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Value at Risk in the Formation of Optimal Portfolio on Sharia-Based Stocks

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Abstract*: This study aims to formation an optimal portfolio and find out the value of Risk at Sharia-based stocks in the Jakarta Islamic Index. Risk is one of the important things that must be considered by investors to invest. In this case, risk can be minimized by diversification (portfolio). Based on the research period from June 2015 to November 2017 there were 39 companies that became the study population, while the number of companies that were sampled as many as 10 companies were taken by purposive sampling technique with criteria always consistent in the list of Jakarta Islamic Index during the observation period, consistently having a return positive expectations and have stock price movements. The data analysis technique for optimal portfolio formation uses the Markowitz model and is carried out to obtain certain returns with the lowest risk level and to find out the proportion of funds in each share included in the optimal portfolio. The results of data analysis on portfolio formation are then simulated by measuring Value at Risk with the Monte Carlo model. Measurement of Value at Risk with the Monte Carlo model uses stock return data. This study uses a significance level of 90%, 95% and 99% and uses three time horizons, namely 1 day, 1 week and 1 month. The results of this study indicate that there are eight stocks included in the optimal portfolio with the optimal proportion of funds owned by TLKM and UNVR stocks, each at 25%. The highest at Value at Risk in each stocks at 99% confidence level is from ADRO stocks, namely -7.24% at 1 day time horizon, -18.98% at 1 week time horizon and -39.17% at time horizon 1 month. While the Value at Risk in the portfolio is smaller than the Value at Risk for each stock and is expected not to exceed -0.43% and this is in accordance with the purpose of establishing a portfolio that is to minimize investment risk.

***Keywords* : Value at Risk, Monte Carlo Model, Portfolio, Sharia-Based Stocks**

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I. INTRODUCTION

Investment activities or investing money in the production process which is expected to provide benefits in the future. Investment activities can be done in many ways such as owning gold, buying property, placing funds on deposit and buying securities. Of course, in investing investors must be able to face and protect their assets against risk. The importance of measuring this risk is because investors are risk averse [1]. Form a portfolio is one way to reduce investment risk [2], [3]. A portfolio is a combination of a group of assets, both real assets and financial assets. The optimal portfolio is the portfolio chosen by investors from a collection of efficient portfolios. The formation of an optimal portfolio is to maximize the expected return and minimize the important risks because the risk weights for each stock instrument are different [4]. Value at Risk is one method of measuring risk by calculating market risk that determines the maximum level of loss that will be borne by a portfolio with a certain level of confidence, for a certain period and normal market conditions [5]. The researcher took the Value at Risk technique with the Monte Carlo approach because the Monte Carlo calculation focused on the downside risk which means it does not depend on distribution and return. VaR is usually calculated with a confidence level of 95% (for daily periods). It can be interpreted that with this 95% confidence level within 1 day there are 5% losses that will be experienced by the company [6]. Generally VaR, has three calculation methods, namely the historical method, the Variance-Covariance method, and the Monte Carlo simulation method [7], [8], [9], [10]. All three models have their respective characteristics. VaR with the Monte Carlo method develops a future stock return model by means of simulations. This simulation is used to get random numbers of stock returns based on past trading patterns. This method has advantages in accuracy, but has weaknesses in terms of computation which is more complicated than other methods [6].

II. LITERATURE REVIEW

A. Investment

Investment is an expenditure or investment in a company in the form of goods or funds used to assist production activities that will generate profits in the future. The purpose of someone investing is to produce profits that will increase welfare [11].

B. Return dan Risk

Return is the profit that will be obtained by investors and potential investors. The level of return can be a benchmark for investors whether the assets or shares are worth maintaining [11].

Risk (risk) is an uncertainty about a future situation due to decision making based on various current considerations. Risk is an uncertain condition that can lead to differences in expected returns with received returns [1]. To minimize risk, an optimal portfolio formation method is used as a form of risk diversification and also to maximize the returns expected by investors [4].

C. Portfolio Diversification

In a portfolio, investors have the opportunity to invest their capital in one or more securities. Investors should diversify their portfolios to reduce the portfolio risk to be borne [12], [13].

Diversification in a portfolio is a way of forming a portfolio that can reduce risk without having to reduce its profits. Diversification of a portfolio is seen as a solution to avoid risks that arise and increase profits. Here portfolio diversification is seen as a way of investing in two or more good securities because it spreads risk, which means minimizing the risk borne. The more spread of risk that occurs, the lower the volatility of the portfolio [14].

