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Formation of stock portfolio using Markowitz method and measurement of Value at Risk based on generalized extreme value (Case study: company's stock The IDX Top Ten Blue 2017, Period 2 January - 29 December 2017)

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Abstract. In financial investment, investors will try to minimize risk and increase returns for portfolio formation. One method of forming an optimal portfolio is the Markowitz method. This method can reduce the risk and increase returns. The performance portfolio is measured using the Sharpe index. Value at Risk (VaR) is an estimate of the maximum loss that will be experienced in a certain time period and confidence level. The characteristics of financial data are the extreme values that are alleged to have a heavy tail and cause financial risk to be very large. The existence of extreme values can be model Generalized Extreme Value (GEV). This study uses company stock data of The IDX Top Ten Blue 2017 which forms an optimal portfolio that is a combination of TLKM and BMRI shares with the expected return rate of 0.0111 and a standard deviation of 0.01057. Portfolio performance measured by the Sharpe index is 1.6190 indicating the return obtained from investing in the portfolio above the average risk-free investment return rate of -0.01010. Risk calculation is obtained based on Generalized Extreme Value (GEV) if you invest both of these stocks with a 95% confidence level is 0.206 or 2.06% of the current assets.

1. Introduction

These Investments made in financial assets have a special attraction for investors can form a portfolio, a combination of various investments in accordance with the risks that are willing to be borne and the expected level of profit. The Markowitz method is one of the right models in choosing a portfolio that emphasizes efforts to maximize return expectations and can minimize uncertainty or risk of shares. The final stage of the investment process in stocks is to assess the performance of the portfolio that has been formed previously using the Sharpe index.

VaR can be interpreted as the worst measure of loss that is expected to occur at a certain time in normal market conditions with a certain level of trust [1]. In the financial time series, it is suspected that the tail has a heavy tail distribution, that is, the tail of the distribution decreases slowly when compared to the normal distribution which can cause financial risk to be very large. It can be overcome using the Block-Maxima approach which identifies extreme values based on the maximum value of observation data grouped according to a certain period following the distribution of Generalized Extreme Value (GEV). In this study, researchers used data from The IDX Top Ten Blue 2017's daily stock closing price, which focused on a large number of investors and the growth of their shares, which were selected through several selection criteria.

2. Literature review

2.1. Capital market

Capital market is a market (a place in the form of a building) that is prepared to trade stocks, bonds and other types of securities by using securities brokerage services [2]. Through the capital market, the people who act as investors can channel the excess funds to divest to various companies through the purchase of shares, bonds and derivative instruments from securities issued by the company.

2.2. The IDX Top Ten Blue 2017

The IDX Top Ten Blue 2017 is a stock that focuses on a large number of investors and the growth of its shares, which are selected through several selection criteria. The IDX Top Ten Blue 2017 stocks of the company are also shares that are in great demand by investors as presented in table 1.

Table 1. List of companies The IDX Top Ten Blue 2017

No	Company Name	Symbol
1	PT Hanjaya Mandala Sampoerna Tbk	HMSP
2	PT Bank Central Asia Tbk	BBCA
3	PT Telekomunikasi Indonesia (Persero) Tbk	TLKM
4	PT Bank Rakyat Indonesia (Persero) Tbk	BBRI
5	PT Unilever Indonesia Tbk	UNVR
6	PT Bank Mandiri (Persero) Tbk	BMRI
7	PT Astra International Tbk	ASII
8	PT Bank Negara Indonesia (Persero) Tbk	BBNI
9	PT Gudang Garam Tbk	GGRM
10	PT United Tractors Tbk	UNTR

Source: *IDX Monthly Statistics* (*December* 2017) [3]

2.3. Risk

Rivai and Ismail [4] stated that risk is a condition that arises because of uncertainty with the chance of certain events which, if they occur, will have unfavorable consequences. This type of risk can be known in advance by measuring the exposure that can be experienced. Exposure is the object that is susceptible to risks and impact on the company's performance in a predictable risk actually occur.

2.4. Stock

According to [5], stocks are a sign of participation or ownership of a person or entity in a company or limited liability company. Form of stocks is a sheet of paper that explains that the paper's owner is the owner of the company that publishes the company.

2.5. Return

According to [6], return from an asset is the rate of return or results obtained due to investing. Return is one of the factors that motivate investors to invest because it can describe the significant price changes.

