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ESTIMATION OF VALUE AT RISK IN ISLAMIC STOCKS USING MONTE CARLO SIMULATION IN JAKARTA ISLAMIC INDEX (JII) PERIOD 2017-2020

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Abstract:

The purpose of this study is to determine the *Value at Risk* (VaR) in the Islamic stock's portfolio with the *Monte Carlo* simulation in the Jakarta Islamic Index during 2017 – 2020. The data analysis technique employed in this study was descriptive statistical analysis, in which the analysis carried out to describe or provide information and overview of the object to be studied using a population and sample without making general conclusions. In this study, the data used in the mining sector were ADRO, ANTM, INCO and PTBA.

From the results of the study, it is revelaed that the calculation of the average *VaR* value obtained are Rp. 1,182,813 at 95% confidence level in a period of one day. It can be interpreted that if an investor invests initial funds in a portfolio consisting of ADRO, ANTM, INCO and PTBA stocks with a fund of Rp. 10,000,000, the maximum loss that will be experienced by the investor in the next period (1 day after the period) with a confidence level of 95 % will not exceed Rp.1.182.813 or it can be said that there is a 5% possibility that investment losses in the portfolio consisting of ADRO, ANTM, INCO and PTBA stocks will exceed Rp.1.182.813.

Keywords:

1. INTRODUCTION

In today's digital era, it is very easy for people to invest. This convenience is the main attraction for people who want to invest only with a smartphone and the internet. Investment itself is an activity, either directly or indirectly, where the party who wants to invest (company or individual) invests their capital within a certain period of time in the hope of getting a profit from the investment.

One investment that is quite widely used today is non-real investment, namely in the financial sector such as the capital market. According to the Capital Market Law of the Republic of Indonesia No. 8 of 1995, the capital market is defined as activity related to public offerings and securities trading, public companies related to the securities they issue, as well as professional institutions related to securities.[1]

The capital market instrument that is in great demand by investors is stocks. According to Husnan (2005) a stock is a piece of paper that shows the rights of investors, which is the right of the owner of the paper to obtain a share of the prospects or wealth of the organization that issued the stocks and various conditions that allow the investors to work on their rights.[2]

In investing, investors will experience two things, they are profits and losses. This risk of loss is the main problem for investors who are still unsure about which stocks to trade. In overcoming this problem, it can be done by measuring the risk of loss using the *Value at Risk* (VaR) method. *Value at Risk* is one of the most popular risk measurements. *Value at Risk* is a statistical method used to measure the level of financial risk in a company, portfolio, or position over a certain period of time.[3] In calculating *Value at Risk,* there are three commonly used methods, the *Variance-Covariance* method, the *Monte Carlo* simulation method, and the *Historical* simulation method .

Of the three methods, the researchers chose to use the *Monte Carlo* method because *Monte Carlo* has advantages that other VaR calculation methods do not have, including: (1) providing more accurate calculation results. (2) can be used on all types of distribution assumptions (normal distribution and others) and can be used for the distribution of *fat*

[1] Undang-undang tentang Pasar Modal, UU no 8 tahun 1995, Lembaran Negara no. 64 tahun 1995, Tambahan Lembaran Negara no. 3608

[2] Suad Husnan. Dasar-dasar Teori Portofolio dan Analisis Sekuritas. Yogyakarta (2005) :UPP STIM YKPN. Hlm 303

[3] Will Kenton, *What is Value at Risk (VaR*), Investopedia, 2019, URL : www.investopedia.com, di akses pada 12 Januari 2021.

tails (leptokurtic). In estimating the VaR value, the *Monte Carlo* simulation method performs a simulation by generating random numbers based on characteristics of the data to be generated, which is then used to estimate the VaR value.

This study analyzed data on stocks listed in the Jakarta Islamic Index (JII) because the stocks have been selected and have the highest capitalization value.

Figure 1.1
Graph of the Development of *Jakarta Islamic Index for the* Year 2017-2020

Source: www.indopremier.com

Based on Figure 1.1 above, it is known that the graph of the development of the *Jakarta Islamic Index* in 2017 to 2020 has fluctuated. There was a significant decline in share price values in March 2020. Then it experienced the highest increase in January 2018.

This study is focused on examining four mining sector stocks in the *Jakarta Islamic Index* (JII) which are consistent during 2017 to 2020, namely PT Adaro Energy Tbk (ADRO), PT Aneka Tambang Tbk. (ANTM), PT Vale Indonesia Tbk. (INCO), and PT Tambang Batu Bara Bukit Asam (Persero) Tbk. (PTBA). This is because the mining sector has a fairly large income capitalization value due to its abundant natural resources so that it has a higher level of profit which makes the mining sector much in demand by investors. The higher the level of profit obtained by the investor, the higher the risk of loss that will be obtained by the investor. This makes the mining sector more suitable for this study.

Based on the explanation of the background above, the formulation of the problem to be studied is how to measure *Value at Risk* (VaR) in Islamic stocks with a *Monte Carlo* simulation? with the aim of the study is to determine the measurement of *Value at Risk* (VaR) in Islamic stocks with a *Monte Carlo* simulation.