D. Optimal Stock Portfolio

The optimal portfolio is a combination of several assets that have been selected by investors or potential investors [16]. The formation of an optimal portfolio is to maximize the expected return and minimize the important risks because the risk weights for each stock instrument are different [2], [4].

E. Value at Risk

The concept of Value at Risk was introduced by J.P. Morgan in 1994. Value at Risk is one method of measuring risk by calculating market risk in single and multi-instrument instruments that determine the maximum level of loss that will be borne with a certain level of confidence, for a certain period and normal market conditions [5]. VaR is usually calculated with a confidence level of 95%. This can be interpreted that with this 95% confidence level within 1 day there are 5% losses that will be experienced by the company [6].

Generally VaR, has 3 calculation methods, namely the historical method, the Variance-Covariance method, and the Monte Carlo simulation method. All three have their respective characteristics. VaR with the Monte Carlo method develops a future stock return model by means of simulations. This simulation is used to get random numbers of stock returns based on past trading patterns [7], [8], [9], [10].

III. RESEARCH METHODS

This type of research is quantitative descriptive. The objects of this study are all companies on the Jakarta Islamic Index which are listed on the Indonesia Stock Exchange which are still active during the period June 2015 - November 2017.

The sample of this study were 10 companies out of a population of 39 companies. Data collection techniques used in this study are documentation. Data taken in the form of share prices in companies included in JII. Sources of data taken are secondary data obtained from the publication of data on IDX and Morning Star. In addition, the source of the data I obtained came from scientific literature relating to the Optimal Portfolio and Value at Risk and also the internet. Data analysis in this study uses the Markowitz Model Optimal Portfolio and the Monte Carlo Value at Risk Model. The following are the stages of analysis:

a. Portofolio Optimal Model Markowitz [17]

1. Calculate the return of each stock using the formula:

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \quad (1)$$

R_{it} = Return on stock realization i period t
P_{it} = Stock price i at the end of the period
P_{it-1} = Stock price i at the beginning of the period

2. Calculate the expected return of each stock using the formula:

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

$E(R_i)$ = Return expectations
R_{it} = Return on stock realization i period t
n = number of research periods

3. Calculate stock risk which will explain the actual return and expected return using the formula:

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

σ = Standard deviation
R_{it} = Return on stock realization i period t
$E(R_i)$ = Return expectations
n = number of research periods

4. Calculate the correlation coefficient with the formula:

$$r_{A,B} = \frac{\sum_{t=1}^{n}(R_{A,i} - R_{B,i}) - n\,E(R_A)\,E(R_B)}{\sqrt{[\sum_{t=1}^{n} R_{A,i}^2 - n\,E(R_A)^2][\sum_{t=1}^{n} R_{B,i}^2 - n\,E(R_B)^2]}} \quad (4)$$

$r_{A,B}$ = The correlation coefficient of stock returns A and B
$R_{A,i}$ = Stock returns A in period t
$R_{B,i}$ = Stock returns B in period t
$E(R_A)$ = Expected stock return A
$E(R_B)$ = Expected stock return B
n = number of research periods

5. Calculate stock covariance with the formula:

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

$\sigma_{RA,RB}$ = Covariance between stocks A and B
$R_{A,i}$ = Stock returns A in period t
$R_{B,i}$ = Stock returns B in period t
$E(R_A)$ = Expected stock return A
$E(R_B)$ = Expected stock return B
n = number of research periods

The results of this calculation will show stocks that are positive and negative. Positive shares will be taken and included as a portfolio.

6. Calculate expected portfolio returns using the formula:

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

$E(R_p)$ = Return expectations from the portfolio
$E(R_i)$ = Stock expectations return i
W_i = Share of stocks i to all stocks in the portfolio

7. Calculate expected return and portfolio risk in proportion to funds using the formula:

$$\sigma_p = \sum_{i=1}^{n} W_i \sigma^2 i + 2 \sum_{i=1}^{n} \sum_{i=1}^{n} W_i W_j \sigma_{ij} \quad (7)$$

σ_p= Standard deviation of the portfolio
σ_i= Stock return variance i
σ_{ij}= Covariance between stocks i and j
W_i= Proportion of funds invested in stocks i
W_j= Proportion of funds invested in stocks j
$\sum_{i=1}^{n} \sum_{i=1}^{n}$ = Double addition marks, meaning n^2 will be added together
n = number of stocks in the portfolio