2.6. Portfolio

Portfolio is a combination of two or more securities that are selected as investment targets from investors in a certain period of time with certain conditions [6]. The basic concept stated in the portfolio is how to allocate a certain amount of funds to various types of investments that will produce optimal benefits.

2.7. Markowitz model

Markowitz states that if a security type is added continuously into the portfolio, the benefits of risk reduction obtained will be even greater until it reaches a certain point where the reduction benefits begin to diminish. According to [7], the Markowitz model can be done with the following formulations:

1. Calculate the level of return (return) of each stock

$$\mathrm{R_{it}} = \ln\left[\frac{\mathrm{P_t}}{\mathrm{P_{(t-1)}}}\right] \tag{1}$$

with,
R_{it} : The rate of profit (return) stock to-i in period-t
P_t : The closing price stock in the period-t
$P_{(t-1)}$: The closing price of the previous stock in the period to (t-1)

2. Calculate the expected return rate of each stock return

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

with,
$E\,(R_i)$: The level of expected return from the stock to-i
R_{it} : The level of return of the stock to-i in the period-t
n : Number of observations

3. Calculate the risk (variance and standard deviation) of each stock return

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

$$\sigma_i = \sqrt{\frac{\sum_{t=1}^{n}(R_{it} - E(R_i))^2}{n-1}} \quad (4)$$

with,
σ_i^2 : Variance of stock return to-i
σ_i : Standard deviation of stock return to-i
$E\,(R_i)$: The level of expected return from the stock to-i
R_{it} : The level of return of the stock to-i in the period-t
n : Number of observations

4. Calculate combination between stocks

$$C_{(r,N)} = \frac{N!}{r!(N-r)!} \quad (5)$$

with,
$C_{(r,N)}$: Combination of portfolio level (r) from the number of stocks (N)
N! : Factorial number of stocks
r! : Factorial portfolio level is factorialized

5. Determine the weight of the stock portfolio

$$\sum_{i=1}^{N} W_i = 1 \quad (6)$$

with,
W_i : The weight of the stock portfolio to-i
N : Number of observations

6. Calculate the expected return portfolio rate

$$E(R_p) = \sum_{i=1}^{N} W_i \,.\, E\,(R_i) \quad (7)$$

with,
$E(R_p)$: The level of expected return of the stock portfolio
W_i : The weight of the stock portfolio to-i
$E(R_i)$: The level of expected return from the stock to-i

7. Calculate variances and standard deviations which are risk of stock portfolio

$$\sigma_p^2 = \sum_{i=1}^{n} W_i^2 . \sigma_i^2 + 2\sum_{i=1}^{n}\sum_{j=1}^{n} W_i\, W_j \,.\, \rho_{i,j}\ \sigma_i\sigma_j \quad (8)$$

$$\sigma_P = \sqrt{\sum_{i=1}^{n} W_i^2 . \sigma_i^2 + 2\sum_{i=1}^{n}\sum_{j=1}^{n} W_i\, W_j \,.\, \rho_{i,j}\ \sigma_i\sigma_j} \quad (9)$$

with,
σ_p^2 : Variance of stock portfolio
σ_P : Standard deviation of stock portfolio
σ_i^2 : Variance of stock return to-i
σ_i : Standard deviation of stock return to-i
σ_j : Standard deviation of stock return to-j

$\rho_{i,j}$: Correlation coefficient between stocks to-i and j
W_i : The weight of the funds invested in the stock to-i
W_j : The weight of the funds invested in the stock to-j

As for calculating $\rho_{i,j}$ (correlation coefficient between stocks) can be calculated using the formula:

$$\rho_{i,j} = \frac{\frac{1}{n-1}\{\sum_{t=1}^{n}[(R_{it} - E(R_i))\,(R_{jt} - E(R_j))]\}}{\sqrt{\frac{\sum_{t=1}^{n}(R_{it} - E(R_i))^2}{n-1}\;\frac{\sum_{t=1}^{n}(R_{jt} - E(R_j))^2}{n-1}}} \tag{10}$$

with,
$\rho_{i,j}$: Correlation coefficient between stocks to-i and j
$E\,(R_i)$: The level of expected return from the stock to-i
$E\,(R_j)$: The level of expected return from the stock to-j
R_{it} : The level of return of the stock to-i in the period-t
R_{jt} : The level of return of the stock to-j in the period-t
n : Number of observations