2. LITERATURE REVIEW

Capital Market

The capital market has an important role for the economy of a country because the capital market performs two functions, firstly as a means for business funding or for companies to obtain funds from the investor community. Funds obtained from the capital market can be used for business development, expansion, additional working capital, and others. Secondly, the capital market is a means for the public to invest in financial instruments such as stocks, bonds, mutual funds, and so on. Thus, the public can place their funds according to the characteristics of the benefits and risks of each instrument.[4]

Instruments in the capital market are securities traded in the capital market. Each of these securities can provide different returns and risks. Capital market instruments include stocks, bonds and mutual funds.

Islamic Capital Market

In general, what is meant by Islamic capital market is all activities in the capital market that meet Islamic principles. Based on this definition, there are two main factors that shape the Islamic capital market, those are the capital market itself and Islamic principles in the capital market. Activities in the capital market include market participants, market infrastructure, market mechanisms and securities traded. Thus, a capital market is said to meet Islamic principles or is categorized as an Islamic capital market if the market participants, transaction mechanisms, market infrastructure and the securities being traded meet Islamic rules.

In the Financial Services Authority (OJK), the Islamic capital market or sharia principles in the capital market are defined as "*Islamic legal principles in sharia activities in the capital market based on the fatwa of the National Sharia Council-Indonesian Ulema Council (DSN-MUI), as long as the said fatwa does not conflict with the Financial Services*

[4] Zulfikar, *Pengantar Pasar Modal dengan Pendekatan Statistika*. Yogyakarta: Deepublish 2016. hlmn 3

Authority regulations regarding the application of Islamic principles in the capital market and/or other Financial Services Authority regulations based on the DSN-MUI fatwa ."

Shares

Shares are one of the most sought after capital market instruments for investors because they provide an attractive rate of return. According to the terms that exist in society, one of the definitions of shares says that "shares are securities which are instruments of proof of ownership or participation of individuals or institutions in a company".[5]

Meanwhile, according to Darmadji and Fakhruddin (2012) in the journal Liya Ariani (2017) "share (stock) is a sign of participation or ownership of a person or entity in a company or limited liability company". Shares are in the form of a sheet of paper that explains that the owner of the paper is the owner of the company that issued the securities because there is a greater the profit provided to shareholders and also the possibility of an increase in the amount of dividends received by shareholders.[6]

The definition of Islamic shares according to the Financial Services Authority (OJK) is securities as proof of capital participation in a company and with this proof of participation, shareholders are entitled to get a share of the results of the business company that does not conflict with sharia principles. Meanwhile, according to the National Sharia Council, Islamic shares are defined as proof of ownership of a company that meets Islamic criteria and does not include shares with special rights.[7]

The types of shares are divided into two, namely as follows:

a) Preferred Stock

These stocks have general characteristics that are different from common stocks. In preferred stock, dividends are paid in a fixed amount or value. In addition, preferred stock can be converted into a type of common stock. If the company goes into liquidation, preferred stockholders have prior claims compared to ordinary stocks. The most striking difference is that preferred stock is not traded on a stock exchange like common stock.

b) *Common Stock*

This type of stock is known as common stock. Investors who own this type of stock will get a share of the profits obtained by the company in the form of dividends. Dividend distribution by the company will be carried out if the company's financial performance is good enough and is able to pay other financial obligations.[8]

As a potential stock investor, there are definitely advantages to investing in stock instruments, namely:

a) Capital Gain

Investors who are able to choose good stocks in their investments are expected to receive income benefits in the form of capital gains. This profit is obtained from the differences in the selling price of the stocks which is higher than the purchase price of the stocks. If the stock price rises high enough, investors will be benefited according to the portion of the stocks they own.

b) Dividend

Smart stock investors will choose stocks from issuers that have good earnings performance. That way, they can expect a cash dividend distribution from the issuer. This means that stock investors will get additional income from capital gains.

In addition to the possibility of getting cash dividends, stock investors are also possible to benefit from the distribution of stock dividends.[9]

According to Jogiyanto (2010: 205) in the Journal of Ratna and Noer Rafkah (2018) *return* is the result obtained from investment. *Returns* can be in the form of realized *returns* that have occurred or expected *returns* that have not yet occurred but are expected to occur in the future. *Return* realization is very important because it is used as a measure of the company's performance and the basis for determining *return* expectations. *Return* expectation (*expected return*) is the *return* that is expected to be obtained by investors in the future.[10]

Investment is a commitment to a number of funds or other resources made at this time, with the aim of obtaining a number of benefits in the future. An investor buys a number of stocks today with the hope of profiting from an increase in stock prices or a number of dividends in the future, in return for the time and risk associated with the investment (Tandelilin, 2007: 3).[11]

Management is defined as a process that includes planning, organizing, directing and supervising a particular organization in order to achieve a goal within the organization. While risk is the result or consequence that will be experienced by someone where it occurs because of an ongoing process or future event. Basically risk management is

[5] Sapto Rahardjo, *Kiat Membangun Aset Kekayaan.* Jakarta: PT Elex Media Komputindo 2006. hlmn 31

[6] Liya Ariani dkk. Pasar Pengaruh EPS, CR, DER, dan PBV terhadap Harga *Saham* Dengan Kebijakan Dividen sebagai Variabel Intervening. Semarang: Universitas Pandanaran Semarang. 2017. hlmn 4

[7] Choirunnisak, *"Saham Syariah: Teori dan Implementasi",* Jurnal Ekonomi. Vol 4. No 2. Februari 2019. Hlmn 67.