8. Conduct a Normality Test
Before calculating VaR, normality test of stock returns will be carried out using the Jarque Bera test. Jarque Bera Test is one of the normality test methods involving skewness and kurtosis values which are then compared with the Chi-Square table with degrees of freedom (dk) with a certain level of significance. Data can be said to be normal if JB value is smaller than Chi-Square table value. If there are shares that are not normally distributed, they will be corrected using the Cornish-Fisher approach. Jarque Bera test was conducted with the Eviews program while Cornish-Fisher was carried out with the Excel program. The Cornish-Fisher approach is done by the equation [18]:

$$\alpha' = \alpha \frac{1}{6}(\alpha^2 - 1)\varepsilon \quad (8)$$

α = A value with a certain level of confidence
ε = Skewness Coefficient

b. Value at Risk of the Monte Carlo Model for Each Stock [19]

1. Determine the parameter value that is stock return.
2. Simulate return value by randomly generating return assets with parameters obtained from the first step of n pieces so that an empirical distribution is formed from the simulation results.
3. Look for the estimated maximum loss at the confidence level (1-α) as the α-quantile value of the empirical return distribution obtained in the second step, denoted by the symbol R*.
4. Calculates the VaR value at the level of confidence (1-α) in a period of time t days ie

$$VaR_{(1-\alpha)}(t) = \mu - (Z\ x\ \sigma)\sqrt{t} \quad (9)$$

μ = the mean of a stock return simulation
Z = level of confidence
σ = standard deviation
$\sqrt{t}$ = period of time

c. Value at Risk of the Monte Carlo Model for portfolio [20]

1. Determine the parameter values for portfolio returns and correlations between variables (stock returns).
2. Sort portfolio returns from the lowest to the highest by blocking all returns and then sort the smallest to large.
3. Determine the exposure value (V_0) or investment value.
4. Determine the percentile value of the return distribution with relevant confidence, for example 5% of the amount of data using a function in Microsoft Excel, which is = PERCENTILE (array, k).
5. Calculates the VaR value at the level of confidence (1-α) in a period of time t days ie

$$VaR_p = \mu_p - (Z\ x\ \sigma_p)\sqrt{t} \quad (10)$$

μ_p = the mean of a portfolio return simulation
α = level of confidence
σ_p = standard deviation of the portfolio
$\sqrt{t}$ = period of time

IV. RESULT AND DISCUSSION

A. Markowitz Model Optimal Portfolio Calculation Results

Data on the daily closing price of shares is processed so as to produce a daily return (rate of return) from each company which is then obtained by the expected return value of each share contained in the following table:

Table I: JII Stock Expectation Returns for the Period of 2015-2017

No.	Issuer Code	Return Ekpekstasi
1.	ADRO	0.0015
2.	AKRA	0.0005
3.	ASII	0.0003
4.	ICBP	0.0004
5.	INDF	0.0002
6.	PWON	0.0008
7.	TLKM	0.0007
8.	UNTR	0.0011
9.	UNVR	0.0003
10.	WSKT	0.0006

Source: Processed Data (2019)

Table I shows that as many as 10 companies had positive expectations of return. Positive returns provide benefits to potential investors.

Table II: Standard Deviation of JII Stock 2015-2017

No.	Issuer Code	Standard Deviation
1.	ADRO	0.0307
2.	AKRA	0.0213
3.	ASII	0.0200
4.	ICBP	0.0174
5.	INDF	0.0202
6.	PWON	0.0251
7.	TLKM	0.0151

8.	UNTR	0.0253
9.	UNVR	0.0154
10.	WSKT	0.0195

Source: Processed Data (2019)

Table II shows the risks posed by each optimal portfolio candidate stock. The biggest standard deviation is from ADRO shares that is 0.0307, this number shows a high level of risk while the stock with the smallest standard deviation is TLKM stock which is 0.0151, this number indicates a low level of risk. This standard deviation also shows the heterogeneity that occurs in the data being studied. The greater the value of the standard deviation, indicating the more spread of observational data and the tendency for each data to differ from one another.