2.8. Measurement of portfolio performance using The Sharpe index

The final stage that is very important for investment managers and investors from the investment process in stocks is to assess the performance of the portfolio that has been formed previously. One of them is the Sharpe index which aims to find out and analyze whether the portfolio formed has been able to increase the likelihood of achieving investment objectives. Mathematically, the Sharpe index is formulated as follows [8]:

$$SP_i = \frac{E(R_p) - R_f}{\sigma_p} \tag{11}$$

with,
$E(R_p) = \sum_{i=1}^{N} W_i \,.\, E\,(R_i)$
$R_f = E\,(S) = \frac{\sum_{t=1}^{n} S_t}{n}$
$\sigma_P = \sqrt{\sum_{i=1}^{n} W_i^2 . \sigma_i^2 + 2\sum_{i=1}^{n}\sum_{j=1}^{n} W_i\, W_j \,.\, \rho_{i,j}\; \sigma_i \sigma_j}$
SP_i : Sharpe portfolio index to-i
$E(R_p)$: The level of expected return of the stock portfolio
$R_f = E\,(S)$: The average risk-free investment interest rate return
$E(R_i)$: The level of expected return from the stock to-i

2.9. Extreme Value Theory (EVT)

EVT is a branch of statistics that discusses data deviations from mean values in the distribution of opportunities. EVT is a theory that focuses on the tail behavior of a distribution.

2.10. Block-Maxima method

In the Block-Maxima method, the risk data entered in the sample is the highest observation value (maximum loss), because the maximum value is the extreme value of the data in a certain period. Tsay [9] states that the Block-Maxima method is expected to follow the distribution of Generalized Extreme Value (GEV) with the formula cumulative distribution function (cdf) as follows:

$$F_{\varepsilon,\mu,\beta}\,(X_i) = \begin{cases} \exp\left\{-\left[1 + \xi\left(\frac{X_i - \mu}{\beta}\right)\right]\right\}^{-\frac{1}{\xi}} & ,\text{if } \xi \neq 0 \\ \exp\left\{-\exp\left[-\left(\frac{X_i - \mu}{\beta}\right)\right]\right\} & ,\text{if } \xi = 0 \end{cases}$$

with:
$\left[1 + \xi\left(\frac{X_i - \mu}{\beta}\right)\right] > 0$
ξ : Shape parameter
β : scale parameter

μ : location parameter

Based on parameter values ξ, *Generalized Extreme Value* (GEV) can be divided into three types, namely: Type I (Gumbel Distribution) if the value $\xi = 0$, Type II (Frechet Distribution) if $\xi > 0$ and Type III (Weibull Distribution) if $\xi < 0$. The greater the value of ξ, the distribution will have a tail that is heavier (heavy tail) the implication of the probability of the occurrence of extreme values will be even greater. Based on the three types of distribution above, those with fat tails are Frechet Distribution.

2.11. Estimation parameter of Generalized Extreme Value

In general, GEV has a probability density function (pdf) as follows:

$$f(x_i|\xi,\beta,\mu) = \begin{cases} \frac{1}{\beta}\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}-1} e^{\left\{-\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}}\right\}} & ,\text{if } \xi \neq 0 \\ \frac{1}{\beta}\exp\left(-\frac{x_i-\mu}{\beta}\right)\exp\left\{-\exp\left[-\left(\frac{x_i-\mu}{\beta}\right)\right]\right\} & ,\text{if } \xi = 0 \end{cases}$$

The steps to determine the GEV likelihood maximum estimator are as follows [10]:

1. Determine the likelihood function

$$f(x_i|\xi,\beta,\mu) = \frac{1}{\beta}\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}-1} e^{\left\{-\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}}\right\}} \tag{12}$$

$$L(\xi,\beta,\mu|x_1,x_2\ldots,x_n) = \prod_{i=1}^{n}\frac{1}{\beta}\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}-1} e^{\left\{-\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}}\right\}}$$

$$= \left(\frac{1}{\beta}\right)^n \prod_{i=1}^{n}\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}-1} e^{\left\{-\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]^{-\frac{1}{\xi}}\right\}} \tag{13}$$