[8] Sapto Rahardjo, *Kiat Membangun Aset Kekayaan.* Jakarta: PT Elex Media Komputindo 2006. hlmn 31

[9] *Ibid*. hlmn 32

[10] Ratna Handayani dkk. Pengaruh Earning Per Share (EPS), *Debt to Equity Ratio (DER), dan* Return on Assets (ROA) terhadap Return Saham pada Perusahaan Manufaktur yang Terdaftar di BEI. Universitas Islam Lamongan: 2018. Jurnal Penelitian Ilmu Manajemen. Vol 3 No. 1. Hlmn 616

[11] Nita Sofiana,Pengukuran *Value at Risk pada Portofolio dengan Simulasi Monte Carlo,*Universitas Negeri Yogyakarta:2017. Hlmn 2019

the application of management functions in overcoming risk, especially the risks faced by organizations or companies, families and communities. Thus, risk management includes the activities of planning, organizing, leading, coordinating, and supervising risk mitigation programs.[12]

Portfolio Theory

Portfolio theory states that risk and return both must be considered assuming a formal framework exists to measure them in the formation of a portfolio. In its basic form, portfolio theory begins with the assumption that future rates of return on securities can be estimated and then determines risk by varying the distribution of returns. With certain assumptions, portfolio theory produces a linear relationship between risk and return.

Portfolio theory is an investment approach initiated by Harry M. Makowitz (1927), an economist who graduated from the University of Chicago. Portfolio theory is concerned with investors' estimates of risk and *return* expectations, which are measured statistically to make their investment portfolios. *Markowitz* described ways to combine assets into an efficient diversified portfolio. In this portfolio, risk can be reduced by increasing the number of types of assets into the portfolio and the level of *expected return* can increase if the investment has different price movements of the combined assets.[13]

According to Husnan (2003:45) portfolio means a collection of investments. This stage involves identifying which securities will be selected and some proportion of funds to be invested in each of these securities. The selection of many securities (investors diversify) is intended to reduce the risk borne. The selection of these securities is influenced, among others, by risk preferences, patterns of cash needs, tax status, and so on. In reality we will find it difficult to form a portfolio consisting of a large number of stocks or market indexes. For example, the Jakarta Stock Exchange uses the Composite Stock Price Index (CSPI) or the LQ45 index [14]

Value at Risk (VaR)

Value at Risk is one of the most popular risk measurement methods. Value at Risk (VaR) is a market risk calculation method to determine the maximum risk of loss that occurs in a portfolio, either single-instrument or multi-instruments, at a certain confidence level, during a certain holding period, and under normal market conditions. According to Philip Best (1998) Value at Risk is a statistical risk measurement method that estimates the maximum possible loss of a portfolio at a certain level of confidence. In short, Value at Risk can be interpreted as a number that summarizes the total risk of a portfolio containing various financial assets. So, VaR can measure the maximum loss that may occur tomorrow, the day after tomorrow, next week, and so on according to the desired time period.[15]

The following statement is the definition of VaR quoted from Philip Best (1998) in the journal Astrid Juniar (2020): "Value at Risk is one method of measuring risk by calculating market risk in single and multi-instrument that determine the maximum level of confidence, for a certain period and normal market conditions.[16] In journal of Nashirah and Sofian (2019), Ilham (2010) Value at Risk approach was used to compute the volatility (risk) of returns and expected losses of Islamic bank financing in Indonesia and it was found that the equity and debt-based financing produce sustainable returns of bank financing. He also found that the performance of service-based financing is very sensitive to the economic conditions and that risk of investment and expected losses are well managed.[17]

The advantage of VaR is that this method focuses on downside risk, does not depend on the assumed distribution of returns, and this measurement can be applied to all traded financial products. Figures obtained from measurements with this method are the results of an aggregate or comprehensive calculation of the risks of products as a whole. VaR also provides an estimate of the probability of the occurrence of a loss that is greater than the predetermined loss figure. This is something that is not obtained from other risk measurement methods. VaR also pays attention to changes in the price of existing assets and their effects on other assets. This allows measurement of the reduced risk caused by product group or portfolio diversification.[18]

VaR has three methods for calculation, namely Historical Simulation Method, Variance-Covariance Method, and Monte Carlo Simulation Method.