Table III: Proportion of Portfolio Funds Before Solver

No.	Issuer Code	Proportion
1.	ADRO	10%
2.	AKRA	10%
3.	ASII	10%
4.	ICBP	10%
5.	INDF	10%
6.	PWON	10%
7.	TLKM	10%
8.	UNTR	10%
9.	UNVR	10%
10.	WSKT	10%
TOTAL		100%

Source: Processed Data (2019)

Based on table III it can be seen that all shares have the same weight of 10%, so a solver is needed to determine the total weight of each stock.

Table IV: Proportion of Portfolio Funds After Solver

No.	Issuer Code	Proportion
1.	ADRO	3%
2.	AKRA	13%
3.	ASII	4%
4.	ICBP	13%
5.	INDF	0%
6.	PWON	0%
7.	TLKM	25%
8.	UNTR	3%
9.	UNVR	25%
10.	WSKT	14%
TOTAL		100%

Source: Processed Data (2019)

According to Table IV it can be seen that after the solver has been assigned to each of the shares there are 2 shares worth 0%, so the stock is not eligible for optimal portfolio.

Table V: Optimal Portfolios

No.	Issuer Code	Proportion
1.	ADRO	3%
2.	AKRA	13%
3.	ASII	4%
4.	ICBP	13%
5.	TLKM	25%
6.	UNTR	3%
7.	UNVR	25%
8.	WSKT	14%
TOTAL		100%

Source: Processed Data (2019)

The stocks that make up the optimal portfolio are only 8 shares with the largest proportion of funds owned by TLKM and UNVR shares, each worth 25% and the smallest proportion of funds owned by ADRO and UNTR with a value of 3%.

B. Stock Data Normality Test Results

Before the VaR calculation is done. Stock return data must be tested for normality, namely the Jarque Bera Test. This study uses dk = 7 obtained from dk = k-1, then k is the number of categories / variables. This study uses 3 levels of significance, namely the 0.01 significance level with a value of 18.475 while the 0.05 significance level with a value of 14.067 and a significance level of 0.1 value of 12.017. Data can be said to be normal if JB value is smaller than Chi-square value. If there are shares that are not normally distributed, they will be corrected using the Cornish-Fisher approach. Following are the results of Jarque Bera's normality test:

Table VI: Fallow Jarque Test Results

No.	Issuer Code	Jarque Bera
1.	ADRO	145,2349
2.	AKRA	9,830915
3.	ASII	254,6977
4.	ICBP	243,9590
5.	TLKM	265,7230
6.	UNTR	75,26821
7.	UNVR	389,0956
8.	WSKT	363,9477

Source: Processed Data (2019)

From the calculation of the Jarque Bera Test it can be seen that 7 shares of 8 shares are not normally distributed. Judging from the value of JB is greater than the value of the chi-square table of the three levels of significance. There is only 1 stock that is normally distributed, AKRA shares with JB value 9,830915.

C. Adjustment of the Normality Test With the Cornish-Fisher Approach

The results of the normality test of stock return data in the fallow jar test show that some stocks are not normally distributed or have skewness. Having a skewness value means that the data has asymmetry between the left and right on the distribution curve. For this reason, it is necessary to adjust the chi-square value so that it has a normal distribution. For shares with normal distribution, the skewness value is 0, which means there is no correction. Stocks that are not normally distributed can have a positive skewness value (skewed to the right) or negative (skewed to the left) which means it needs correction.

Based on the adjustments made all shares have a Z-correction value smaller than the Z-score value and no negative values are found in the skewness.

D. Results of Monte Carlo Model VaR Calculations on Each Stock

This model uses the value of stock returns as data that will be used in research to take simulations and get random values from the returns owned by each company stock. In this study 1000 simulations were conducted. This study uses a significance level of 90%, 95%, and 99%. In addition, this study also uses three time horizons, namely 1 day, 1 week and 1 month.

Table VII: Value at Risk Measurement Results with the Monte Carlo Model on Each Stock (T = 1 Day)

No.	Issuer Code	VaR (90%)	VaR (95%)	VaR (99%)
1.	ADRO	-4,04%	-5,15%	-7,24%
2.	AKRA	-2,94%	-3,73%	-5,22%
3.	ASII	-2,49%	-3,22%	-4,58%
4.	BSDE	-2,12%	-2,76%	-3,94%
5.	ICBP	-1,69%	-2,18%	-3,12%
6.	INCO	-3,13%	-4,03%	-5,74%
7.	INDF	-1,90%	-2,45%	-3,48%
8.	INTP	-2,58%	-3,33%	-4,73%

Source: Processed Data (2019)

Based on Table VII PT. Adaro Energy Tbk (ADRO) has the highest Value at Risk compared to other shares, namely within 1 day the VaR value is -7.24% at a significance level of 99%. This means that ADRO will experience a loss of 7.24% over the next 1 day.