2. Form the ln-likelihood function of the likelihood function

$$\ln L(\xi,\beta,\mu|x_1,x_2\ldots,x_n) = \ln(\beta)^{-n} + \left(-\frac{1}{\xi}-1\right)\sum_{i=1}^{n}\ln\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right] - \sum_{i=1}^{n}\left[\left(1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right)\right]^{-\frac{1}{\xi}}$$

$$= n\ln(\beta) - \left(\frac{1}{\xi}+1\right)\sum_{i=1}^{n}\ln\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right] - \sum_{i=1}^{n}\left[\left(1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right)\right]^{-\frac{1}{\xi}} \tag{14}$$

3. Determines the derivative of the ln-likelihood function for each of the parameters ξ, β, and μ.

$$\frac{\partial \ln L}{\partial \xi} = \frac{1}{\xi^2}\sum_{i=1}^{n}\ln\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right] + \left(-\frac{1}{\xi}-1\right)\left(\sum_{i=1}^{n}\frac{x_i-\mu}{\beta+\xi(x_i-\mu)}\right)$$
$$\sum_{i=1}^{n}\left\{\left[\left(1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right)^{-\frac{1}{\xi}}\right]\left[\frac{\ln\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]}{\xi^2} - \frac{x_i-\mu}{\beta+\xi(x_i-\mu)}\right]\right\} \tag{15}$$

$$\frac{\partial \ln L}{\partial \beta} = \beta^{-1}[-n-1(-1-\xi)]\sum_{i=1}^{n}\left(\frac{x_i-\mu}{\beta+\xi(x_i-\mu)}\right) - \sum_{i=1}^{n}\left[\frac{\left(1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right)^{-\frac{1}{\xi}} x_i-\mu}{(\beta^2+\beta\xi(x_i-\mu))}\right] \tag{16}$$

$$\frac{\partial \ln L}{\partial \mu} = \frac{(1+\xi)}{\sum_{i=1}^{n}\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]} - \sum_{i=0}^{n}\frac{\left[\left(1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right)\right]^{-\frac{1}{\xi}}}{\left[1+\xi\left(\frac{x_i-\mu}{\beta}\right)\right]\beta} \tag{17}$$

4. Form the completion of the first derivative equation with zero. Estimated value is obtained if the equation of the first derivative is closed form. If the equation that is formed is not closed form, a numerical approach is taken to solve the problem using the Newton-Raphson method.

2.12 Distribution suitability test

Visually, inspection of distribution can be seen with quantile plot whether the distribution of value data follows a linear line or not. While formally, the distribution of suitability testing can be done using the Kolmogorov-Smirnov test [11]. Following the distribution suitability test using Kolmogorov-Smirnov:

Hypothesis:

H_0: $F(x) = F^*(x)$ (data follows the theoretical distribution of F * (x))

H_1: $F(x) \neq F^*(x)$ (data does not follow the theoretical distribution of F * (x))

Significance level: α

Test statistics:

$$D_{statistic} = \sup_x |F^*(x) - S(x)| \tag{18}$$

with:

- $S(x)$: Sample distribution function (empirical) or cumulative opportunity function calculated from sample data
- D : Supremum for all x (smallest upper limit)
- $F^*(x)$: The cumulative distribution function is hypothesized
- $F(x)$: The observed cumulative distribution function

Test criteria:

H0 is rejected if $D_{statistic} > D_{(1-\alpha,n)}$ or *p-value* < α.

2.13. Value at Risk of Generalized Extreme Value

According to [12], VaR is defined as the estimated maximum loss that will be experienced in a certain period of time and level of trust. According to [13], obtained VaR GEV values as follows:

$$VaR_{GEV} = \mu - \frac{\beta}{\xi}\{1 - [-\ln(1 - m\alpha)]\}^{-\xi} \tag{19}$$

with,

- μ : Location parameter values from the results of the GEV parameter estimation
- m : The number of observations each block
- α : Significance level
- ξ : Shape parameter values from the results of the GEV parameter estimation
- β : Scale parameter values from the results of the GEV parameter estimation

3. Research methodology

3.1 Types and Data Sources

The data used in the preparation of this final project is secondary data closing price of the company's daily shares of The IDX Top Ten Blue 2017 which can be seen in Table 1 period 2 January - 29 December 2017 as many as 254 data can be downloaded from the historical stock data provider site namely *http://finance.yahoo.com* [14]. While the 2017 monthly Bank Indonesia Certificate (SBI) interest rate data can be downloaded from *http://bi.go.id* [15].