1) The variance-covariance approximation or also called the delta normal method has advantages in terms of ease of computation and implementation. This model was introduced by JP. Morgan in the early 1990s. The assumptions used in the Variance-covariance model are:
    a. The portfolio is composed of linear assets. More precisely, changes in the value of a portfolio are linearly dependent on all changes that occur in the value of assets. So, portfolio returns are also linearly dependent on asset returns.

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[12] Reni Maralis dkk. Manajemen Risiko. Yogyakarta: Deepublish 2019. hlmn 8

[13] Adi Setiawan Marsis, Rahasia Terbesar Investasi.Second Hope:2013. Cetakan 1. Hlmn 41

[14] *Ibid,* Hlmn 42

[15] Lina Nur Hidayati, *Mengukur Risiko Perbankan dengan Value at Risk (VaR).* Jurnal Ilmu Manajemen: Yogyakarta 2006. hlmn 9

[16] Astrid Juniar dkk. *Value at Risk in the Formation of Optimal Portfolio on Sharia-Based Stocks*. International Journal of Recent Technology and Engineering (IJRTE). (Volume 8, Issue 5) 5 Januari 2020. Hlmn 1199.

[17] Nashirah Abu Bakar dan Sofian Rosbi, *Monte Carlo Simulation for Data Volatility Analysis of Stock Prices in Islamic Finance for Malaysia Composite Index.* International Journal of Advanced Engineering Research and Science (IJAERS): Malaysia. (Vol-6 Issue-3, Maret 2019) hlmn 7.

[18] *Ibid.* hlmn 11

b. Asset return is normally distributed

2) Historical Simulation Method is the simplest and most transparent method of calculation. Included in the calculation of the portfolio value. The weakness of this method is that it does not use a normal distribution of asset returns.
3) The Monte Carlo Simulation Method is also a relatively simple VaR measurement method compared to the Variance-Covariance method. The Monte Carlo Simulation Method has advantages in accuracy, but has a weakness in terms of computation which is more complicated than the historical simulation method.

VaR calculation results are usually presented in the form of an amount of money and not in the form of a percentage. This makes *VaR* very easy to understand well.[19]

Monte Carlo Simulation

The Monte Carlo simulation was introduced by Compte de Buffon in 1997. This simulation was firstly used in World War II which at that time was introduced by Stanislaw Ulam and John von Neumann at the Los Alamos Scientific Laboratory. At the time it was used to design nuclear armor. They need data about the distance that neutrons can penetrate in various materials. This problem is very difficult to solve analytically/ mathematically. Then they solve the problem using a computer, with the help of random numbers.

According to Kakiay (2004:1) in the thesis of Wiwik Muniroh (2008:13) simulation is a system that is used to solve or describe problems in real life that are uncertain in nature by not or using certain models or methods and more emphasis on using computers to get the solution. One method that has a lot of role in computer simulation is the Monte Carlo method. This method has the ability to form logic such as mathematical operations in a model, and can also follow a model and then develop its implementation in a computer. Thus the Monte Carlo simulation is a method that requires a simulation model that includes random numbers and computer-based samples.[20]

According to Rubinstein (1981) in Aulia Rizky (2016) Monte Carlo simulation is a method for analyzing uncertainty propagation where the aim is to determine how random variations or errors affect the sensitivity, performance, or reliability of the system being modeled. Monte Carlo simulation is classified as a sampling method because the input is generated randomly from a probability distribution for the sampling process from a real population. Therefore, a model must choose an input distribution that is closest to the data it has.[21]

The following statement is the definition of Monte Carlo quoted from Samik Raychaudhuri (2008): "Monte Carlo is type of simulation that relies on repeated random sampling and statictical analysis to compute the result. This method of simulation is very closely related to random experiments for which the specific result is not known in advance. In this context, Monte Carlo simulation can be considered as a methodical way of doing so called what-if analysis.[22]

JP Morgan in Aulia Rizky (2016) explains that the advantages of the Monte Carlo simulation compared to other VaR calculation methods are: 1) this simulation provides more accurate calculation results for all types of instruments. 2) can be used on all types of distribution assumptions (normal distribution, etc.) and can be used for types of fat tails distribution (leptokurtic). Meanwhile, the weakness in the Monte Carlo simulation lies in the computations because it requires quite a lot of risk factor simulation.[23]

Mean Variance Efficient Portofolio (MVEP)

Markowitz Efficient Portfolio is a portfolio that provides the highest return among existing portfolios with the same level of risk. Harry M. Markowitz (1952) proved that portfolio risk is influenced by covariance or correlation between portfolio-forming stocks. In addition, there is an investment strategy by allocating funds to various stocks with the aim of reducing risk without reducing returns, which is called diversification. Markowitz's diversification strategy is related to the level of covariance between the returns that make up the portfolio.[24]

The Markowitz efficient portfolio is also known as the Mean-Variance Efficient Portfolio (MVEP). MVEP is one method in the formation of an optimal portfolio. The optimal portfolio is the portfolio that an investor chooses from among the many choices available in an efficient portfolio pool. In MVEP, investors only invest in risky stocks. Risky stocks are stocks where the return to be received in the future is uncertain. MVEP creates a portfolio that has the minimum variance among all possible portfolios that can be formed. This is equivalent to optimizing the weights $w = [w_1 \ldots w_n]^T$ by minimizing the given variance.

