopin, which is 0.3401012953, and for the lowest value of the lowest stock return, bank BSI is -0.1439999311. Furthermore, standard deviation is the square root of the variance of returns per day during the investment period (Buchdadi, 2008, p. 3), while the description of stock return observation data from 2020 to 2023 there are 973 data from 973 days for each bank.

4.1 Value at Risk Analysis using Historical Simulation Method

Calculation of value at risk (VaR) using the historical simulation method using the formula written in the method section. A confidence level of 95% is used, which means that the risk that an error will occur from the research results is 5%.

Table 2: Analysis Result of VaR Value of Historical Simulation Method

	BBKP	**BJBR**	**MEGA**	**BRIS**	**BNGA**
$\mu(R)$	-0.000060453352	0.000194172213	0.000727139557	0.002532981776	0.000785468972
Standard Deviation	0.03928283932	0.02076038372	0.02814610151	0.04142099933	0.02049758211
Confidence Level (α)	95%	95%	95%	95%	95%
Rα	-0.04708500821	-0.03012123739	-0.03511518435	-0.051175669	-0.0265607064
VaR	0.04702455486	0.0303154096	0.0358423239	0.05370865078	0.02734617537
VaR (%)	4.70%	3.03%	3.58%	5.37%	2.73%
Initial Funds (IDR)	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
VaR (IDR)	470,246	303,154	358,423	537,087	273,462

According to the results of table 2, it is assumed that investors make an investment of 10,000,00.00 IDR with a confidence level of 95%. This means that the risk value of Bank Bukopin stock is 0.04702455486 or 470,246 IDR. The risk value of Bank BJB stock is 0.0303154096 or 303,154 IDR. The risk value of Bank MEGA stock is equal to 0.0358423239 or 358,423 IDR. The risk value of Bank BSI stock is 0.05370865078 or 537,087 IDR. The risk value of Bank CIMB Niaga stock is 0.02734617537 or 273,462 IDR.

4.2 Value at Risk Analysis using Monte Carlo Simulation Method

In this method, the average value and standard deviation of returns from each company will be used to create simulations. The simulation will be made 500 times, and the average value and standard deviation of the return will be calculated again from the simulation. Then the value at risk will be obtained.

Table 3: Analysis Results of VaR Monte Carlo Simulation Method

	BBKP	BJBR	MEGA	BRIS	BNGA
$\mu(R)$	-0.000060453352	0.000194172213	0.000727139557	0.002532981776	0.000785468972
σ	0.03928283932	0.02076038372	0.02814610151	0.04142099933	0.02049758211
$\mu(R)$*	0.0025095114	-0.0009005351	-0.0000780065	0.0038726324	0.0004673841
σ*	0.0380272909	0.0198026867	0.0294219446	0.0413996013	0.0214886534
Confidence Level(α)	95%	95%	95%	95%	95%
Z_{95}	1.644853625	1.644853625	1.644853625	1.644853625	1.644853625
VaR	0.06003982	0.03347306	0.04847280	0.06422365	0.03487831
VaR (%)	6.00%	3.35%	4.85%	6.42%	3.49%
Initial Funds (IDR)	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
VaR (IDR)	600,398	334,731	484,728	642,237	348,783

$\mu(R)$* and σ* are the average value and standard deviation of returns after 500 simulations.

The results of table 3 show that if it is assumed that investors make an investment of 10,000,00.00 IDR with a confidence level of 95%. Thus the risk value of Bank Bukopin stock is 0.06003982 or 600,398 IDR. The risk value of Bank BJB stock is 0.03347306 or 334,731 IDR. The risk value of Bank MEGA stock is 0.04847280 or 484,728 IDR. The risk value of Bank BSI stock is 0.06422365 or 642,237 IDR. The risk value of Bank CIMB Niaga stock is 0.03487831 or 348,783 IDR.

4.3 Value at Risk Analysis Results

Table 4: VaR Analysis Results

Stock	**Historical Simulation VaR**	**Historical Simulated VaR (IDR)**	**VaR Simulation Monte Carlo**	**VaR Simulation Monte Carlo (IDR)**
Bank Umum Koperasi Indonesia (BBKB),	4.70%	470,246	6.00%	600,398
Bank Pembangunan Daerah Jawa Barat dan Banten (BJBR)	3.03%	303,154	3.35%	334,731
Bank MEGA (MEGA)	3.58%	358,423	4.85%	484,728
Bank Syariah Indonesia (BRIS),	5.37%	537,087	6.42%	642,237
Bank CIMB Niaga (BNGA).	2.73%	273,462	3.49%	348,783

Table 4 shows that the stock with the highest risk is Bank Syariah Indonesia or BRIS. From the results of the analysis using the Monte Carlo simulation method, a much larger loss is obtained because it uses a much larger sample than the historical simulation method.

5. Conclussion

After analyzing value at risk using the historical simulation method and the Monte Carlo simulation method previously described, the following conclusions can be drawn:

a. The results of Value at Risk with the Historical simulation method using a confidence level of 95% and an initial fund assumption of 10,000,00.00 IDR show that Bank CIMB Niaga stock has the lowest risk value compared to other bank stock, which is 273,462 IDR. The next VaR results are Bank Bukopin, which is 470,246 IDR, Bank BJB, which is 303,154 IDR, and Bank MEGA, which is 358,423 IDR. Bank BSI stock have the highest risk value, which is 537,087 IDR.

b. The results of Value at Risk with the Monte Carlo simulation method using a confidence level of 95% and an initial fund assumption of 10,000,00.00 IDR show that Bank BJB stock has the lowest risk compared to stock in other banks, namely 334,731 IDR. After that there is Bank CIMB Niaga with results of 348,783 IDR, Bank MEGA of 303,154 IDR, and Bank Bukopin of 484,728 IDR. Bank BSI stock has the greatest risk value of 642,237 IDR.

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