3.2 Data analysis methods

In this study, the analysis used to determine the stock portfolio using the Markowitz method and the measurement of Value at Risk (VaR) based on Generalized Extreme Value (GEV). The steps of data analysis in this study are as follows:

1. Download and collect data used in research.
2. Calculate descriptive statistics for each daily stock closing price.
3. Establishing a stock portfolio with the Markowitz method:
   a. Calculate the return value of each stock.
   b. Calculate the expected return rate of each stock return.
   c. Calculate variance and standard deviation which are the risks of each stock return.
   d. Determine the weights for the stock portfolio.
   e. Calculate correlation coefficient of stock portfolio.

f. Calculate the expected return for the stock portfolio.
g. Calculate the value of variance and standard deviation which is the level of risk of the stock portfolio.
h. Calculate portfolio return.

4. Identifying portfolio return data to determine the presence of fat-tailed data using kurtosis.
5. Determine the optimal stock portfolio based on the value of the greatest expected return.
6. Measuring optimal stock portfolio performance with the Sharpe index.
7. Identify extreme values using the Block-Maxima method based on Generalized Extreme Value (GEV).
8. Identify extreme value data to determine the presence of fat-tailed data using a histogram.
9. Checking the suitability of the distribution of Generalized Extreme Value (GEV) using the Kolmogorov-Smirnov hypothesis test.
10. Estimation parameter of Generalized Extreme Value (GEV) using the Maximum Likelihood Estimation (MLE) method.
11. Calculating Value at Risk (VaR) values based on Generalized Extreme Value (GEV).

4. Results and Discussion

4.1 Description of research objects
The method used in completing this research is the formation of a stock portfolio with the Markowitz method and the measurement of Value at Risk based on Generalized Extreme Value.

Table 2. Descriptive statistics of stock closing prices

Name	Average	Variance	Standard Deviation	Maximum	Minimum
HMSP	3,914.84252	51,910.44941	227.83865	4,730.00000	3,370.00000
BBCA	18,275.88583	3,916,661.76162	1,979.05578	21,925.00000	14,950.0000
TLKM	4,311.06299	85,120.20946	291.75368	4,800.00000	3,830.00000
BBRI	2,875.76772	111,110.96955	333.33312	3,640.00000	2,335.00000
UNVR	47,070.76772	12,977,321.44385	3,602.40495	55,900.00000	38,800.00000
BMRI	6,407.57874	391,648.11631	625.81796	8,000.00000	5,450.00000
ASII	8,292.81496	131,264.87076	362.30494	9,150.00000	7,650.00000
BBNI	7,019.98031	900,051.28420	948.71033	9,925.00000	5,450.00000
GGRM	70,253.05118	40,218,565.25824	6,341.81088	83,800.00000	60,150.00000
UNTR	28,533.16929	15,057,633.09771	3,880.41661	36,250.00000	21,000.00000

4.2. Characteristics of stock closing prices
Table 2 shows the security of each stock using a standard deviation measure. GGRM stock standard deviation is greater than other stocks that show the magnitude of the data distribution is greater than the average. This indicates that the risk of GGRM is greater in investing this business. The value of the GGRM stock variance is greater than the other stocks which show the fluctuation of the stock data is very high between one data to another.

4.3. Characteristics of stock returns
The first stage in the formation of a portfolio is to calculate the daily stock return (return) of each sample company using equation (1) presented in table 3 and the calculation of the return on interest rates on Bank Indonesia Certificates (SBI) is presented in table 4.

Table 3. Level of profit of stock return

Date	HMSP	BBCA	TLKM	BBRI	UNVR	BMRI	ASII	BBNI	GGRM	UNTR
1/2/2017										
1/3/2017	-0.00786	0.01759	-0.00757	0.01909	0.00064	-0.02404	-0.00910	-0.00909	-0.00943	-0.01183
…	...	...	...	...	...	...	...	…	…	…
12/28/2017	0.00426	0.001841	0.02071	0.02229	0.00507	-0.00627	-0.01235	0.00252	0.00429	0,.00072
12/29/2017	0.00424	-0.00114	0.01133	0.00275	0.02720	0.00627	0.03058	-0.00252	0.02477	0.02286

Table 4. Interest rate of SBI

Date	Interest Rate of SBI (%)	Return
1/19/2017	4.75000	
2/16/2017	4.75000	0.00000
…	…	…
12/14/ 2017	4.25000	0.00000

The level of expected return is obtained by calculating the average of the rate of return (return) during the positive period of research which shows the advantages in investing in these 10 stocks and presented in table 5.