3. RESEARCH METHODS

The type of research used in this study is a quantitative descriptive approach using secondary data. The secondary data used in this study is the monthly closing price of stocks, namely the stokcs of PT Adaro Energy Tbk (ADRO), PT Aneka Tambang Tbk. (ANTM), PT Vale Indonesia Tbk. (INCO), and PT Tambang Batu Bara Bukit Asam (Persero) Tbk. (PTBA) which are mining stocks that is included in the consistent list of the Jakarta Islamic Index (JII) during the 2017-2020 period. The data collection technique used was by recording or copying the monthly closing price data taken from

[19] *Ibid*. hlmn 12

[20] Wiwik Muniroh, *oim* UIN Malang: 2008. hlmn 13

[21] Aulia Rizky, *Simulasi Monte Carlo untuk Perhitungan Value at Risk pada Model Generalized Autoregressive Conditional Heteroscesdastic In Mean*. Universitas Islam Negeri Maulana Malik Ibrahim. Malang: 2016. hlmn 36

[22] Samik Raychaudhuri, *Introduction to Monte Carlo Simulation.* (University of Wisconsin: USA, 2008) hlmn 91

[23] *Ibid.* hlmn 36

[24] Elga Fitaloka dkk. Pengukuran Value at Risk pada Portofolio dengan Simulasi Monte Carlo. Buletin Ilmiah Math. Stat dan Terapannya: 2012. Vol. 7 No. 2. Hlmn 143.

the websites www.idx.co.id and www.yahoofinance.co.id . To analyze the data in this study, R software and Microsoft Excel were used.

The steps for calculating *VaR* using a *Monte Carlo* simulation are as follows:

1. Calculating portfolio *return* at time *t* using the following equation parameters:

$$R_p \sum_{i=1}^{n} (wiRi)$$

where *n* is the number of stocks in the portfolio, Ri is the *return* from stock *i*, and wi is the weight of stocks *i,* with $\sum_{i=1}^{n}(wi) = 1$.
2. Determining parameter values and correlations on portfolio *returns. The* stock returns that make up the portfolio are assumed to be normally distributed so that the parameters needed include the *mean* and standard deviation of the portfolio *returns.*
3. Simulating the *return* value of the portfolio by randomly generating the *return* of each stock which is normally distributed with the parameters obtained in step (2) as many as *k.*
4. Finding the estimated maximum loss at a confidence level (1 - *α*).
5. Calculating the value of *VaR* at the confidence level (1 - *α*) in the time period *t* day with the following equation$VaR_{(1-a)} = W_0 R^* \sqrt{t}$
6. M Repeat step (2) to step (5) *m* times.
7. Calculate the average of the results from step (6).

4. DISCUSSION

1. Determining the Value of Stock Return

Return of a stock is the rate of return or the results obtained from investing. Return is one of the factors that motivate investors to invest because it can clearly describe changes in price changes. The return from stock *i* is defined as follows:

$$R_i = \text{LN}(\frac{\text{P(Pt+1)}}{\text{Pt}}$$

where $P_{(t+1)}$ is the stock price at time (t + 1) and P_t is the stock price at time *t*. The results obtained from the return value of each stock during 2017 to 2020 is that the highest average stock return is owned by ANTM stocks with an average return of 0.018793 while the lowest average stock return is owned by ADRO stocks which is -0.0036172.

2. Normality test

Normal test needs to be known to find out whether the data is normally distributed or not. The normality test on stock returns used in this study is the *Kolmogorov-Smirnov test* using the *R* software to test the data distribution with the following hypothesis:

H_0 : stock *return* data is normally distributed

H_1 : stock *return* data is not normally distributed

Based on the results of the Normality Test obtained shows that ADRO stock returns obtained a *p-value of* 0.478, ANTM stocks obtained a *p-value* of 0.462, INCO stocks obtained a *p-value* of 0.812 and PTBA stocks obtained a *p-value* of 0.815. If the *p-value* > 0.05 then H_0 is accepted. It can be concluded that the stock *return* data for ADRO, ANTM, INCO and PTBA are normally distributed. These results indicate that this research data deserves to be analyzed further.

3. Calculating *Mean* and *Variance Covariance*

Gunthorpe and Livy (1994) assumed that investors use mean-variance analysis to make portfolio decisions and demonstrate that changes in the investment horizon can affect portfolio beta and portfolio composition.[25]

The results of the calculation of the *mean and variance* obtained with the help of *Microsoft Excel* are presented in table 1.

Table 1 Calculation of *Mean* and *Variance* on *Stock Return*

Stock Code	*Mean*	*Variance*
ADRO	-0,003617	0,012138
ANTM	0,018793	0,027281
INCO	0,016305	0,019038
PTBA	0,004077	0,012049

The results of the calculation of the covariance between stock returns are obtained with the help of Software *R* which is presented in Table 2.