Table VIII: Value at Risk Measurement Results with the Monte Carlo Model of Each Stock (T = 1 Week)

No.	Issuer Code	VaR (90%)	VaR (95%)	VaR (99%)
1.	ADRO	-10.51%	-13.45%	-18.98%
2.	AKRA	-7.54%	-9.63%	-13.56%
3.	ASII	-6.71%	-8.62%	-12.22%
4.	BSDE	-5.80%	-7.48%	-10.62%
5.	ICBP	-4.57%	-5.89%	-8.36%
6.	INCO	-8.40%	-10.81%	-15.31%
7.	INDF	-5.10%	-6.55%	-9.29%
8.	INTP	-6.93%	-8.90%	-12.62%

Source: Processed Data (2019)

Based on Table VIII of PT. Adaro Energy Tbk (ADRO) has the highest Value at Risk compared to other shares, which is within one week its VaR value
amounting to -18.98% at a 99% confidence level. This means that ADRO will experience a loss of 18.98% over the next 1 week.

Table IX: Value at Risk Measurement Results with the Monte Carlo Model for Each Share (T = 1 Month)

No.	Issuer Code	VaR (90%)	VaR (95%)	VaR (99%)
1.	ADRO	-21.64%	-27.73%	-39.17%
2.	AKRA	-15.45%	-19.78%	-27.90%
3.	ASII	-13.95%	-17.92%	-25.37%
4.	BSDE	-12.13%	-15.60%	-22.10%
5.	ICBP	-9.54%	-12.26%	-17.37%
6.	INCO	-17.48%	-22.45%	-31.78%
7.	INDF	-10.61%	-13.62%	-19.28%
8.	INTP	-14.40%	-18.50%	-26.18%

Source: Processed Data (2019)

Based on Table IX PT. Adaro Energy Tbk (ADRO) has the highest Value at Risk compared to other shares, namely within 1 month the VaR value is -39.17% at a 99% confidence level. This means that ADRO will experience a loss of 39.17% over the next 1 month.

E. Results of Monte Carlo Model VaR Calculations on Portfolios

The Monte Carlo model uses portfolio stock return values as data to be examined which then determines the standard deviation and the quantile value of the portfolio returns. Followed by calculating the multiplication between the exposure value (V_0) or the investment value with the quantile value and time horizon. The time horizon used in this study is 1 day, 1 week and 1 month.

Table X: Value at Risk Measurement Results with the Monte Carlo Model of the Portfolio

Time Horizon	90%	95%	99%
1 Hari	-0.03%	-0.04%	-0.06%
7 Hari	-0.10%	-0.13%	-0.20%
30 Hari	-0.23%	-0.30%	-0.43%

Source: Processed Data (2019)

From table X data it can be seen that the VaR value of the portfolio at a 90% confidence level for the next 1 day is -0.03%, while for the next 1 week the value is -0.10% and for the next 1 month the value is -0.23%. The VaR value of the portfolio with a 95% confidence level for the coming 1 day is -0.04%, while for the next 1 week the value is -0.13% and for the next 1 month the value is -0.30%. The VaR value of the portfolio with a 99% confidence level for the next 1 day is -0.06%, while for the next 1 week the value is -0.20% and for the next 1 month the value is -0.43%.

V. CONCLUSION

The stocks included in the Markowitz model optimal portfolio from a sample of 10 stocks to 8 stocks with the optimal proportion of funds owned by TLKM and UNVR stocks, each at 25%. The largest Value at Risk is in ADRO stocks (PT. Adaro Energy Tbk), namely in the 1 day time horizon the Value at Risk is -7.24% at the 99% significance level, in the 1 week time horizon the Value at Risk is -18.98% at the confidence level 99% and within one month time horizon the Value at Risk is a number -39.17% at the 99% confidence level. The Value at Risk in the portfolio is proven to be smaller than the Value at Risk for each stock and this is in accordance with the purpose of the portfolio itself to minimize investment risk.

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