The standard deviation of UNTR stock returns is greater than other stock shows the amount of data distribution is greater than the expected return (average) and indicates that the risk of stock returns of UNTR is greater in investing this business. The value of UNTR stock return variance is greater than other stock shows the fluctuation of the stock data is very high between one data to another.

Table 5. Descriptive statistics of stock return

Name	Average	Variance	Standard Deviation	Maximum	Minimum
HMSP	0.00083	0.00023	0.01520	0.06150	-0.05000
BBCA	0.00140	0.00014	0.01170	0.04240	-0.04770
TLKM	0.00043	0.00015	0.01240	0.07270	-0.04270
BBRI	0.00180	0.00017	0.01290	0.05350	-0.03670
UNVR	0.00140	0.00011	0.01070	0.03480	-0.02900
BMRI	0.00130	0.00015	0.01230	0.05990	-0.03390
ASII	0.00001	0.00018	0.01350	0.06490	-0.04590
BBNI	0.00230	0.00020	0.01420	0.04450	-0.04130
GGRM	0.00110	0.00033	0.01820	0.06030	-0.05160
UNTR	0.00200	0.00048	0.02190	0.08660	-0.04970

4.4. Establishment of a stock portfolio with the Markowitz method

The combination of stock consisting of two stocks per portfolio, so that there will be many possibilities of stock portfolios that will be formed. In this study, there were 45 combinations of stock portfolios due to the 10 stocks used during the study period with equation (5).

The weight of the funds invested is the sum of each share will be equal to 100%. Based on Table 6, the weight of this stock portfolio fund is divided into optimal conditions with the highest expected return (average) of 20%: 80% for 45 stock portfolio combinations using equation (10).

Table 6. Descriptive statistics of return portfolios of each weight

Characteristics	Average	Variance	Standard Deviation	Maximum	Minimum	Skewness	Kurtosis
10% : 90%	0.00053	0.00013	0.01145	0.06631	-0.03812	1.14340	6.76800
20% : 80%	0.00111	0.00011	0.01057	0.05788	-0.03017	1.25310	6.01500
30% : 70%	0.00103	0.00010	0.00997	0.05742	-0.02830	1.39530	7.25280

40% : 60%	0.00094	0.00009	0.00960	0.05750	-0.02643	1.51030	8.19240
50% : 50%	0.00086	0.00009	0.00948	0.05759	-0.02457	1.57010	8.58220
60% : 40%	0.00077	0.00009	0.00962	0.05767	-0.02559	1.55880	8.42270
70% : 30%	0.00069	0.00010	0.01002	0.05776	-0.02986	1.48270	7.96980
80% : 20%	0.00060	0.00011	0.01064	0.05785	-0.03412	1.36520	7.49690
90% : 10%	0.00052	0.00013	0.01145	0.06435	-0.03839	1.23190	7.14250

Merging these two stocks correlates close to zero will reduce the risk of the stock portfolio.

Table 7. Correlation coefficient of stock portfolio

Portfolio no	Correlation coefficient
1	0.08390
…	…
44	0.27420
45	0.15140

The level expected return of the stock portfolio is obtained by calculating the average of the sum of the profit level (return) multiplied by the weight of the funds invested by each share during the study period using equation (8) and presented in Table 8.

Table 8. Descriptive statistics of stock return portfolio

Portfolio no	Average	Variance	Standard deviation	Maximum	Minimum	Skewness	Kurtosis
1	0.00126	0.00010	0.01008	0.03136	-0.04178	-0.22340	2.57046
2	0.00051	0.00011	0.01069	0.05766	-0.03621	0.89073	5.13652
…	…	…	…	…	…	…	…
19	0.00124	0.00009	0.00949	0.03147	-0.02581	0.08360	0.86132
20	0.00111	0.00011	0.01057	0.05788	-0.03017	1.25294	6.01434
…	…	…	…	…	…	…	…
44	0.00207	0.00034	0.01848	0.07062	-0.03916	0.24892	0.28748
45	0.00183	0.00034	0.01840	0.07242	-0.04331	0.29515	0.46997

The level of risk of the stock portfolio obtained depends on the value of the variance and the standard deviation generated during the study period. Based on these 10 stocks, 2 shares were taken with fat tails. Judging from table 7, it was found that there were only 2 stock portfolios that had a kurtosis value greater than 3 which was a portfolio combination between BBCA and TLKM stocks (10th portfolio) and TLKM with BMRI stocks (20th portfolio). This indicates the existence of a heavy tail. Furthermore, the optimal portfolio formation is determined based on the value of the largest expected return (average) of the two combinations of stock portfolios. So that the formation of the optimal portfolio used for the next analysis is the 20th portfolio which is a combination of TLKM and BMRI stocks.