Table 2 *Covariance* Between Stock *Returns*

Covariance	ADRO	ANTM	INCO	PTBA
ADRO	0,012138	0,005885	0,007726	0,00642
ANTM	0,005885	0,027281	0,015346	0,006809
INCO	0,007726	0,015346	0,019038	0,006709
PTBA	0,00642	0,006809	0,006709	0,012049

[25]Guntrphoe dan Haim Levy. *Portofolio Composition and The Investment Horizon.* Financial Analyst Journal 50(1): 51

4. Calculating the Correlation between Stock Returns

Based on the results of the correlation analysis between stock returns, it is found that there is no strong correlation between stock returns where the correlation is less than 0.75.

Table 3 Calculation Results of Correlation between Stock Returns

Correlation	ADRO	ANTM	INCO	PTBA
ADRO	1	0,323378	0,508247	0,530885
ANTM	0,323378	1	0,673358	0,375546
INCO	0,508247	0,673358	1	0,442946
PTBA	0,530885	0,375546	0,442946	1

5. Calculating Portfolio Weight with MVEP Method

The next step is to calculate the portfolio weight using the MVEP method. To calculate the weight of the portfolio using the MVEP method requires the inverse of the variance-covariance matrix of the returns of the stocks that make up the portfolio. The variance-covariance matrix is the result of the calculation of the *covariance* on the *returns* of the stocks that make up the portfolio and is calculated using *R software,* so it can be written in matrix notation as follows:

$$\sum = \begin{bmatrix} 0{,}012138 & 0{,}005885 & 0{,}007726 & 0{,}00642 \\ 0{,}005885 & 0{,}027281 & 0{,}015346 & 0{,}006809 \\ 0{,}007726 & 0{,}015346 & 0{,}019038 & 0{,}006709 \\ 0{,}00642 & 0{,}006809 & 0{,}006709 & 0{,}012049 \end{bmatrix}$$

where Σ is the *variance-covariance* matrix.
Furthermore, the *inverse* of the above equation is obtained as follows:

$$\sum_i^{-1} = \begin{bmatrix} 132{,}6545 & 7{,}919019 & -41{,}9663 & -51{,}7929 \\ 7{,}919019 & 68{,}45894 & -53{,}8397 & -12{,}9281 \\ -41{,}9663 & -53{,}8397 & 117{,}3845 & -12{,}5725 \\ -51{,}7929 & -12{,}9281 & -12{,}5725 & 124{,}8993 \end{bmatrix}$$

where Σ^{-1} is the *inverse of the variance-covariance matrix*.

After the inverse of the variance-covariance matrix is obtained, the weight of each stock in the portfolio will then be calculated by distributing the equation above into the equation $= W = \frac{\Sigma^{-1}1n}{1_n{}^T \Sigma^{-1}1n}$ as follows:

$$w = \frac{\begin{bmatrix} 132{,}6545 & 7{,}919019 & -41{,}9663 & -51{,}7929 \\ 7{,}919019 & 68{,}45894 & -53{,}8397 & -12{,}9281 \\ -41{,}9663 & -53{,}8397 & 117{,}3845 & -12{,}5725 \\ -51{,}7929 & -12{,}9281 & -12{,}5725 & 124{,}8993 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}}{\begin{bmatrix} 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 132{,}6545 & 7{,}919019 & -41{,}9663 & -51{,}7929 \\ 7{,}919019 & 68{,}45894 & -53{,}8397 & -12{,}9281 \\ -41{,}9663 & -53{,}8397 & 117{,}3845 & -12{,}5725 \\ -51{,}7929 & -12{,}9281 & -12{,}5725 & 124{,}8993 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}}$$

Based on the above equation, the weights of the stocks that make up the portfolio are obtained which are presented in table 4.

Table 4 Stock Weight

Share	Stock Weight
ADRO	0,414153
ANTM	0,085019
INCO	0,079674
PTBA	0,421155

6. Calculating *Expected Return* and *Standard Deviation* on Portfolio *Return*

Next, the Expected Return and Standard Deviation of the portfolio return are calculated as parameters that will be used to calculate VaR with Monte Carlo simulation. Return portfolio is obtained by performing calculations using the equation $= \Sigma_{i=1}^{n} \left(w_i R_i \right)$ The results of the calculation of the *Expected Return* and *Standard Deviation* of the portfolio *return are* presented in Table 5

Table 5 *Expected Return* Calculation Results

Ekpected Return			
Share	**$E(R_i)$**	**w_I**	**$E(R_p)$**
ADRO	-0,003617198	0,4141525	-0,00150
ANTM	0,018792572	0,08501858	0,00160
INCO	0,016305332	0,07967365	0,00130
PTBA	0,004076964	0,42115527	0,00172
E(Rp)			0,003116

Table 5 shows that the *expected return* portfolio *value* is 0.003116. *The* largest portfolio *return* is in ANTM stock, which is 0.018792, while the smallest portfolio *return* is in ADRO stock.

Table 5 Calculation of *Standard Deviation*

Standard Deviation of* Portfolio *Return			
Share	***Stdev***	**w_i**	**(Stdev^2) *(wi^2)**
ADRO	0,110172406	0,4141525	0,002081931
ANTM	0,165170156	0,08501858	0,000197193
INCO	0,137979222	0,07967365	0,000120853
PTBA	0,10976703	0,42115527	0,002137117
ADRO*ANTM	0,076710905	0,035210657	0,000007296
ADRO*INCO	0,087898299	0,032997041	0,000008412
ADRO*PTBA	0,080125851	0,174422508	0,000195322
ANTM*INCO	0,12387842	0,006773741	0,000000704
ANTM*PTBA	0,082515096	0,035806023	0,000008729
INCO*PTBA	0,081906471	0,033554978	0,000007554
Varians			0,004993126
Stdev			0,070662055

Table 5 shows the *standard deviation of the* portfolio *return* or risk accepted by investors is 0.070662055 or 7%. The biggest risk is owned by PTBA stock, while the smallest risk is owned by the ANTM*INCO stock pair. Thus the value of *Expected Return* and *Standard Deviation of* Portfolio *Return* can be seen in table 6.

Table 6 *Expected Return* and *Standard Deviation of* Portfolio *Return*

Expected Return	0,003115786
Standar Deviasi	0,070662055

7. Random Return

The next step is to find the portfolio random return value. The portfolio random return is obtained with the help of Microsoft Excel using the RAND function, then the portfolio random return value is generated with the NORMINV function based on the mean and standard deviation parameters in Table 6. The portfolio random return value is simulated as much as k = 300 which abbreviated using the symbol ⋮. The results of the portfolio random return simulation are presented in Table 7

Table 7 Simulation Results of Random Return

NO	Normal Random Return	Parameter Random Return
1	0,915830004	0,100456821
2	0,533507471	0,009057742
3	0,345498843	-0,024972486
4	0,488910038	0,00115124
5	0,342173308	-0,025611094
6	0,724543754	0,045258165
7	0,973561926	0,139912651
8	0,564728885	0,014631566
9	0,870097532	0,082741485
10	0,581264024	0,017610568
⋮	⋮	⋮
300	0,946351111	0,1169141

8. Calculating VaR

From 300 random portfolio returns obtained, each iteration will look for the maximum estimated loss value at the confidence level (1-5%) with the help of *Microsoft Excel* using the percentile function. Furthermore, the VaR of the portfolio is calculated using the equation $VaR_{(1-\alpha)} = W_0 R^* \sqrt{t}$ with initial funds (w_0) invested in the portfolio of Rp. 10,000,000. Before calculating the *value at risk*, the step that must be taken is to determine the time period and level of confidence. This study used a 95% confidence level. Determination of the level of confidence in the calculation of *VaR* depends on the use of *VaR*. Determining the level of trust plays a very important role because it can describe how much the company is able to take a risk with a loss price exceeding *VaR.* The greater the risk taken, the greater the confidence level of the capital allocation to cover losses. The time period used is one day. The results of the calculation of the maximum estimated loss *R** and the calculation of *VaR are* presented in table 8.

Table 8 Calculation Results of *R and *VaR***

No	*R**	*VaR*
1	0,11148	Rp 1.114.793
2	0,11848	Rp 1.184.795
3	0,11556	Rp 1.155.645
4	0,11469	Rp 1.146.870
5	0,12534	Rp 1.253.407
6	0,12027	Rp 1.202.750
7	0,13017	Rp 1.301.733
8	0,11668	Rp 1.166.785
9	0,11243	Rp 1.124.255
10	0,12045	Rp 1.204.465
11	0,12338	Rp 1.233.799
12	0,10726	Rp 1.072.643
13	0,11957	Rp 1.195.735
14	0,09895	Rp 989.485
15	0,12776	Rp 1.277.627
16	0,12780	Rp 1.278.048
17	0,10654	Rp 1.065.375
18	0,11265	Rp 1.126.497
19	0,12840	Rp 1.283.996
20	0,11646	Rp 1.164.612
21	0,12357	Rp 1.235.661
22	0,12088	Rp 1.208.805
23	0,11527	Rp 1.152.720
24	0,12267	Rp 1.226.660
25	0,12032	Rp 1.203.161

From 25 replications, the average *VaR* value was Rp. 1.182.813. This means that if investors invest their funds in a portfolio consisting of ADRO, ANTM, ICBP, and PTBA stocks with a fund of Rp. 10,000,000, the maximum loss that will be suffered by investors in the next period (1 day after the period) with a rate of Rp. 95% confidence does not exceed Rp1,182,813.