4.5. Measurement of stock portfolio performance with Sharpe Index
Sharpe index has a positive value of 1.06190, which means that the return obtained from investing in the portfolio is above the average risk-free investment return rate of -0.01010.

4.6. Identifying Extreme Values with Block-Maxima

The block division is done every week and the 20th stock portfolio return data (a combination of TLKM and BMRI stocks) is first eliminated which will be determined by the extreme value with the highest observation data for each block presented in table 9.

Table 9. Identification of extreme values with Block-Maxima

Block	Extreme value
1	0.02075
2	0.01479
…	…
51	0.02286
52	0.03318

4.7. Suitability Test for Generalized Extreme Value Distribution

Before further analysis is carried out, it is first examined the suitability of the distribution test to its extreme values which can be seen visually through quantile plots and probability density functions while formally through the Kolmogorov-Smirnov test.

Based on figure 1, we can see that the plots of extreme value data are around the linear line which is the Generalized Extreme Value distribution line. Based on figure 2, it is said to be right-handed because it has a long right tail compared to the far shorter left tail so that the positive skewness value. So it can be concluded that the extreme value data follows the Generalized Extreme Value distribution.

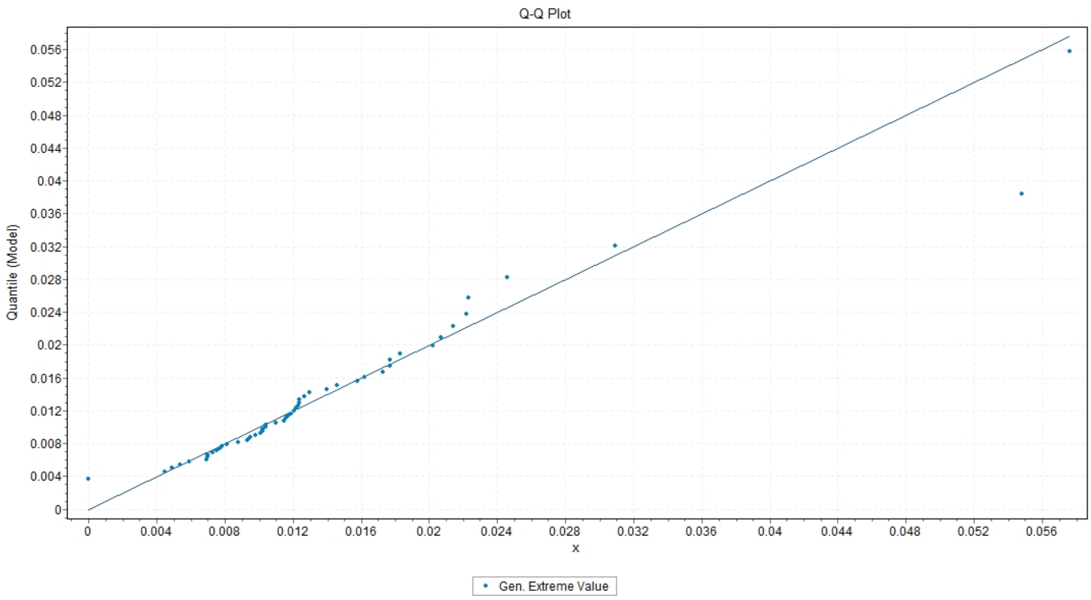

Figure 1. Quantile plot of Generalized Extreme Value

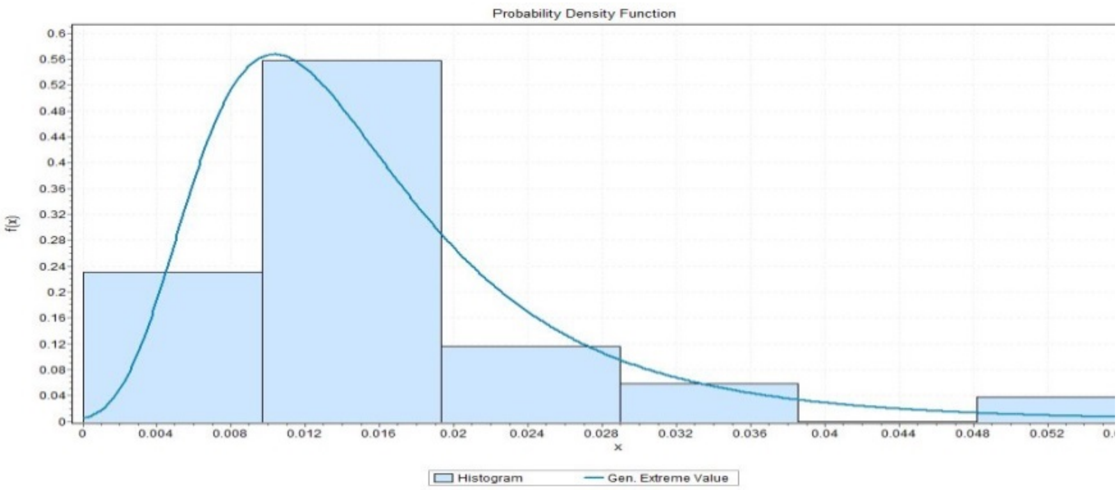

Figure 2. Probability density function of Generalized Extreme Value

Hypothesis:
H_0: Extreme value follow the Generalized Extreme Value distribution
H_1: Extreme value does not follow the Generalized Extreme Value distribution
Significance level:
$\alpha = 5\% = 0.05$
Statistical test:
$D_{statistic} = \sup_x |F^*(x) - S(x)| = 0.10724$
p-value = 0.55193
Test criteria:
H_0 is rejected if $D_{statistic} > D_{(1-\alpha,n)}$ or p-value < α
Decision:
H_0 is accepted if $D_{statistic} = 0.10724 < D_{(1-0,05,52)} = 0.18482$ or p-value = 0.55193> α = 0.05
Conclusion:
On the significance level of 5%, it can be concluded that data from the extreme value distribution of the following Generalized Extreme Value.

4.8. Estimation parameter of Generalized Extreme Value