DISCUSSION

In determining the *value at risk* using the *Monte Carlo* simulation, the first step that must be done is to calculate the stock *return* value. The rate of stock *return* is the level of profit earned on each stock. The individual stock *return* rate can be calculated by subtracting the current period's stock price by the previous period's stock price divided by the previous period, where the individual stock price is based on changes in the *closing price of* stocks per month. According to Jorion P. (2007) in the Journal of Elga Fitaloka et al (2018) *Return* of a stock is the rate of return or results obtained from investing. *Return* is one of the factors that motivate investors to invest because it can clearly describe price changes.[26]

Based on the results of the calculation of the *return* value of each company, it is known that the average *return* value of ADRO stock is -0.0036172, lower than PTBA stock which are only 0.004077 and INCO stock are 0.016305, different from ANTM stock which has an average *return value* of 0.018793 where this observation was carried out for 48 months during 2017 to 2020.

After the normality test using the *Kolmogorov-Smirnov* test*, the* results showed that the stock *return* data for ADRO, ANTM, INCO and PTBA were normally distributed. In table 1 the results of the calculation of the *Mean* and

[26] Elga Fitaloka dkk. Pengukuran Value at Risk pada Portofolio dengan Simulasi Monte Carlo. Buletin Ilmiah Math. Stat dan Terapannya: 2012. Vol. 7 No. 2. hlmn 142

Variance for the four stocks are used to make portfolio decisions and demonstrate that changes in the *investment horizon* can affect the portfolio and its composition (Gunthorpe and Livy: 1994).[27] Based on the results obtained in Table 2, it can be concluded that the *covariance* value between the same stock *returns* is the *variance* value of the stock returns themselves. In addition, it is known that the correlation values between stock *returns are* all positive. This means that the risk of the portfolio made as a whole can be reduced, because the minimum risk can be achieved if the stock *return* correlation is close to a perfect negative value or less than +1. An investor can reduce investment risk by diversifying investments. Investment diversification will provide optimum benefits if the correlation between investments in one portfolio is less than positive 1. If financial assets in one portfolio have a *return* correlation of less than +1, the overall portfolio risk can be reduced.

Table 4.6 shows that the stocks that have the largest weight are PTBA stocks, which is 0.421155, while the stocks that have the smallest weight are INCO stocks, which is 0.079674. The stocks weight value was obtained using the MVEP method. *Markowitz Efficient* Portfolio is a portfolio that provides the highest *return* among existing portfolios with the same level of risk. Harry M. Markowitz (1952) proved that portfolio risk is influenced by covariance or correlation between portfolio-forming stocks. In addition, there is an investment strategy by allocating funds to various stocks with the aim of reducing risk without reducing returns, which is called diversification. *Markowitz's* diversification strategy is related to the level of covariance between the returns that make up the portfolio.[27]

The results of the calculation of the expected return and standard deviation of the portfolio as the parameters will be used for the calculation of VaR with Monte Carlo Simulation. For the simulation results, random returns obtained using the RAND function are then generated with the NORMINV function based on the expected return and standard deviation parameters in table 4.8 which are simulated as much as k=300. Then the random return value of the portfolio is repeated m = 25 times.

VaR can be defined as the estimated maximum loss that will be obtained during a certain time *period* under normal market conditions at a certain confidence interval .[29] The level of confidence is the probability that the confidence interval formed actually contains the population parameters if the estimation process is carried out repeatedly which is denoted by (1 –). Confidence levels that are often used are 90% (with = 0.1), 95% (with = 0.05), and 99% (with = 0.01). Of the three options, the level of confidence used in this study is 95% because this level of confidence is the most frequently used in every *Value at Risk* calculation and provides a balance between precision and reliability.[30] Based on the explanation above, it can be concluded that if investors invest their funds in a portfolio consisting of ADRO, ANTM, ICBP, and PTBA stocks with an initial fund of Rp. 10,000,000, the maximum loss that will be suffered by investors in the next period (1 days after the period) with a 95% confidence level is not exceeding Rp.1.182.813.

5. CONCLUSION

From this study, it can be concluded that the measurement of the *Value at Risk* (*VaR*) in the stock using the *Monte Carlo* simulation is the monthly closing price (*close price*) of Adaro Energy Tbk's stocks. (ADRO), Aneka Tambang Tbk. (ANTM), Vale Indonesia Tbk. (INCO), and Bukit Asam Coal Mine, Tbk (PTBA) for the period 2017 to 2020. The difference in the *VaR* value in each replication was due to the difference in the results of each simulation carried out, but the results did not differ much from one another because the parameters used in the simulation were the same. Therefore, in order to stabilize the results, the average value of the resulting *VaR* was taken.

Based on the results of the calculation, the average value obtained is Rp. 1,182,813 at a 95% confidence level in a period of one day. It can be interpreted that if an investor invests initial funds in a portfolio consisting of ADRO, ANTM, INCO and PTBA stocks with a fund of Rp. 10,000,000, the maximum loss that will be experienced by investors in the next period (1 day after the period) with a confidence level of 95 % will not exceed Rp.1.182.813 or it can be said that there is a 5% possibility that investment losses in the portfolio consisting of ADRO, ANTM, INCO and PTBA stocks will exceed Rp.1.182.813.

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