The results parameter estimation of Generalized Extreme Value (GEV) using the Maximum Likelihood Estimation (MLE) method is presented in table 10.

Table 10. Estimation Parameters of Generalized Extreme Value

Characteristics	Extreme value
Observation of each block (m)	5
Shape parameter (ξ)	0.09490
Scale parameter (β)	0.00680
Location parameter (μ)	0.01150

The Block-Maxima method will produce Generalized Extreme Value (GEV) distribution by observing each block (block) of 5 to 52 the amount of extreme value data. Shape parameter value (ξ) is 0.09490> 0, this indicates the distribution that is formed is the distribution of Generalized Extreme Value (GEV).

4.9. Value at Risk of Generalized Extreme Value

Based on the results of the Generalized Extreme Value (GEV) parameter estimation presented in Table 10, the next step is to calculate Value at Risk Generalized Extreme Value (GEV) by using equation (19) of 0.02060 which indicates a 95% confidence level of possible loss on the next day, investors receive 0.02060 or 2.06%. Examples of current assets owned are Rp. 100,000,000,000, then the maximum possible loss is 2.06% x Rp. 100,000,000,000 = Rp 2,060,000,000.

5. Conclusion

Based on the analysis and discussion that has been done, the following conclusions are obtained: Establishment of an optimal stock portfolio with the Markowitz method is the 20th portfolio which is a combination of TLKM and BMRI shares with the expected return rate of 0.00111 and a standard deviation of 0.01057. Portfolio performance as measured by the Sharpe index is 1.06190 indicating the return obtained from investing in the portfolio above the average risk-free investment return rate of -0.01010. Identification of extreme values in the stock portfolio with the Block-Maxima method based on Generalized Extreme Value obtained by observing each block (block) of 5 to 52 the amount of extreme value data. Parameter estimation of Generalized Extreme Value is obtained by observing each block (m) = 5, shape (ξ) = 0.09490, scale (β) = 0.00680 parameter, and location parameter (μ) = 0.01150. Risk calculation is obtained based on Generalized Extreme Value (GEV) if you invest both of these stock with 95% confidence level is 0.0206 or 2.06% of the current assets.

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